INTERSECTIONS POSTER SYMPOSIUM

Friday, December 5, 2025
Veale Convocation, Recreation, and Athletic Center

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Page 2: Refreshable 8-Pin Braille Display Utilizing a Bistable Compliant Mechanism

Hania Abdelhafez and **Everett Will,** Department of Biomedical Engineering, Case Western Reserve University, Cleveland, OH

Refreshable braille displays allow individuals that are blind or visually impaired to have greater access to digital information. These devices are commercially available, but they are usually cost prohibitive for individuals in need of these types of devices. Currently, braille displays on the market cost between $1,800 and $8,000, and are often vital for visually impaired individuals to maintain employment. This is a significant hurdle for the visually impaired as, according to Cornell University in 2023, they have an earnings disparity of around 20% as compared to people without visual impairments. In this project, we aim to create a mechanism via additive manufacturing to reduce the overall cost of a braille display. While a final display would have multiple 8-pin units, this project focuses on a proof of concept with a single two by four braille unit. One of the other key aspects of this project is the bistable compliant mechanism that allows the pins to be either retracted or extended without needing constant power. In this braille unit, the pin mechanisms will have a permanent magnet at their base and will be moved from retracted or extended with an electromagnet. Due to the bistable mechanism, the electromagnet will not need to be powered the entire time that a pin is extended; it is only powered in the moment of retracting or extending the mechanism. In this project we will be using resin additive manufacturing for the compliant mechanisms, but final devices would need more durable, wear-resistant materials for the pins. With this project we hope to make progress in creating a more cost-effective product for those who are visually impaired, and providing greater digital accessibility and quality of life.

Project Mentor: Dr. Matthew Williams and Dr. Colin Drummond, Department of Biomedical Engineering, School of Engineering

Page 3: Investigating the role of strain-level diversity in vaginal microbiome stability through the use of a simulated vaginal fluid (SVF)

Camila Acosta Matos, Systems Biology; Anya Wojtkowiak, School of Medicine; Dr. Gina Lewin, Department of Pathology, Center for Global Health and Diseases.

The female genital tract is naturally colonized by diverse bacterial communities, with Lactobacillus species supporting vaginal health by producing lactic acid and maintaining a low pH. Disruption of this balance can lead to bacterial vaginosis (BV), a condition affecting nearly 30% of women worldwide and linked to higher risk of sexually transmitted infections and adverse pregnancy outcomes. Despite its prevalence, BV's causes remain poorly understood, and nearly half of treated cases recur within a year. Recent studies have shown that in addition to species-level diversity, an individual's vaginal tract also contains diversity within species, but a major knowledge gap is the role of this intrahost intraspecies diversity within the vaginal microbiome. We hypothesize that increased microbial intraspecies diversity of lactobacilli within a host promotes a more stable and optimal vaginal microbiota. To test this, we are analyzing intraspecies diversity within clinical vaginal swabs collected through THRIVE, a longitudinal cohort study following BV-positive and BV-negative women over six months. Thus far, across two BV-negative (control) participants, we have isolated 885 bacteria and completed whole-genome sequencing on eleven isolates. Preliminary analyses indicate that Lactobacillus crispatus strains from a single host display notable genetic variation in both gene content and sequence, supporting the presence of strain-level diversity. To experimentally test the consequences of this diversity, we identified a simulated vaginal fluid (SVF) which reproduces the in situ vaginal nutritional environment. Current efforts focus on optimizing mucin sterilization for use within SVF. Future work will involve continued bacterial isolation, strain characterization, and culturing experiments in SVF. Together, this work will contribute to a deeper understanding of the microbial ecology of the vaginal environment and may inform future microbiome-based treatments for BV.

Project Mentor: Dr. Gina Lewin, Department of Pathology, Center for Global Health and Diseases

Page 4: The Intersectionality of the Black Maternal Health Crisis: How Social, Familial, and Psychological Factors affect the Pregnancy and Childbirth Outcomes of Black Women

Sarah A. Tabi, Psychology, Case Western Reserve University

Black women in the United States have the highest rate of maternal deaths, with 50.3 deaths per 100,000 live births—higher than any other racial group of women. Oftentimes, these deaths are preventable, highlighting gaps in perinatal healthcare. The crisis dubbed "Birthing while Black" in America illustrates that black women are not protected in the intimate moments of pregnancy and childbirth and should be more protected as they are bringing life into the world. The purpose of this poster is to examine through existing literature how mental health, intergenerational trauma, socioenvironmental factors, family contexts, and systemic inadequacies affect the health of black women during the pregnancy and childbirth period (maternal health). An extensive literature search was conducted using databases such as PsycINFO, Web of Science, Scopus, and PsycArticles in which key words were used to find empirical journal articles. The key words included black women, maternal health, mental health, depression, anxiety, racism, discrimination, healthcare, developmental psychology, and child psychology. Review of existing literature revealed that black women during pregnancy and childbirth are more likely to experience negative outcomes due to mental struggles that are often concealed or ignored, systemically oppressive systems, and environmental/social contexts. These issues highlight the necessity for policy change, advocacy, and culturally relevant care and education for black women.

Project Mentor: Rachel McClaine, Department of Psychological Sciences

Page 5: Wheelchair Lifter Apparatus

Carter Adams and **William Chandler,** Mechanical Engineering, Case Western Reserve University

It is sponsored by Prof. Majid Rashidi in the dept. of Mechanical and Aerospace Engineering and instructed by Prof. Ya-Ting Liao also in the dept. of Mechanical and Aerospace Engineering. The goal of this project is to design and construct a prototype wheelchair lifter apparatus able to transfer a person from the wheelchair seat onto the seat of a typical Sport Utility Vehicle (SUV). Our prototype will be a 1:4 scale replica able to demonstrate the mechanisms required for the device to function properly. This project was born out of multiple instances in which the Emergency Medical Service (EMS) was called to help transfer people from wheelchairs into their car seats after their helpers were unable to do so. EMS calls can be very expensive, and situations like this may pull them away from more serious events. This design will allow a much easier transfer into the car seat and minimize physical exertion for the helper. The apparatus must be able to lift 250lb person to the height of a typical SUV seat and then transfer them into the seat with minimal physical exertion. At the end of our project, we expect to have a fully functioning small-scale replica that can demonstrate the lifting and transfer mechanisms required for the design.

Project Mentor: Majid Rashidi and Ya-Ting Liao, Department of Mechanical and Aerospace Engineering, School of Engineering

Page 6: Life Factors That Protect Wellbeing Among U.S. Adults with Activities of Daily Living Limitations and Low Mental Health

Kwabena Agyemang, Applied Mathematics, Case Western Reserve University

Understanding the contributors to wellbeing among adults with functional and mental health challenges is critical for improving population health equity. This project bridges gaps between physical functioning and mental health research by identifying the life factors that sustain meaning and purpose despite impairment. Insights gained can inform the development of integrated rehabilitation and psychosocial support interventions, guide policy on disability inclusion, and enhance the quality of life for working-age adults facing ADL limitations. By integrating functional health and psychological wellbeing perspectives, this study seeks to clarify the mechanisms through which ADL limitations and mental health challenges jointly shape hedonic and eudaimonic wellbeing. The findings may contribute to the design of integrated rehabilitation and psychosocial interventions aimed at improving both functional independence and subjective wellbeing among adults living with ADL limitations. This study investigates factors that contribute to differences in hedonic (happiness) and eudaimonic (purpose and meaning) wellbeing among individuals living with moderate to severe limitations in activities of daily living (ADL) and low self-rated mental health. Findings from a published peer-reviewed study are reproduced to deepen an understanding of the analytic approaches and data structures used to examine wellbeing disparities in functionally limited populations. Data are drawn from the 2021 National Wellbeing Survey, a nationally representative, web-based survey of U.S. adults aged 18–64. The analytic sample comprises 3,775 respondents. Contingency tables and Chi-square tests are employed to assess associations between ADL status and self-rated mental health. Multivariate logistic regression analyses are then conducted to identify key factors influencing hedonic and eudaimonic well being among individuals reporting both ADL limitations and low mental health.

Project Mentor: Dr. Jenny Brynjarsdottir, Department of Mathematics, Applied Mathematics and Statistics and Dr. Abdus Sattar, Department of Population and Quantitative Health Sciences, School of Medicine

Page 7: Quantifying Ocular Deviations in Parkinson's Disease: A Comparison of DBS On versus Off Using Cover Test Paradigms

Ayaan Ahmad; Ibrahim Quagraine; Aasef Shaikh, MD 3; Fatema Ghasia, MD 2, Case Western Reserve University, Neuroscience; Pediatric Ophthalmology, Cleveland Clinic; Department of Neurology, University Hospitals Cleveland Medical Center

Parkinson's disease (PD) is frequently associated with oculomotor abnormalities such as nystagmus and strabismus, which may be modulated by deep-brain stimulation (DBS). Identifying objective eye movement markers of DBS efficacy could improve both clinical management and understanding of PD-related visual dysfunction. Ocular deviations were assessed using near and far cover tests and alternate cover tests in PD patients with DBS (n = 16 DBS-on, n = 12 DBS-off), PD patients without DBS (n = 8), and healthy controls (n = 10). Eye positions were recorded in right, left, and both-eye viewing modes. Strabismus was calculated as the difference between initial and final eye positions, with the "worse eye" defined as the one showing the greatest absolute deviation. Paired analyses compared DBS on versus DBS off within the same patients, and group comparisons were made relative to controls. Additionally, vergence data was collected from patients, including measures such as gaze and time to fixation, in order to quanitfy any differences in patients. DBS-on patients showed lower average absolute deviations compared to DBS-off. Across all paradigms (n = 13 paired patients), mean deviation was 4.59 units with DBS on versus 6.18 units with DBS off, reflecting an average reduction of –1.58 units (Cohen's dz = –0.40, $t(12) = -1.43$, $p = 0.179$). DBS significantly improved Near Cover deviation, reducing ocular misalignment at near fixation. OFF mean 5.57 → ON mean 3.13; $\Delta = -2.44$. Paired $t(10) = -2.35$, $p = 0.041$; Wilcoxon $p = 0.042$; Cohen's dz = –0.71; N = 11. This benefit did not extend consistently to Far Cover, suggesting that DBS effects may be most pronounced under conditions of higher vergence demand. Vergence dynamics provide mechanistic insight. Although Near vergence gain did not change significantly at the group level, patients with greater increases in vergence gain showed the largest improvements in Near Cover, supporting a functional link between vergence control and binocular alignment. Although results did not reach statistical significance, the consistent directional trend suggests DBS may reduce ocular deviations, particularly in near tasks, aligning PD patients more closely with control values. These findings support the potential use of eye movement metrics as biomarkers of DBS efficacy and underscore the need for larger, longitudinal studies.

Project Mentor: David Friel, Department of Neuroscience, College of Arts and Science and Fatema Ghasia, Pediatric Ophthalmology, Cleveland Clinic

Page 8: Thiol-Functionalized MOFs for Microcystin Detoxification and Cyanobacterial Bloom Mitigation

Lindsey Ahn, Department of Chemistry, Case Western Reserve University; Dr. Matthew Bertin, Department of Chemistry

Cyanobacterial harmful algal blooms (cyanoHABs) are increasing in prevalence and intensity due to anthropogenic causes. Microcystin-Leu-LR m/z 1037 (MC-Leu-LR), a congener of Microcystin-LR (MC-LR), is produced during some cyanoHABs and contributes to water contamination by remaining a potent hepatotoxin. Through Michael addition at the N-methyldehydroalanine site of MC-LR, thiols conjugate to form stable adducts that reduce its hepatotoxicity. Therefore, thiol conjugation of MC-Leu-LR and its functionalization onto Zr-based metal-organic frameworks (MOFs) were evaluated as a detoxification strategy to address cyanoHAB mitigation. This project sought to establish the first principles of MC-Leu-LR conjugation by optimizing aqueous conjugation with biologically relevant nucleophiles (glutathione, GSH and L-cysteine, Cys) and a hydrophobic thiol (11-mercaptoundecanoic acid, MCU), establishing a reproducible liquid chromatography-mass spectrometry (LC-MS) workflow, and assessing thiol competition. While initial experiments conducted in methanol with a 2:1 molar ratio of MC-Leu-LR to each thiol produced weak adduct signals, transitioning to a 5% (w/v) NaHCO3 solution significantly improved thiol nucleophilicity and yielded reproducible conjugate peaks. In competition experiments, GSH dominated adduct formation, with smaller but detectable Cys and MCU conjugates, and a decreased MC-Leu-LR parent signal. Timed MCU reactions revealed a double peak for MC-Leu-LR-MCU, attributed to diastereomeric thiol adducts. Signal peaks grew from 2-8 h but declined at 12 h, highlighting the importance of reaction reversibility between adduct formation and reverse degradation when optimizing reaction kinetics. Furthermore, these results established aqueous bicarbonate conditions to drive thiol conjugation, identified GSH as the most competitive nucleophile, and recognized reaction reversibility as a key parameter for optimizing future experiments. Subsequent work will also explore conjugation with polymers for improved dispersion and the potential for simultaneous release of antibiotics like tetracycline to target the mitigation of high density bloom areas. Overall, thiol-functionalization shows promise towards detoxifying MC-LR and mitigating the impact of cyanoHABs.

Project Mentor: Dr. Matthew Bertin, Department of Chemistry

Page 9: Investigating the Role of ALDH Subcellular Localization in Breast Cancer Drug Resistance and Stemness

Woojin Ahn, Biomedical Engineering, Case Western Reserve University

Breast cancer relapse is often driven by therapy tolerant subpopulations (Cancer Stem Cells (CSCs)) with high aldehyde dehydrogenase (ALDH) activity, yet how isoform identity and subcellular localization shape drug tolerance remains unclear. We test the hypothesis that cells with predominantly mitochondrial ALDH2 exhibit greater chemoresistance than cells with cytosolic ALDH1A1/ALDH3A1 localization or low overall ALDH. Using MCF-7 (ER^+) and MDA-MB-468 (TNBC) models, we will map isoform localization by immunofluorescence/confocal microscopy (Mitotracker CMXRos; DAPI) and identifying co-localization. Protein expression will be validated by the Western blot for ALDH1A1/ALDH2/ALDH3A1. Functional enzyme activity will be measured with a colorimetric ALDH Activity Assay (Abcam ab155893). To connect localization with phenotype, we will run a broad chemotherapy panel spanning distinct mechanisms of action and compute IC50 and survival endpoints (short-term viability and clonogenic assays). Where feasible, flow-cytometry-defined subpopulations (eg. high vs low intracellular ALDH2 signal in combination with mitochondrial dyes) will be sorted directly into lysis buffers so that downstream RNA and DNA can be quantified from the exact populations tested. We expect to identify an ALDH2-mitochondria high fraction with higher IC50s and survival across multiple drugs, accompanied by increased mitochondrial protein markers on Western blot and elevated mtDNA/mitochondrial transcripts in post sort lysates. These results will clarify whether mitochondrial ALDH2 localization is a tractable determinant of chemoresistance and provide a foundation for future studies of mitochondrial targeted delivery or pharmacologic modulation of the ALDH axis to curb post-therapy regrowth.

Project Mentor: Dr. Mei Zhang, Department of Biomedical Engineering, CWRU; Dr. Monali Nandy Mazumdar, Department of Biomedical Engineering, CWRU

Page 10: Linking Donor Plasma and Lung Biomarkers (cell free hemoglobin) to Organ Yield and post Graft Performance

Arvan Ahuja, Biology, College of Arts and Sciences, Case Western Reserve University

This study investigates the relationship between donor biomarkers and subsequent organ yield and post graft function in major transplanted organs, including the liver, heart, kidney, and lungs. The purpose of this research is to identify biochemical markers that can predict early graft viability and performance, ultimately improving donor selection and transplant outcomes. Current limitations in predicting organ suitability lead to variable transplant success rates and underutilization of potentially viable organs. Understanding the molecular indicators of donor tissue injury and immune activation could significantly enhance clinical decision making and organ allocation strategies. To explore these relationships, this experimental study will quantify levels of cell-free hemoglobin, a product of red blood cell breakdown in plasma and bronchoalveolar lavage samples collected from human organ donors. These measurements will be integrated with previously obtained biomarker profiles and correlated with organ utilization data and early post transplant performance metrics over a 30 day period via UNOS. Through this approach, the project aims to elucidate the biological mechanisms linking donor injury responses to graft outcomes. Preliminary findings are expected to demonstrate associations between elevated cell free hemoglobin and reduced organ viability or function, suggesting its potential as a predictive biomarker. Ultimately, this work seeks to deepen our understanding of donor derived tissue injury and immune activity, guiding the development of biomarker based tools to improve transplant success and organ preservation practices.

Project Mentor: Ellis Gardner, Department of Biology, College of Arts and Sciences; James Reynolds, School of Medicine

Page 11: A Simple and Low-Cost SpikerBox-Based Platform for Electroantennogram Recordings in Moths

Jade Aich, Neuroscience, Case Western Reserve University

Electroantennography (EAG) is a bioassay used to measure insect antennal responses to volatile compounds, providing insight into complex olfactory detection mechanisms. Traditional EAG setups are often expensive and technically demanding, limiting their use to well-funded laboratories. This study demonstrates that the SpikerBox, an affordable electrophysiological recording device from Backyard Brains, can serve as a suitable alternative for conducting insect EAG recordings, particularly in educational or K–12 environments. This experiment evaluates the SpikerBox's ability to detect antennal responses of male Manduca sexta moths to various odorants at different concentrations. For precise stimulus delivery, an automatic odor puffer was integrated through the SpikerBox expansion connection. The puffer circuit included a 5 V latching solenoid, an L298N H-bridge motor driver, an Arduino microcontroller, and an external power supply. Proper grounding of the entire SpikerBox–solenoid assembly effectively eliminated electrical noise that often complicates such recordings. EAG responses were recorded for linalool, hexanol, geraniol, and limonene, with air and mineral oil controls. Odor presentation and response timing were synchronized using SpikeRecorder software, and the resulting .wav files were analyzed in MATLAB. Signal processing, including waveform smoothing and filtering, revealed clear antennal responses above mechanical artifacts and background electrical interference. These results confirm that the grounding and L298N shielding strategies effectively reduced noise and isolated the true EAG signal. By providing detailed circuit explanations, this study ensures reproducibility and ease of troubleshooting. Overall, the low-cost SpikerBox EAG platform expands access to olfactory electrophysiology for secondary institutions and resource-limited research settings, enhancing both education and outreach in sensory neuroscience.

Project Mentor: Angela Dixon, Department of Biomedical Engineering, College of Arts and Sciences

Page 12: Contradiction and Conviction: Motivated Reasoning Across Religious and Political Belief Systems

Antonio Alameda, Psychology, Case Western Reserve University

Belief systems (whether religious or political) help people make sense of the world, yet they also shape how individuals handle contradiction. This project will examine how people interpret and integrate information that conflicts with their deeply held convictions, focusing on the cognitive and emotional processes that sustain belief in the face of opposing evidence. The central question asks: Are there meaningful differences between religious and political domains in how individuals rationalize or reject contradictory information? For example, do people who rely on religious belief systems handle contradiction differently than those who rely on political ones, and what motivates these differences? Methodologically, this project is a literature-based analysis that synthesizes empirical research in cognitive and social psychology. It will explore and analyze a wide variety of psychological frameworks developed to understand both religious and political coping, including motivated reasoning, cognitive dissonance, and identity-protective cognition. The expected conclusion is that both political and religious reasoning rely on overlapping identity-based cognitive processes, though religious belief may also engage unique moral and existential dimensions. Understanding these parallels can deepen insight into why people cling to beliefs despite contradiction and how identity, evidence, and meaning interact in shaping conviction and worldview.

Project Mentor: Rachel McClaine M.A, Department of Psychological Sciences, Case Western Reserve University

Page 13: Induced mitochondrial function drives resistance to chemotherapy in melanoma

Semmer Ali, Neuroscience, Case Western Reserve University

Malignant melanoma is one of the most common types of cancer in the United States. Despite improvements in therapeutics, advanced disease is often lethal if the cancer develops resistance to immune and targeted therapies. Metabolic reprogramming is an important hallmark of cancer and is drives resistance to certain therapies. Previous efforts to modulate cancer metabolism have focused on targeting glycolysis, whereas targeting mitochondrial oxidative phosphorylation (OXPHOS) and the TCA cycle is relatively less developed for melanoma. Herein, we show that melanoma cells rely heavily on mitochondrial function, particularly under chemotherapy-associated stress, as evidenced by increased OXPHOS activity. Pharmacologic inhibition of the mitochondrial electron transport chain (ETC) with complex I inhibitors (Phenformin and IACS-010759) synergizes with conventional anti-melanoma chemotherapy in pre-clinical in vitro models of melanoma, with added benefit in animal models. Our findings suggest that targeting the ETC offers a compelling strategy to enhance chemotherapy activity in patients with advanced and treatment-refractory melanoma.

Project Mentor: Jordan Winter, Department of Surgery

Page 14: Human Robot Collaboration for Electric Vehicle Front Trunk Assembly

Andrew Ali, Mechanical and Aerospace Engineering; **Brian Keys**, Mechanical and Aerospace Engineering; Ethan Regal, Department of Mechanical and Aerospace Engineering, CWRU

Human-Robot Collaboration (HRC) integrates human cognition with robotic endurance to enable more efficient, flexible manufacturing. In partnership with General Motors (GM), this project focuses on developing AI/ML methods to introduce HRC to GM's EV assembly line. Specifically, this project focuses on training and deploying data-driven methods to discern human intent and control a collaborative robot to enable HRC during assembly operations of a GM EV front-trunk (frunk). To achieve this, a testbed mimicking the GM frunk assembly workstation is constructed with depth sensitive cameras for data collection. Subsequently, video data of worker assembly demonstrations are used to train/fine-tune various AI/ML methods to predict human action classification and forecasting. Time permitting, the use of an e.DO 6-axis robot arm will also be employed to carry out collaborative tasks in response to human intent prediction. The methods explored in this project aim to develop an HRC framework for EV frunk assembly, thereby contributing to GM’s overarching goal of mitigating physical fatigue and improving assembly efficiency within the EV manufacturing environment.

Project Mentor: Robert Gao, Ethan Regal and Ya-Ting Liao, Department of Mechanical and Aerospace Engineering

Page 15: Continuously Variable Transmission Primary Clutch for Baja SAE Vehicle

Ammar Ali Asghar, Mechanical Engineering, CWRU Motorsports

Baja SAE is a collegiate racing series that challenges teams to build an off-road race car that can traverse a wide array of off-road terrains with unknown surface conditions. The series requires a standard, unmodified engine with 10 horsepower and a standard sized fuel tank; thus with little power and limited fuel, the goal of a Baja SAE drivetrain is to be lightweight and efficient to maximize the given performance of the engine under all conditions. A continuously variable transmission (CVT) is used in the CWRU Motorsports Baja vehicle to address the constraints of the competition. This type of transmission can be specifically designed to force the engine to operate at the point of peak power production to minimize time spent outside the power band. Various off-the-shelf solutions exist but do not provide the necessary performance reliability or desired tunability to operate in both short maneuverability courses and 4 hour endurance races. The goal of this project is to design a CVT to meet the performance requirements of the vehicle and competition while allowing for maximum freedom of tunability in the flyweight geometry, helix geometry, and spring adjustability. The scope of this project is limited to the design and analysis of the custom Primary clutch of the CVT, which controls the upshift of the system. A state space of valid CVT and drivetrain geometries was developed using vehicle level requirements to help pick overall CVT geometry and select a belt. A numerical approximation of the transmission was used to determine flyweight geometry and initial tuning options for springs in the system. Assembly level finite element analysis models were used in Ansys Mechanical to validate the physical components in the system for a service life of 14 hours.

Project Mentor: Dr. Richard Bachmann, Department of Mechanical and Aerospace Engineering

Page 16: A Three-Cohort Assessment of the Nord Family ESP Summer Bridge Program: A Focus on Success Skills and Sense of Belonging

Manal Alkabani, Department of Psychological Sciences; Dave Ki, Department of Psychological Sciences; Dr. Rita Obeid, Department of Psychological Sciences; Arthur Evenchik, Office of the Dean of the College of Arts and Sciences; and Dr. Stephen E. Haynesworth, Department of Biology

Summer bridge programs nationwide have proven effective in helping college students from underrepresented and minoritized groups transition successfully into higher education. However, the majority of the literature on these programs relies primarily on quantitative analyses and often focuses on GPA and academic performance. Recent studies recommend using mixed methods to evaluate summer bridge programs and including measures of psychosocial factors. At Case Western Reserve University (CWRU), the Nord Family Emerging Scholars Program (Nord Family ESP) offers academic guidance and support to students from under-resourced high schools and has held an annual summer bridge program since 2011. While the program initially served only commuting students, a residential component was introduced in 2023. This study represents the continuation of a three-year research effort evaluating the Nord Family ESP summer bridge program, with new data from the 2025 cohort added to analyses. The research assessed the program's impact on students' sense of belonging and success skills, including collaborative learning and time management. Using a mixed-methods approach that combined quantitative surveys with qualitative interviews, the study found significant improvements from pre-test to post-test program measures in all areas. Interview data further demonstrated enhanced academic strategies, a stronger connection to CWRU, and greater awareness of college life. Overall, the findings reinforce prior research and ongoing program evaluations showing that summer bridge programs effectively promote student success and belonging in higher education.

Project Mentor: Dr. Rita Obeid, Department of Psychological Sciences, CWRU; Dr. Stephen Haynesworth, Department of Biology, CWRU

Page 17: Metastable Dark Degradation and Light Recovery in UV Exposed Commercial TOPCon Cells

Affan Altaf, Engineering Physics, Case Western Reserve University; D. Sempertegui, S. Cheng, L. S. Bruckman, I. T. Martin, A. Lininger, Case Western Reserve University; C. Chen, K. Davis, University of Central Florida, Department of Materials Science and Engineering; N. Moser-Mancewicz, M. Bertoni, Arizona State University, School of Electrical, Computer and Energy Engineering

Tunnel-oxide passivated contact (TOPCon) solar cells deliver high initial efficiency and performance and are gaining commercial popularity. However, maintaining long-term performance is critical for increasing lifetime energy yield and minimizing the levelized cost of electricity (LCOE). The widespread use of TOPCon necessitates understanding efficiency changes, especially from UV-induced degradation (UVID), which is noted as a primary vehicle of degradation in past research. While UV-Induced Degradation (UVID) is associated with performance loss in TOPCon cells, it can also induce metastability whereby UVID performance loss and related effects can be partially recovered through light soaking, including both UV and full-spectrum exposures. The opposite of light-induced recovery is dark degradation, where the cell reverts to its degraded state after prolonged storage in darkness, generally caused by a loss in V_{OC} (open-circuit voltage), leading to lower power conversion efficiency. This research addresses the critical need to understand the metastable behaviors following UVID, specifically dark degradation and the mechanisms of light-induced recovery in performance. In this study, unencapsulated commercial TOPCon cells are subjected to high intensity UV exposure, and conversion efficiency is examined around the metastable light-recovery state. Light recovery and dark degradation are evaluated using localized external quantum efficiency (EQE) measurements. A significant dose and wavelength dependence of light recovery is observed, with maximum J_{SC} recovery at 340nm exposure wavelength. A UV dose of 20–30 mJ/cm² is required to induce full recovery, and a full return to the dark state occurs in 55 hours. However, substantial inter-vendor differences in both initial UVID degradation and metastable behavior underscore the difficulty of defining a single characteristic response for the TOPCon architecture. These findings establish that light-induced metastability operates on the same timescale as the natural day–night cycle and must be considered when assessing long-term degradation.

Project Mentor: Andrew Lininger, Department of Physics, Case Western Reserve University; Ina T. Martin, Department of Material Science and Engineering, Case Western Reserve University

Page 18: Halteres Integrate and Direct Leg Movements for Postural Stability in Tipulidae

Madeline Ang, Neuroscience; Kristianna Lea, Department of Biology; Jessica Fox, Department of Biology

Proprioception is essential for all mobile animals to maintain stable posture and navigate their environment. True flies (Insecta: Diptera) possess mechanosensory organs called halteres, which function as biological gyroscopes to provide rapid sensory feedback. Halteres are crucial to achieve steady and maneuverable flight, but also contribute to walking, gravity sensing, and righting reflexes. To explore the haltere's role in non-flight stabilization, we used high-speed videography to quantify the haltere kinematics of crane flies, Tipulidae, when subjected to various perturbations. We found that leg proprioception drives haltere activity, triggering motions scaled with limb displacement and velocity, which subsequently informs leg movements for postural stability. In response to a mechanical stimulus, flies executed stilting and jumping behaviors, where changes in body position and leg angles prompted haltere oscillations. To parse out what elicits these oscillations, we displaced the animal's legs at different directions and speeds, observing haltere motor outputs of varying amplitudes and frequencies correlated with the magnitude of leg movements. When freely moving flies experienced rotational, vertical, and lateral perturbations, we found the presence of halteres necessary for stabilization. Intact flies rapidly recovered from a sudden shift in their body center of mass, while haltere-ablated flies demonstrated postural imbalances and took significantly longer to recover from the perturbation. Outside of the haltere's canonical role in flight, crane flies utilize their halteres for stilting and jumping maneuvers, to communicate with the legs for postural control, and to detect, brace against, and recover from perturbations. These findings introduce an example of multi-sensory integration where sensors directly interact with one another to form a feedback loop.

Faculty Mentor: Dr. Jessica Fox, Department of Biology

Page 19: Novel regulator of IFNγ signaling in macrophages

Nikhil Angani, Hang-Pong Ng, Yashwant Pantra, Kanishk Bhat, Ganapati H. Mahabaleshwar, Department of Pathology, Case Western Reserve University School of Medicine, Cleveland, Ohio, USA; E Ricky Chan, Cleveland Institute for Computational Biology, Case Western Reserve University School of Medicine, Cleveland, Ohio, USA.

Excessive IFNγ levels are associated with chronic inflammatory and autoimmune diseases. However, the precise mechanisms governing IFNγ-induced signaling pathways and transcriptional regulation of inflammatory gene expression remain incompletely defined. In our previous studies, we identified Krüppel-like factor 6 (KLF6) as a novel regulator of macrophage activation. Here, we investigated the role of KLF6 in regulating IFNγ-induced signaling pathways, inflammatory gene expression, and macrophage function. Here, our *in vivo* studies show that myeloid-specific KLF6 deficiency significantly attenuated zymosan-induced macrophage and neutrophil accumulation in lung tissue. Our unbiased transcriptomic and gene set enrichment analyses (GSEA) revealed that KLF6 deficiency curtailed nearly half of IFNγ-inducible gene targets and broadly impaired IFNγ-induced cytokine, chemokine, and inflammatory signaling pathways in macrophages. Further, our *ex vivo* and *in vivo* studies show that KLF6 deficiency significantly curtailed IFNg-induced IFNg-response, TNFa-response, IFNa-response, inflammatory response, and chemokine signaling target gene expression in macrophages. More importantly, KLF6 deficiency markedly reduced IFNg-induced STAT1 phosphorylation (Try701 and Ser727) in macrophages. Collectively, these findings identify KLF6 as a critical regulator of IFNγ-induced signaling, pro-inflammatory gene expression, and pathogenic macrophage activation *in vivo*.

Project Mentor: Ganapati H. Mahabaleshwar, Department of Pathology, Case Western Reserve University School of Medicine

Page 20: Modeling the Negative and Positive Aspects of Caregiving for Dementia Caregivers in the United States

Matthew Angeles, Department of Biology, Case Western Reserve University

To develop a System Dynamics (SD) model that (1) projects the U.S. population living with dementia, (2) estimates the volume and composition of caregiving burden, and (3) captures both negative and positive aspects of caregiving and their feedback effects on care capacity and outcomes. Dementia prevalence in the United States continues to rise, creating a growing dependence on both unpaid and paid caregivers. This project constructs an SD model with stocks representing the dementia population by severity and care setting, and caregiver supply (family/friend vs. paid aides). Flows include incidence, progression, mortality, caregiver entry/exit, and substitution between informal and formal care. The dual emotion of caregiving can be seen by two feedback loops: strain and uplift. The strain loop reflects time burden, depressive symptoms, and financial stress, while the uplift loop incorporates meaning, support, and skill development. Both of these loops influence caregiver retention and hours of care provided, affecting overall caregiving and unmet needs. The model draws on national datasets from the CDC, NIA, NADRC, and the U.S. Census. Policy experiments will simulate the effects of interventions such as training programs, assistive technology, and paid leave. Over the next 10 to 25 years, improving positive feedback systems can improve caregiver well-being, retention, and care quality. Still, increasing dementia prevalence, if left unchecked, will worsen caregiver stress, and overall caregiving will decrease.

Project Mentor: Dr. John Pastor Ansah, Center for Global Health and Diseases, School of Medicine; Fritz Petersen, Department of Biology

Page 21: Mechanical and Functional Reliability of High-density Connectors and Lead Bodies for Neuroprosthetic Systems

Winifred Asante, Materials Science and Engineering; **Eesha Reddy**, Biomedical Engineering; Jerry Yang, Biomedical Engineering and Electrical Engineering

Sensorized prosthetics restore the sense of touch in amputees by interfacing directly with peripheral nerves. This project focuses on the connector that links implanted electronics generating electrical pulses to electrodes interfacing with the nerves. The connector and the implanted leads must demonstrate stable mechanical and electrical performance to ensure patient safety and device efficiency. Electrochemical Impedance Spectroscopy (EIS) was used to evaluate the electrical integrity of high-density connectors made of 35N LT, a Co–Ni–Cr–Mo alloy composite wire with 28% silver core drawn-filled tube insulated with PFA, encapsulated in silicone, and housed within a titanium package. EIS is a non-destructive technique that measures system impedance by applying small AC voltages across a frequency range. EIS was performed using a potentiostat on 6- and 8-channel connectors following immersion in a buffered saline solution at 37°C to simulate physiological conditions and at 60°C for accelerated aging. 10mV was applied over a 1Hz-10kHz range to measure impedance through channels and between neighboring channels at various time intervals for 16 days. Impedance magnitude, phase, and 1kHz impedance were analyzed. Changes in impedance and phase were interpreted as indicators of corrosion, microcracks, or insulation degradation, providing insight into connector biostability. Fatigue testing was performed on 32-channel leads using a flex ductility tester to assess mechanical reliability. A constant-amplitude strain-controlled test was used to evaluate leads over 2.5mm bend radius for 20 cycles to simulate handling and 1cm bend radius for 1 million cycles to simulate in vivo behavior. Optical microscopy was used to image center sections of leads after fatigue, and lead functionality was further monitored by measuring the electrical resistance of the individual channels using a digital multimeter. The data from this study will be used to support an Investigational Device Exemption (IDE) application to further evaluate device/lead safety to the FDA.

Project Mentor: Douglas B. Shire, Advanced Platform Technology Center and Janet L. Gbur, Advanced Platform Technology Center / CWRU Materials Science and Engineering Department

Page 22: Investigating the relationship between olfactory dysfunction and depression in Drosophila melanogaster using neuropeptide inhibition

Keerthana Ashok, Neuroscience; Dr. Andrew Dacks, Department of Biology

Major depressive disorder (MDD) is a serious mental health disorder that affects a significant portion of the population. Recent studies have shown that loss of olfaction contributes significantly to depressive affect. Studies on the connection between olfactory dysfunction and depression have also found that inhibiting olfactory function in rodents induces depressive-like symptoms. Although this relationship is well studied on a phenomenological level, the cellular mechanisms behind it remain unclear. Previous experiments focused on silencing different populations of olfactory sensory neurons (OSNs) in Drosophila melanogaster. We then performed CAFE (capillary feeder) assays and found that flies with silenced OSNs exhibited a reduced feeding drive. Given that neuropeptides are known modulators for appetitive behaviors and regulate feeding based on internal states, we now aim to investigate the role of neuropeptide signaling on feeding drive. Tachykinin is a neuropeptide released by local interneurons in the antennal lobe that modulates olfactory receptor neuron (ORN) activity via the tachykinin receptor (TKr86c). Using the UAS-GAL4 system, two knockdown experiments will be conducted: 1) Orco-Gal4 > TKr86c-RNAi and 2) Patchy-LN-Gal4 > Tachykinin-RNAi. Knockdown of TKr86c in ORNs will impair neuromodulatory control of odor sensitivity while knockdown of tachykinin in local interneurons will reduce inhibitory control of odor responses. By targeting tachykinin and its receptor, we can determine whether neuropeptide signaling OSNs affects feeding drive independently of olfactory stimulation. To determine if neuropeptide signaling to OSNs impacts food drive regardless of odor stimulation, we will perform CAFE assays using varying concentrations of sucrose (5%, 10%, 15%). Additionally, we will perform assays with apple cider vinegar to evaluate how our manipulations to tachykinin and TKr86c impact odor-driven feeding behavior. We expect that knockdown of TKr86c will primarily increase odor-driven feeding and knockdown of tachykinin will increase overall feeding drive for both sucrose and apple cider vinegar.

Project Mentor: Dr. Andrew Dacks, Department of Biology

Page 23: Imprinting Tool for Spent Gunpowder Cartridges from a Hypervelocity Gas Gun

Andrew Ausse, Department of Mechanical and Aerospace Engineering, CWRU

The hypervelocity gas gun is used to accelerate projectiles to hypervelocity speeds and study the projectiles motion. While gunpowder is often used as the primary source for accelerating projectiles to high speeds there is a limit due to the size of the gunpowder particles reaching a terminal velocity. Therefore, the hypervelocity gas gun uses hydrogen or helium gas as the medium to launch the projectile through compression of the gas. A gunpowder cartridge is used to accelerate the ram compressing the gas. This project is concerned with designing an imprinting tool for the spent gunpowder cartridge to imprint the lab logo, FPI, and the university logo, CWRU, onto the casing. The design is expected to imprint the casing in a fast manner, be handheld, and preserve the casing's shape. The goal of this project is to provide lab vistos with a souvenir from the lab to provide them with a memory and way to network the campus and lab to others.

Project Mentor: Professor Bryan Schmidt, Department of Mechanical and Aerospace Engineering, CWRU

Page 24: Urine Vaporization Cartridge for Individuals with Indwelling Catheters

Seth Lieberum, Department of Biomedical Engineering; **Alyssa Ayala**, Department of Biomedical Engineering; **Catherine Feng**, Department of Biomedical Engineering; **Rachel Chang**, Department of Biomedical Engineering; and **Zain Syed**, Department of Biomedical Engineering; and Dr. Matthew Williams, Department of Biomedical Engineering, CWRU

Urinary drainage systems are essential for patients with limited bladder control, yet traditional leg bags remain bulky, visible, and require frequent emptying, issues that compromise hygiene, comfort, and dignity. To address these limitations, the project focuses on developing a compact, self-managing urinary device that minimizes maintenance and improves quality of life.The Absorption–Filtration–Vaporization (A.F.V.) Capsule is a next-generation urinary drainage system designed to extend the time interval between emptying while enhancing user safety and discretion. The device combines three key processes: absorption of solutes through a specialized membrane, filtration for fluid separation, and vaporization using controlled heating to evaporate water and reduce stored waste volume. This integrated approach reduces odor, leakage risk, and cleaning requirements while maintaining compatibility with standard catheter systems.A weighted decision matrix guided the selection of the A.F.V. Capsule as the optimal design among multiple concepts, prioritizing effectiveness (0.6), maintenance safety (0.25), and user-friendliness (0.15). Although the inclusion of heating and battery modules introduces potential safety and power challenges, these can be mitigated through thermal insulation, automatic shutoff mechanisms, and efficient power management.During Fall 2025, the team will develop a proof-of-concept prototype to validate the device's filtration, evaporation, and sensor-control subsystems using synthetic urine. The focus will include capsule fabrication, integration of heating and filtration modules, and microcontroller-based automation for safe operation. By the end of the semester, a functioning prototype capable of filtering and evaporating urine without leaks or external heat hazards is expected. These results will lay the groundwork for Phase 2 (Spring 2026), where the fully wearable, battery-powered A.F.V. Capsule will be refined for continuous, user-safe operation.

Project Mentors: Dr. Jonathan Shoag, Department of Urology, University Hospitals Cleveland Medical Center; Dr. Matthew Williams, Department of Biomedical Engineering, CWRU

Page 25: Loss of TET2 increases MHC class I expression in AML and Breast Cancer

Rosy Bae, Department of Biology, Case Western Reserve University; Xiaorong Gu, Department of Cardiovascular and Metabolic Sciences, Cleveland Clinic, Lerner Research Institute; Yahan Zhang, Dongxu Jiang, Daniel Vail and Babal K Jha, Center for Immunotherapy & Precision Immuno-Oncology, Cleveland Clinic, Lerner Research Institute; Jaroslaw P Maciejewski, Department of Translational Hematology and Oncology Research, Taussig Cancer Institute

Among the greatest challenges to curing cancer in general and acute myeloid leukemia (AML) in particular, is the persistence of cancer initiation progenitors, responsible for relapse and refractory disease. Immunotherapy is promising but remains limited by cancer's ability to disguise itself as "self." Enhancement of MHC Class I (HLA-A/-B/-C) on tumor cells can enhance immune detection and removal. *TET2*, a DNA dioxygenase that is frequently mutated in AML and myelodysplastic syndromes, regulates DNA demethylation and transcriptional control, and its loss has been implicated in immune evasion. We investigated whether genetic deletion or pharmacologic inhibition of *TET2* increases MHC Class I expression and thereby enhances tumor immunogenicity. Using CRISPR-Cas9–generated *TET2* knockout models (THP1, K562) and naturally *TET2*-deficient lines such as OCI-AML-5 ($TET2^{+/-}$) and SIGM5 ($TET2^{-/-}$), we observed dramatically enhanced MHC Class I surface expression compared to wild-type controls. Interestingly, this loss of TET2 in increased expression on class I HLA can be mimicked by pharmacological inhibition of TET2 in wild-type cells with a *TET*-specific inhibitor (TETi). TETi has no effects on HLA expression in knockout models, confirming target specificity. Furthermore, interferon-γ–mediated HLA upregulation was blunted in TET2-deficient cells, suggesting *TET2* controls interferon-responsive transcription of antigen-presentation genes. To ask whether this regulatory relationship extends beyond hematologic malignancies, we extended our investigation to breast cancer models utilizing MCF-7 (luminal A), MDA-MB-231 (triple-negative), and MCF-10A (non-tumorigenic) cell lines. *TET2* knockdown and pharmacologic inhibition increased MHC Class I expression in malignant but not non-malignant cells, uncovering a cancer-specific epigenetic vulnerability. These findings show that *TET2* deficiency or inhibition increases tumor immunogenicity through increased antigen presentation across cancer types. Pharmacological inhibition of *TET2* is thus a reversible and clinically feasible strategy to sensitize tumors to immune recognition and immunotherapy through epigenetic reprogramming.

Capstone Instructor: Kathleen Hershberger, Ph.D., Department of Biology, CWRU; Babal Jha, Department of Molecular Medicine

Page 26: Analysis of Third Space Impact on Loneliness

Sean Bae, Nursing; Dr. Scott Emory Moore, PhD, MSN, RN, AGPCNP-BC, FAAN, Frances Payne Bolton School of Nursing

Loneliness, the subjective feelings of social isolation, is associated with poorer physical and mental health, increased risk for cardiovascular disease, cognitive decline, depression, anxiety, premature mortality, including suicide. “Third places”, locations that are not home or work where individuals spend time, have been associated with reductions in stress, depression, and anxiety, which may be a result of third places’ facilitating increased social interactions. This study examined variation in loneliness across intersectional social strata and the potential amelioration of loneliness by third-place access. Using the intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy, we examined variance in risk for severe loneliness across social strata, then assessed change in variance after adding recreation as a fixed effect, and assessed disparities in severe loneliness when considering recreation access and social strata. We specified 80 intersectional strata as unique combinations of race, gender and sexuality, sex, and age. The sample of 161,876 All of Us Research Program participants is predominantly White (80.8%), cisgender-heterosexual (88.5%), female (65.4%), and 65+ (32.3%). Severe loneliness was defined as scoring 50% or more on the 8-item UCLA loneliness scale. Access to recreational facilities was self-reported. The 18-30 years old, Black or African American, sexual gender minority, and female social strata had the highest predicted proportion with severe loneliness at 52.5% (95% CI 59.50-45.35); and the 65+, white, Cisgender heterosexual, and male strata had the lowest predicted proportion (13.6% [95% CI 14.82-12.32]). Including recreation availability modestly improved model accuracy (reducing between-stratum variance by 2.08%). Adding recreation accounted for minimal between-stratum variance, while stratum and structural factors explained a greater degree of variance in severe loneliness. Although at an individual level, severe loneliness may be affected differently by recreation, at the stratum level, the effects are limited.

Project mentor: Dr. Scott Emory Moore PhD, MSN, RN, AGPCNP-BC, FAAN, Department of Nursing

Page 27: Leucine-Rich α2 Glycoprotein 1 plays a proinflammatory role in Ulcerative colitis by promoting NET formation

Jennifer Baek, Department of Electrical, Computer and Systems Engineering, Case School of Engineering; Elizabeth Smith, Alabama College of Osteopathic Medicine; Kimberly Curry[2], Moeez Rathore Ph.D. and Rui Wang Ph.D.,Case Comprehensive Cancer Center, Case Western Reserve University School of Medicine

Inflammatory bowel disease (IBD) is a group of chronic inflammatory diseases in the gastrointestinal tract with unknown etiology, including Ulcerative colitis (UC). UC affects ~1.3 million people in the US alone and puts patients at approximately 2.6 times higher risk of developing colitis-associated cancer (CAC). For physicians and patients, treating UC-associated chronic inflammation and reducing the risk of CAC remain major challenges. It has been shown that neutrophils are overactive in UC and promote GI mucosal inflammation by releasing inflammatory cytokines and mediators, ROS, and proteases that damage the epithelial barrier. Neutrophil extracellular traps (NETs), released in response to inflammation, have been shown to be elevated in the inflamed gut mucosa, serum, and stool of patients with IBD. Several studies have shown that elevated Leucine-Rich α2 Glycoprotein 1 (LRG1) expression in the serum of patients with UC correlates with disease severity. Apart from UC, it has also been shown that LRG1 promotes NET formation and slow wound healing in diabetic patients. However, the mechanism by which LRG1 promotes colonic inflammation in IBD is not fully understood. We hypothesize that LRG1 plays a proinflammatory role in UC by promoting NET formation. To test this hypothesis, Dextran Sodium Sulfate (DSS) was given to wild-type (WT) and $LRG1^{-/-}$ mice to induce UC. Disease severity was evaluated by measuring body weight loss, rectal bleeding, diarrhea, and overall disease activity index. Colon tissue was also collected for immunohistochemical staining. Additionally, neutrophils were isolated from healthy WT and $LRG1^{-/-}$ mice and stimulated *ex vivo* with PMA before performing immunofluorescence staining for neutrophil and NET markers. Our preliminary data demonstrate that, compared to WT siblings, male $LRG1^{-/-}$ mice form fewer NETs when healthy and have less UC symptoms induced by DSS. Future directions include elucidating the mechanism by which LRG1 aggravates UC symptoms and promotes NET formation.

Project Mentor: Rui Wang, Case Comprehensive Cancer Center, Case Western Reserve University School of Medicine

Page 28: Modernization and Malnutrition: Economic Progress and the Obesity Epidemic in Developing Nations

Ore Bajela, Department of Data Science and Analytics; **Luka Boskovic**, Department of Computer Science; **Junhao Zhen**, Department of Accounting

In recent decades, developing countries have experienced rapid economic growth, urbanization, and globalization, which are transformations that have profoundly reshaped population health. Once dominated by undernutrition and infectious diseases, these nations are now facing a new public health challenge: the rise of obesity, particularly among children. This project examines how modernization and economic development have contributed to shifting patterns of obesity across the developing world, while many of these same countries continue to struggle with malnutrition and food insecurity- a phenomenon known as the double burden of malnutrition. Using data from the NCD Risk Factor Collaboration (NCD-RisC) and the World Bank, we conduct a cross-country analysis covering the years 2000-2022 to investigate the relationships between obesity prevalence, GDP per capita, and urbanization rates. Our units of observation are countries over time, allowing us to identify both regional and temporal trends. Special attention is given to childhood obesity as a key indicator of how economic and lifestyle transitions are influencing younger populations. By integrating economic and health data, our research aims to reveal how rising incomes, urban living, and changing diets have altered the nutritional landscape of developing nations. We highlight the paradox of progress, where growth and modernization, while improving living standards, simultaneously fuel new health risks. The findings will provide insight into how policymakers can address the intertwined challenges of obesity and malnutrition in the context of ongoing development.

Project Mentor: David Clingingsmith, Department of Economics, Case Western Reserve University

Page 29: “Do Goals Pay Off? Examining How Performance Metrics Relate to Wages in the English Premier League”

Kofi Osei-Tutu, Accounting and Business Information Technology; **Akshay Balaji**, Economics; **Humberto Castaneda**, Education and History

This project explores the relationship between player performance and wages in the English Premier League (EPL). The research aims to determine whether there is a measurable correlation between players’ on-field statistics,such as goals, assists, saves, and appearances, and their reported salaries or weekly wages. The study also investigates how these relationships vary by player position (goalkeeper, defender, midfielder, forward) and how compensation patterns have evolved from the early 2000s to the 2024–2025 season. This topic is significant because professional soccer represents one of the most financially influential global industries; yet, the link between player productivity and pay remains a topic of debate, as EPL Teams have been on a spending spree this past summer. By combining data on both player performance and salaries, this project aims to provide insight into whether compensation accurately reflects on-field contributions and how market factors may influence pay discrepancies across positions and time periods. The methodology involves integrating data sets from key years. The datasets will be pulled from FBREF for the important years we are tracking within the project. Key variables include name, club, position, nationality, age, appearances, wins, losses, goals, and goals per match. The analysis will clean and merge datasets, create derived variables such as average goals per game, and use statistical tools to identify trends and relationships between wages and performance metrics. While the project is ongoing, preliminary expectations suggest that forwards and midfielders may display stronger correlations between pay and performance than defenders or goalkeepers, reflecting differing valuations of positional contributions. The findings will contribute to discussions on wage fairness, market efficiency, and data-driven talent valuation in the professional soccer sector.

Project Mentor: Professor David Clinginsmith, Department of Economics, Case Western Reserve University

Page 30: Investigation of nanoparticles coated in decellularized extracellular matrix

Arrthru Ban, Biomedical Engineering; Douglas Wu, Department of Biomedical Engineering and Medical Scientist Training Program (CWRU); Dr. Sam Senyo, Department of Biomedical Engineering.

While natural biomaterials are promising candidates for various biomedical applications, decellularized heart matrix (DHM) has not been subject to deep exploration in the context of drug delivery. Previous work in the Senyo lab has demonstrated the benefit of intramyocardial injection of DHM in both liquid solution and solid microgel states for protection of cardiac function in a murine myocardial infarct model. While promising, the current DHM vehicles suffer from limited site retention and penetration. We hypothesized that DHM exerts some of its beneficial effects due to increased association with cardiomyocytes, though the previous forms it has been used in (injectable solutions, solid microgels) do not fully capitalize on this effect. To address this issue, we propose and developed formulations of DHM-coated polymer nanoparticles which will take advantage of preferential cell-matrix interactions to reveal augmented targeting of cardiac relevant cell types. We have evaluated association of polystyrene nanobeads coated in porcine DHM against various other formulations, such as species variations between gelatins(porcine, bovine, fish), and variations between different isolated matrix proteins (fibronectin, laminin, collagen). Using in vitro uptake studies in H9-C2 cardiomyoblasts, uptake was assessed using fluorescent microscopy and image processing applications to determine the degree of association between the various particle coatings and our target cells. Coated nanoparticles were also characterized for changes in size, surface charge, and degree of aggregation using dynamic light scattering (DLS) and zeta potential measurements.

Project Mentor: Dr. Sam Senyo, Department of Biomedical Engineering, Case School of Engineering

Page 31: The Influence of Urbanicity on Schizophrenia Development

Oumnia Baqacem, Cognitive Science, Case Western Reserve University

This study investigates the relationship between urban living and the risk of first-time schizophrenia diagnosis (DSM-5 criteria). Drawing on epidemiological and meta-analytic evidence from eight key studies spanning 1939–2025, we examine whether residence in census-defined urban areas (≥1,000 people/km²) increased schizophrenia incidence compared to rural environments. Findings show, individuals raised or residing in highly urbanized areas consistently showed a two- to threefold higher risk of schizophrenia, particularly when combined with high stress, social fragmentation, discrimination, or genetic vulnerability. Results support a causal link between urban social environments and psychosis risk rather than selective migration.

Project Mentor: Fey Parill, Cognitive Science Department, College of Arts and Sciences

Page 32: Trans-Tibial Stimulation Placement Device for the Treatment of Pelvic Floor Disorder-Related Urinary Incontinence

Saloni Baral , Tara Fritscher , Zeynep Ekin Yayci , Anthony DeCarlo , Maanyav Gangaraj, Case Western Reserve University Department of Biomedical Engineering

Overactive bladder (OAB) is a condition characterized by involuntary contractions of the bladder. Patients often experience urinary urgency, which may be accompanied by urge urinary incontinence. OAB is highly prevalent and can significantly impair quality of life. While several treatment options exist, they are often limited by issues such as invasiveness, poor adherence, and variable effectiveness. Trans-tibial stimulation is an emerging treatment for urinary incontinence. It involves the placement of electrodes near the ankle on the lateral side of the leg, sending electrical signals to the bladder via the sacral nerve plexus and the tibial nerve. While effective, current trans-tibial stimulation devices do not have clear indications for the optimal placement of electrodes. Individuals are instructed by a physician or physical therapist in the placement of these electrodes, though there is little consistency in the resulting patient actions. These inconsistencies result in less convincing results and reduced frequency of usage in patients. To address limitations of current urge incontinence treatments, we have developed a transtibial electrical stimulation sock that helps align surface electrodes with a TENS unit to activate pelvic floor muscles through tibial nerve pathways for the management of Pelvic Floor Disorder-related OAB. The approach focused on optimizing proper electrode placement, comfort, and adherence to treatment by designing a reusable sock that precisely aligns electrodes to the optimal stimulation location. The goal of this device is to help patients suffering from OAB receive a more consistent standard of care when receiving at-home TENS stimulation.

Faculty Mentor: Dr. Kenneth Gustafson, Case Western Reserve University Department of Biomedical Engineering; Dr. Matthew Williams and Dr. Colin Drummond, Case Western Reserve University Department of Biomedical Engineering

Page 33: Predictive Framework to Indicate the Age of Plastics for Proper Recycling

Dhoopshikha Lakshmi Devi Basgeet, Department of Chemistry, CWRU

The degradation of plastics over time presents a critical barrier to efficient recycling, as aged polymers lose mechanical integrity and mix poorly with pristine or newer polymers of the same kind (e.g., polypropylene). This research aims to develop a predictive framework that determines the age and condition of plastics through spectroscopic and machine learning approaches, thereby improving sorting efficiency, enhancing the properties of post-consumer recycled (PCR) plastics, and promoting circular reuse. The project integrates experimental polymer characterization with data-driven modeling to achieve three objectives: (1) design and characterization of age-indicator additives, (2) spectroscopic and thermal analysis of aged plastics, and (3) development of a machine learning model for plastic age prediction. The dataset initially used to train the model was obtained from publicly available polymer spectroscopy datasets. Currently, we are conducting accelerated aging experiments on post-consumer plastics such as cups and containers through controlled heat treatment over a two-week period to expand data availability and build a FAIR (Findable, Accessible, Interoperable, and Reusable) dataset. These samples are being analyzed using Fourier Transform Infrared (FTIR) spectroscopy, Thermogravimetric Analysis (TGA), and Differential Scanning Calorimetry (DSC) to identify both additive-based and intrinsic spectral changes that may serve as indicators of aging. The goal is to determine whether polymers themselves display distinct spectral shifts with degradation that can be leveraged for non-invasive age prediction. The resulting data will support retraining and benchmarking of models such as CNN and ResNet1D. Ultimately, this interdisciplinary effort seeks to establish a robust, data-driven system for classifying plastic degradation, enabling higher-quality recycling, upcycling, and sustainable materials design.

Project Mentors: Dr. Metin Karayilan, Department of Chemistry, Case Western Reserve University, Dr. Sanmukh Kuppannagari, Department of Computer and Data Sciences, Case Western Reserve University

Page 34: From Rivals to Partners: How Trade Interdependency Shapes State Behavior

Christopher Batarseh, Political Science and Sociology

The research question at hand is how trade interdependency affects relations between nation-states. The project aims to discover how relations between nation states are affected by trade between said countries. In particular, whether trade encourages peaceful, or hostile relations, or a mixture of the aforementioned factors. Additionally, the project wants to explore the impact trade interdependence has on average in inter-state relations. The research question arises from a long-held debate, does trade interdependence prevent interstate conflict and promote peace. Scholars following concepts such as Liberal Peace Theory and "End of History" argued after the Cold War that the expansion of global trade would reduce interstate wars or even make the practice non-existent. In essence, many scholars assert that trade interdependence between Nation States would prevent or, at the very least, deter conflict between said countries due to the economic interdependence it creates. To give them credit, by the end of the Cold War, interstate conflicts were nearly non-existent. In stark contrast, during most of the Cold War, the inter-state conflict was a common occurrence. However, in 2025, interstate conflicts increased to levels equivalent to the Cold War era. Examples of current inter-state conflicts include the Russo-Ukrainian war, Armenia-Azerbaijan war, and the recent Cambodia-Thailand conflict, among many more. To answer the research question, the project will employ qualitative methods including case studies, historical analysis, and secondary research. It will also utilize quantitative methods, including data sets, surveys, and game-theoretical modeling. Currently, the results expected are that trade interdependence tends to have a minimal effect on inter-state relations, and when it does make a sizable impact, it results in peaceful relations between nation-states.

Project Mentor: Kathryn, Lavelle**,** Political Science Department, Case Western Reserve University

Page 35: Investigating the Molecular Frontiers of Keratoconus Using Tissue-Engineered Corneal Organoids

Kayleigh Bauer , Biomedical Engineering; Andy Chen , Henry Busch and Ashleigh Schaffer, Department of Genetics and Genome Sciences, Case Western Reserve University School of Medicine, Cleveland, OH

Keratoconus (KC) is a degenerative disease involving progressive thinning and cone-shaped protrusion of the cornea that impairs visual acuity. The current literature identifies several genetic and molecular phenomena implicated in KC pathogenesis and progression, including extracellular matrix defects, oxidative stress, and errors in cell differentiation. However, the relationship between these variables, and their specific roles, remain to be elucidated. The heterogeneity of disease onset and symptoms associated with KC may be a product of a diverse molecular landscape surrounding the disease. Current models to study this - including corneal tissue samples and two-dimensional cell culture models - are limited in their ability to consistently recapitulate the three-dimensional structure of the cornea. To address these limitations, three-dimensional corneal organoids can be engineered by aggregating induced pluripotent stem cells (iPSCs) and differentiating them into a corneal lineage. Corneal organoids have the potential to model all three cellular layers of the cornea as well as their interactions. This project is the first to apply corneal organoids to the study of keratoconus by using iPSCs derived from patients with varying degrees of KC severity. Organoids are characterized by morphology, and corneal identity is verified using RT-qPCR for known corneal markers. Future analyses will include bulk RNA sequencing and immunohistochemistry to identify molecular and structural differences in the KC organoids between time points and patient samples. Ultimately, this work aims to identify key molecular determinants of KC and elucidate the temporal sequence of events driving disease pathogenesis. More broadly, it seeks to establish the organoid model as a platform for uncovering the molecular underpinnings of other corneal diseases as well as identifying potential therapeutic routes.

Project Mentor: Ashleigh Schaffer, PhD, Department of Genetics and Genome Sciences, Case Western Reserve University School of Medicine

Page 36: MIRCA 2.0: Portable Microfluidic Impedance Red Cell Assay including temperature control and integrated fluid control.

Yusang B. Ley, Biomedical Engineering B.S.E; Solomon Oshabaheebwa, Christopher A Delianides, Michael A Suster, Pedram Mohseni, Umut Gurkan

While several novel therapies have been developed to combat Sickel Cell Disease, there is still a need for accessible point-of-care devices to monitor disease progression and treatment efficacy. MIRCA is an RBC deformability assay that measures the ability of RBCs to squeeze through narrow passages. MIRCA 2.0 includes miniaturized, low-power piezoelectric pumps and a temperature control system to achieve portability and assess RBC at physiological temperatures. MIRCA utilized a miniaturized impedance analyzer to determine the occlusion index (OI), which represented the percent occlusion of RBCs in a microcapillary network. We developed a temperature control module capable of controlling each device independently. We also integrated a miniaturized fluid flow control module that included two piezoelectric pumps. All components were controlled by a Raspberry Pi 4 with a 12-inch touchscreen. To assess the effect of temperature on RBC occlusion, washed RBCs from SCD patients (n=5) and healthy donors (n=4) were suspended in 1X PBS at 20% hematocrit. Samples were then perfused at 100mbar through the microfluidic device with the temperature set to 37°C or room temperature (22°C). In all experiments, both devices reached within 1°C (SD = 0.367 and 0.260 for channels 1 and 2) of the target temperature within 5 minutes and maintained stable temperatures. The occlusion index was significantly higher in SCD blood samples tested at 37°C versus room temperature ($P = 0.0301$). Results showed that the temperature control system rapidly and stably achieved 37°C. These results also suggest that assays investigating RBC-mediated capillary occlusions in SCD at room temperature may underestimate the occlusions that occur at physiological temperature. Overall, we aim for MIRCA to be an accessible device to study RBC deformability in point of care settings without need for auxiliary equipment and with minimal user expertise required to run tests.

Faculty Project Mentor: Dr. Umut Gurkan, Mechanical and Aerospace Engineering

Page 37: Real-Time Imaging of Acetylcholine to Understand Autism Pathophysiology in the PTEN$^{Y68H/+}$ Mouse Model

Frederick Bell, Neuroscience Department, Case Western Reserve University and Cleveland Clinic Foundation; Emre Lacin, Tenesha Connor, Kemal Ozdemirli, Miguel Maldonado and Murat Yildirim, Neuroscience Department, Cleveland Clinic Foundation

Autism spectrum disorder (ASD) is a complex neurodevelopmental condition whose cellular mechanisms remain poorly understood. Emerging evidence suggests that neuromodulatory imbalance, particularly within the cholinergic system, may contribute to ASD-related circuit dysfunction. To investigate this, we used the PTEN$^{Y68H/+}$ mouse model of ASD and performed widefield one-photon imaging of cortical acetylcholine (Ach) dynamics in awake, behaving animals expressing the GRAB-Ach3.0 fluorescent sensor. Mice were recorded across spontaneous, social interaction, and virtual reality contexts while simultaneously tracking behavioral metrics such as locomotion and pupil diameter.Mutant mice exhibited reduced interregional correlations of Ach release-particularly between motor, visual, and retrosplenial cortices-indicating desynchronization of cholinergic signaling across the cortex. However, correlations between Ach activity and behavioral state measures were maintained or enhanced in mutants, suggesting that while Ach release remains behaviorally coupled, its cortical coordination is disrupted. These results point to preserved upstream cholinergic drive but impaired network-level integration.Given that PTEN loss reduces somatostatin (SST) interneuron populations—key mediators of cholinergic modulation—our findings support a circuit-level mechanism in which SST interneuron deficits disrupt cortical propagation of cholinergic state signals. This work provides the first dynamic visualization of cortical Ach signaling in an awake ASD model and highlights how neuromodulatory desynchronization may underlie abnormal brain-behavior coupling in autism.

Project Mentor: Murat Yildirrim, Department of Neuroscience, Case Western Reserve University

Page 38: Caring for the Caregivers: Evidence-Based Strategies for Preventing Burnout

Catherine Berceli, Department of Psychological Sciences

Burnout among healthcare professionals is a serious and growing public health concern, often recognized by emotional fatigue, a reduced sense of personal accomplishment, and detachment. Repeated exposure to trauma and moral distress frequently contributes to compassion fatigue and desensitization, which can gradually erode their empathy and overall well-being. Systemically implemented well-being interventions, such as mindfulness training, resilience programs, and psychosocial support, have been shown to reduce emotional exhaustion and strengthen resilience, demonstrating that burnout can be addressed through accessible, educational approaches. This study draws on research from the fields of psychology, public health, and bioethics in order to examine how interventions promote emotional recovery and sustainable coping among individuals facing burnout. Research across disciplines consistently finds that participation in well-being programs leads to lower stress levels, improved emotional regulation, and greater moral resilience. While these interventions aim to improve the outcomes for individuals, they also support healthier workplace environments and enhance workers' ability to provide quality patient care. The findings of this study reveal that burnout is not an inevitable consequence for healthcare workers, but rather a preventable condition that can be addressed through the use of evidence-based and institutionally supported wellness initiatives. By emphasizing prevention and emotional well-being, this research highlights the crucial importance of protecting healthcare workers' well-being and their ability to care for patients.

Project Mentor: Rachel McClaine, Department of Psychological Sciences

Page 39: Novel Therapeutic Device for Effective Management of Peptic Ulcers and Prevention of Rebleeding

Jai Thampakkul, Biomedical Engineering; **Filip Goshevski**, Biomedical Engineering; **Lyra Bhatnagar**, Biomedical Engineering; **Katherine Berkner**, Biomedical Engineering; **Gillian Strout**, Biomedical Engineering

Gastrointestinal (GI) bleeding is a medical condition affecting 80 to 150 out of 100,000 people annually. Peptic ulcers, which are caused by the weakening of the stomach lining and often result from H. pylori infections or NSAID overuse, remain the most frequent cause of upper GI bleeding in the United States, leading to approximately 140,000 hospitalizations annually. Despite advances in treatment, the reported mortality rate for upper GI bleeding has remained steady at 5-10%. Current standard of care includes anticoagulant therapy and proton pump inhibitors to prevent rebleeding recurrence. When necessary, catheter-directed thrombolysis, embolization, and endoscopic hemostasis are employed, though each has technical limitations. These methods do not significantly reduce the risk of rebleeding and primarily serve as short-term interventions to stabilize the patient rather than provide a permanent solution. We introduce a novel device for the management of upper GI bleeding caused by peptic ulcer disease, capable of significantly reducing re-bleeding risk following treatment. Our endoscopic device offers an innovative and efficient approach to controlling gastrointestinal bleeding by enabling delivery of a hemostatic agent, allowing rapid gelation and stabilization directly over the bleeding ulcer. This precise application not only enhances clot integrity and clip stability but also reduces procedure time and the likelihood of rebleeding. By providing rapid, localized stabilization and a stronger seal over ulcer sites, this dual-channel device directly addresses one of the biggest challenges in peptic ulcer management, rebleeding, offering a practical, lasting improvement over current endoscopic methods.

Project Mentor: Dr. Matthew Williams, Department of Biomedical Engineering

Page 40: Development of an Endothelialized Chip Model for Thromboinflammation

Katherine Berkner, Department of Biomedical Engineering

A key driver of chronic inflammatory diseases is aberrant neutrophil activation and programmed cell death through the release of neutrophil extracellular traps (NETs), which contribute to tissue damage and thromboinflammation. This project aims to develop and optimize a bio-inspired, endothelialized microfluidic chip to model thrombo inflammatory interactions between neutrophils, platelets, and endothelial cells under physiologically relevant flow conditions. The system will enable visualization and quantification of cell adhesion and activation, characterized through metrics including percent cell coverage and activation biomarkers such as neutrophil elastase expression and secretion from neutrophils, GPIIb/IIIa expression in platelets, and Von Willebrand Factor expression and secretion from endothelial cells. Neutrophils and platelets from whole blood samples were isolated and resuspended in recalcified cell media. Microfluidic channels seeded with confluent human umbilical vein endothelial cells were perfused with activated cells under low shear, then washed to remove unbound cells. Staining and imaging were performed to assess cell morphology and quantify neutrophil and platelet adhesion to the endothelial layer. Flow cytometry was used to optimize neutrophil activation by characterizing responses to known activators including phorbol myristate acetate (PMA), heme, and calcium ionophore A23187. Primary monoclonal antibodies were used to stain three proteins associated with neutrophil activation under inflammatory conditions: CD66b, Neutrophil Elastase, and S100A8/A9. The presence of one or more of these proteins during flow cytometry indicated PMA and A23187 successfully induced neutrophil activation, while heme did not trigger neutrophil activation in the absence of platelets. These same conditions were replicated in microfluidic flow studies to determine whether activation markers remained consistent. Future work will introduce drugs known to affect platelet, neutrophil, and/or endothelial cells to observe how the model functions under therapeutic conditions. Ultimately, this microfluidic chip provides a physiologically relevant system for studying patient-specific thrombo inflammatory responses and testing therapeutic interventions ex vivo.

Project Mentor: Dr. Anirban Sen Gupta, Department of Biomedical Engineering

Page 41: What is the effect of college major on debt and earnings?

Manav Bhandary, Finance and Economics; **Nikhil Bondalakunta**, Mechanical Engineering; **Jonathan Burton,** Computer Science and Business Management

This project examines the relationship between college majors, student debt, and post-graduation earnings using data from the U.S. Department of Education's College Scorecard. The goal is to understand how a student's choice of major influences financial outcomes after graduation, emphasizing the balance between earning potential and debt burden. The dataset provides detailed information on median earnings, average loan amounts, repayment rates, and demographic characteristics for graduates across thousands of U.S. colleges and fields of study. Using R, the project will visualize and analyze these relationships to highlight which majors offer the highest return on investment and which leave graduates with disproportionate debt relative to income. Planned visualizations include scatterplots of average debt versus median earnings by major, density plots comparing debt distributions across academic disciplines, and interactive charts illustrating how these relationships have changed over time. By combining descriptive statistics and data visualization, this study aims to reveal broader patterns in the financial outcomes of higher education. It will also explore how institutional factors such as school type, selectivity, and location affect the link between major, debt, and earnings. Ultimately, the analysis provides insights into the economic trade-offs students face when choosing a field of study. Understanding these patterns can help students make more informed academic and financial decisions and guide policymakers in addressing issues related to college affordability and student debt. By uncovering which majors tend to yield sustainable financial outcomes, this project contributes to a deeper understanding of the long-term value and equity of higher education in the United States.

Project Mentor: Professor David Clingingsmith, Department of Economics

Page 42: SeeCare: An AI-Powered Memory Support System for Dementia Patients

Ashwin Saraswatula, Computer Science, Case Western Reserve University; **Apeksha Malik**, Computer Science, Case Western Reserve University; **Firas Khalife**, Computer Science, Case Western Reserve University; **Vedant Gupta**, Computer Science, Case Western Reserve University; **Adam Hamdan**, Computer Science, Case Western Reserve University; **Vinlaw Mudehwe**, Computer Science, Case Western Reserve University; **Taranveer Singh Anand**, Computer Science, Case Western Reserve University; **Salma Bhar**, Computer Science, Case Western Reserve University

Individuals living with dementia often struggle to recall people, places, and daily experiences, leading to increased dependence on caregivers. The SeeCare project seeks to address this challenge by designing an intelligent, privacy-first mobile application that helps dementia patients track and recall their day-to-day activities and interactions. The project's goal is to bridge the memory gap through an integration of Artificial Intelligence (AI), Computer Vision, and geolocation services, providing cognitive support that enhances autonomy and quality of life. This research explores how multimodal AI technologies, facial recognition, speech-to-text transcription, wake-word detection, and geofencing, can be combined into a single assistive tool. The mobile application is being developed using React Native and FastAPI, supported by cloud-based infrastructure on AWS and external APIs such as OpenAI, Google Places, and ElevenLabs. Data privacy and ethical considerations guide every stage of design, emphasizing encryption, local-first storage, and consent-based data handling. The expected outcome is a functional proof-of-concept that can autonomously identify people, recognize places, and generate meaningful summaries of daily activities. By integrating these capabilities, SeeCare has the potential to transform dementia care through human-centered AI, empowering patients while reducing caregiver strain.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences, Case Western Reserve University

Page 43: Wired Differently: The Hidden Diversity of the Vagus Nerve

Anjali Bhuthpur, Department of Neurosciences, Case Western Reserve University, Cleveland, OH; Brandon Brunsman, Tatiana Pascol, Leina Lunasco, Rebecca Prince, Noa Nuzov, Morgan Griffith, Sophie Scherer, Sydney Rubin, Marissa Brigger, Katherine Workman, Nicole Pelot, Andrew Shoffstall and Andrew Crofton, Department of Anatomy, Case Western Reserve University, Cleveland, OH

Normal anatomical variation from body to body is critical to understand to inform and refine interventions like Vagus Nerve Stimulation (VNS). VNS provides a non-pharmocological treatment for diseases like depression, stroke, and epilepsy, yet is accompanied by many side effects, which might be due to anatomical differences across patients. This study aims to characterize vagus nerve branching to improve our understanding of normal anatomic variation in 56 embalmed human cadavers including 42 White donors (20F, 21M) and 14 Black donors (11F, 3M). Using gross dissection, bilateral vagus nerves were identified and the branches were identified and recorded. In the cervical region, defined as the area between the inferior margin of the jugular foramen and the superior border of the clavicle, we found 18 ± 9 branches (mean ± standard deviation) on the right (range: 5-45) and 15 ± 6 branches on the left (range: 2-39). In the thoracic region, defined as the superior margin of the clavicle to 1 cm superior to the start of the esophageal plexus, there were 16 ± 7 branches on the right (range: 6-42) and 12 ± 5 branches on the left (range: 3-29). Our data suggest that Black donors tend to have a higher number of branches than White donors. It is critical to offer individualized care to patients, starting with recognizing that textbook representations do not encompass the variation that is actually present in human bodies. This study warrants further investigation into understanding the significance of different branching patterns observed across individual people and populations.

Project Mentors: Dr. Andrew Crofton, Department of Anatomy, CWRU; Department of Pathology and Cell Biology, (University of South Florida),;Brandon Brunsman, Department of Anatomy (CWRU); Dr. Jon Niemi, Department of Neurosciences, CWRU

Page 44: Multipurpose Tool for Complex JSONs

Mingyu Bian, Computer Science; **Jianhao Deng,** Computer Science; **Kenneth Li, C**omputer Science; **Beiming Lian,** Data Science; **An Nguyen,** Computer Science; **Andrew Ziets,** Computer Science

As one of the most common structured data storage formats at present, JSON files have wide application and audience in fields such as network transmission and data storage. However, despite its wide usage, they are not the most convenient file for organizing, sorting, and editing data within each file. Manipulation of data within JSON often require opening a secondary code editor as well as a prior knowledge of JSON structures. As of now, there is no mature or public tool to solve this specific problem. Our project proposes a desktop Python application that functions as a tool for allowing editing, conversion, and storage on complex JSON files, all within a presentable user interface that allows for ease of access and manipulation of JSON files that do not have such barriers for entry. The application aims to allow users to input a JSON file and have the following functionality: viewing a JSON, editing the contents of a JSON, parsing and splitting large JSON files, decoding a binary JSON file, and finally, allow for conversions of JSON files into Excel. These are all the expected functionalities and will allow the application to serve its purpose as a all-in-one tool for the handling of JSON files.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences

Page 45: Surface Analysis of Preconditioned Cardiovascular Leads

Emilio Blythe, Biomedical and Materials Science and Engineering; **Tauheed Ahmed,** Biomedical Engineering; **Chase Kulsakdinun**, Mechanical and Aerospace Engineering; Justin Zimmerman, Materials Science and Engineering

Lead bodies in implantable cardiovascular devices such as implantable cardioverter-defibrillators (ICDs) and pacemakers are susceptible to chemical and mechanical degradation, leading to failure over time. As a result, cardiovascular lead extraction is necessary to remove the compromised leads before further complications arise. Extraction places significant tensile stress along the lead, increasing the risk of fracture. Due to fractured components, physicians may be forced to perform open-heart surgery to ensure complete removal without causing patient harm. Previous studies have explored mechanical properties independent of chemical degradation anticipated from the in vivo environment. This research focuses on bridging these perspectives to evaluate how degradation influences lead integrity during extraction. One set of leads was subjected to a preconditioning saline soak recommended by ISO standards (i.e., 37 °C for 12 days). This solution was only expected to produce limited hydrolytic effects rather than the oxidative degradation that occurs in vivo, a second set of leads was subsequently soaked in a peroxide cobalt chloride solution at 37 °C for 30 days. This method induced oxidative degradation but caused severe surface damage that was considered clinically unrealistic. Following preconditioning, the leads were mechanically tested under tension to examine how degradation affected their fracture behavior. The surface of the specimens was characterized using laser profilometry to analyze surface roughness and optical microscopy to image failure points. Although neither the saline nor peroxide cobalt chloride soaks replicated the expected degradation for a 5-10 year implant, as noted by clinicians, analyzing these samples provides valuable context for identifying the desired degree of polymer degradation. These results help inform future experiments aimed at refining chemical preconditioning protocols to more accurately mimic physiological degradation within the body.

Project Mentor: Janet L. Gbur, Department of Materials Science and Engineering

Page 46: HIV Tat stimulates viral transcription by reversing the sequestration of P-TEFb by 7SK snRNP

Sanjna Boda, Department of Biology, CWRU; Taebin Son, Amie Donner, and Uri Mbonye Department of Molecular Biology & Microbiology, Case Western Reserve University School of Medicine, Cleveland, Ohio

Viral latency remains the main challenge to curing HIV infections. In $CD4^+$ T lymphocytes, the virus establishes a transcriptionally latent reservoir that can reactivate and form a spreading infection if antiretroviral treatment is interrupted. Reactivation of HIV from latency requires the host factor Positive Transcription Elongation Factor b (P-TEFb), composed of CDK9 kinase and Cyclin T1, which stimulates RNA polymerase II to transcribe RNA processively. HIV Tat exerts its trans-activator function by binding to P-TEFb and recruiting it to a 60-nucleotide hairpin RNA called TAR, formed immediately downstream of the viral transcription start site. In actively dividing cells, most P-TEFb is kept inactive by the 7SK small nuclear ribonucleoprotein (7SK snRNP) complex. This project explored whether Tat forms a functional intermediate complex with 7SK snRNP in T cells, necessary for mobilizing P-TEFb recruitment to HIV Tat. Reactivation of latently infected T cells resulted in robust nuclear Tat co-localization with the Cyclin T1 subunit of P-TEFb, as shown by high-resolution immunofluorescence microscopy. Affinity tag-based immunoprecipitation of Tat revealed a stable association with the 7SK snRNP complex that displaced the P-TEFb inhibitory component HEXIM1. Conversely, affinity tag-based immunoprecipitation of CDK9 after ectopic Tat expression showed substantial dissociation of P-TEFb from 7SK snRNP. The CDK9 kinase inhibitor flavopiridol, known to dissociate P-TEFb from 7SK snRNP rapidly, also induced efficient dissociation of Tat: P-TEFb from 7SK snRNP in cells and lysates. These studies definitively characterize the Tat:7SK snRNP complex as one that excludes HEXIM1 yet retains P-TEFb. Contrary to the prevailing theory that Tat entry into 7SK snRNP leads to a dead-end complex, we demonstrate that Tat:7SK snRNP is a functional intermediate in which Tat: P-TEFb can be released en bloc.

Project Mentor: Fritz Petersen, Department of Biology, College of Arts and Sciences

Page 47: Telehealth parent mediated treatment for insomnia in young autistic children

Ethan Bogg Biology; Dr. Cynthia R. Johnson, Cleveland Clinic Children's Center for Autism

Sleep disturbances are one of the most common additional challenges experienced by children with Autism Spectrum Disorder (ASD), often contributing to behavioral difficulties and increased caregiver stress. This project focuses on the telehealth implementation of a parent-mediated telehealth intervention designed to improve sleep disturbances in young autistic children. The large, randomized control trial will compare the behavioral parent-mediated intervention (SPT) to an active comparative Sleep Parent Education (SPE). Each of the intervention consists of five structured telehealth sessions (Sessions A–E). While SPT is focused on target sleep concerns, the SPE guides caregivers through useful topics including autism diagnosis, interpreting clinical assessments, identifying evidence-based treatments, and engaging in long-term treatment planning. My role in this project involved reviewing, editing, and standardizing all therapist scripts, activity sheets, parent handouts, and treatment fidelity checklists to ensure internal consistency and procedural accuracy across sessions. Each module was evaluated for alignment with core intervention objectives, such as promoting parental understanding of evidence-based behavioral strategies and maintaining high treatment fidelity during telehealth delivery. Additionally, I cross-referenced fidelity forms and session content to streamline therapist implementation and enhance parent adherence tracking. This ongoing work supports the broader research initiative led by Dr. Johnson, which aims to evaluate the effectiveness of telehealth parent-mediated behavioral sleep interventions for children with ASD as well as evaluate moderators associated with treatment response. By ensuring clarity, consistency, and adherence to research protocol within the intervention materials, this project has the potential to improving the quality and scalability of evidence-based telehealth services for families affected by autism-related sleep challenges.

Project Mentor: Elliot Gardner, Department of Biology, College of Arts and Sciences

Page 48: Hand Weakness Assistance Device

Dylan Bordman, Biomedical Engineering; **Kyla Yung**, Biomedical Engineering; **Arya Iyer**, Biomedical Engineering; **Kianna Verdugo**, Biomedical Engineering; **Kevin Chae**, Biomedical Engineering

Multiple sclerosis is an autoimmune disease of the Central Nervous System, causing degradation of the myelin layer of the nerves. This interrupts the communication between nerves in the central nervous system and can become permanent through the continued damage to the myelin layer. This can lead to problems such as numbness or tingling, confusion, fatigue, lack of coordination, and weakness of the muscles (specifically hand weakness). The symptoms of hand weakness include inability to utilize the full range of motion of the fingers, inability to support weight in the hands, and lack of grip strength. There are several existing methods of managing hand weakness, such as physical therapy and surgical intervention. However, these solutions do not offer immediate assistance with everyday tasks and can be invasive. In recent decades, there have been rapid advances in the development of orthotic devices that better facilitate individual finger movement whilst maintaining comfort for the user. Our approach enhances the user's ability to perform daily living tasks that require hand flexion and extension. This full-sleeve device, composed of neoprene and polyurethane, allows user comfort and longevity. It employs a pneumatic system driven by motor-actuated syringes that inflate rubber bladders on the superior phalanges to perform extension. Servo motors operate the extension mechanism to manipulate the syringes, which control air pressure within the bladders. A speech input device enables users to control the degree of extension as air enters the bladder. Through dexterity and grip testing, we are iteratively developing an orthotic device to improve task performance and grip strength in individuals experiencing hand weakness.

Project Mentor: Matthew Williams, Department of Biomedical Engineering, Case School of Engineering

Page 49: V-Queue

Daniel Borhegyi, Computer Science; **Victor Boyd**, Computer Science; **Jonah Schwab**, Computer Science; **Julio Perez**, Computer Science

V-Queue is a mobile application for waiting in line, primarily for use in amusement parks. The purpose of this is that instead of physically waiting in line, you wait in an equivalent line virtually, on your phone. There are currently many ways to speed up your wait (fast passes at parks, etc.), but there is no option to simply wait in the same line but not have the discomfort of physically standing there for hours. On the business side, while you are in this virtual line, you can roam the park, engage with other activities, and spend money in ways that benefit the amusement park more than just idly waiting in line. This also has an accessibility advantage because people who are physically unable to wait in line do not need a special pass, instead, they can use this app to wait virtually. The functionality of this will be the following steps: you join the line by scanning a QR code or a NFC tag at the beginning of the line. Now that you are in this line, to exit you must rescan that same code. This prevents people from "shopping" for a shorter line and waiting in lines they do not intend to ride. You also can make a group on your app so only one of you and your friends need a phone. This group is made by scanning valid, different amusement park tickets. While you are in line, you see an interface that tells you an estimated wait time and the number of people in front of you. Once your time comes, you can wait in a short "buffer" line before getting on the ride. This idea could be expanded and applied to other venues where waiting in line is not optimal for comfort and/or business.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences

Page 50: Stress in America: Behavioral, Social, and Health Determinants, 2015 to Present

Ashton Anda, Finance; **Nia Brahmbhatt**, Business Information Technology and M.S. Business Analytics and Intelligence; **Graham Tabor**, Finance

This project investigates patterns and predictors of stress in the United States from 2015 to the present using data obtained through the University of Michigan Research Center for Minority Data. The dataset, collected by the American Psychological Association and accompanied by a comprehensive codebook, provides detailed information on stress levels, demographic characteristics, behavioral habits, and mental and physical health indicators. Using this multi-year survey framework, we analyze how stress relates to lifestyle factors including frequency of socialization, physical activity, sleep routines, financial pressures, work demands, and broader indicators of mental well-being. Existing literature establishes chronic stress as a major public health concern associated with poorer physical health, increased anxiety and depression, and long-term biological impacts. However, few studies examine stress across such an extended period while incorporating both behavioral and demographic dimensions. By integrating these variables, our research aims to identify which factors most strongly predict elevated stress levels and how these patterns vary across age groups, gender identities, and socioeconomic conditions. We expect to find that higher levels of stress correlate with lower social engagement, unhealthy or inconsistent physical habits, and poorer mental health outcomes. We also anticipate meaningful disparities across demographic groups, reflecting unequal access to supportive environments, coping resources, and health-promoting behaviors. Identifying these relationships can help inform policies, organizational practices, and community-level interventions aimed at reducing stress and improving overall well-being.

Project Mentor: Professor David Clingingsmith, Department of Economics, Case Western Reserve University

Page 51: Effects of Environmental Stress on Homeostasis in Drosophila melanogaster and Drosophila sechellia

Adam Brann, Department of Neurosciences; Andrew Hsiao, Department of Neurosciences; Alexa Zarjetskiy, Department of Neurosciences; Natalia Pokaleva, Department of Neurosciences; CWRU

In Drosophila, responses to stress are managed in large part by the pars intercerebralis (PI), the major homeostatic center in the fly brain. PI neurons respond to signaling from dopaminergic wedge (DA-WED) neurons which are known to fire in response to stressors like starvation. Here, we use starvation and sleep deprivation as a means of testing the effects of the stress response on homeostasis in Drosophila melanogaster and Drosophila sechellia. In the feeding assay, we show that DA-WED neurons are active under protein-starvation conditions and that they promote protein intake over sucrose intake. In the sleep assay, we show that lack of activation of DA-WED neurons results in a weaker internal homeostatic mechanism and larger disruptions to normal sleep activity. Activation of these behaviors is dopamine-dependent, which is shown by using D. sechellia, which is unable to synthesize endogenous dopamine, as a comparison. These findings suggest that DA-WED neurons are crucial in integrating hunger and stress signals to drive adaptive feeding and sleep behaviors and strengthen the stress response.

Project Mentor: Dr. Masashi Tabuchi, Department of Neurosciences, CWRU; Dr. Ashely Nemes-Baran, Department of Neurosciences, CWRU

Page 52: Sterile versus pathogen inflammation in the dual-disease TNFΔARE mouse

Fiona Brooks[1,2], Emily Miller[1], Jayden Kim[1], Bianca Islam[1,3], Fabio Cominelli[1,3]

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The TNFDARE mouse model is one that mimics the human condition of Crohn's disease-like ileitis through its chronic overexpression of TNF-a. In humans, up to 20% of people with inflammatory bowel disease develop arthritis as a comorbidity. TNFDARE mice in specific pathogen free (SPF) conditions develop both ileitis and arthritis. However, in germ-free (GF) conditions, the mice only develop arthritis. Thus, these two inflammatory conditions come from different pathways: one mediated by bacteria and another by an unknown mechanism. To characterize these differences, ileums from diseased and healthy, GF and SPF were fixed and imaged by stereomicroscopy and histologically scored. Ankle and knee joints were processed for H&E staining to determine levels of immune cell infiltration, and acetabulofemoral cartilage RNA was analyzed by RT-PCR for various Th1 cytokine expression levels. Serum TNF-a levels were measured through an ELISA, and splenic TNF production was also assessed. SPF mice displayed significant ileitis and arthritis along with elevated serum TNF-a. Splenic TNF production was lower in the TNFhet mice compared to the WT controls, which is consistent with cytokine exhaustion. These findings confirm that the TNFDARE mouse ileitis is microbiome-dependent whereas the arthritis occurs through another, distinct inflammatory pathway that could be a useful target for therapies for the treatment of inflammatory bowel disease-associated arthritis.

Project Mentor: Bianca Islam, MD, PhD, Digestive Health Research Institute

Page 53: Wearable Device for Syncope Detection

Frank Bunks[1], Biomedical Engineering; **Danny Saliba**[1], Biomedical Engineering; **Zena Cha**[1,2], Biomedical Engineering; **Krithika Gopalakrishnan**[1,3], Biomedical Engineering; **Arnav Reddy**[1] Biomedical Engineering;

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Syncope, defined as a sudden loss of consciousness, affects upwards of 40% of the population. Of these affected individuals, cardiac syncope makes up 10-30%, postural orthostatic hypotension (POTS) makes up 13%, and orthostatic hypotension makes up 10%. While these syncopes are diagnostically different, they have similarities in some of the underlying cardiac pathophysiology. All three syncopes are characterized by changes in heart rhythms and blood pressure. Syncope can lead to secondary injuries caused by hitting surrounding objects, and a decreased quality of life. Here we propose a wearable syncope monitor that combines electrocardiography (ECG), photoplethysmography (PPG), and a system for undetectable symptoms. The system connects single-lead chest ECG and earbud PPG sensors to an Arduino microcontroller that filters and time-stamps signals, computing pulse-arrival time (PAT). The system uses ECG R-peaks to calculate PAT, applies thresholds to detect risk, and triggers vibration and liquid crystal display (LCD) alerts while logging events and symptoms that a user reports in the mobile app. We will start by individually testing signals from the ECG and PPG for accuracy. Once accuracy is established, we will verify the device's ability to calculate PAT through signal quantification/processing and then comparing it to the published value from healthy individuals. Here we present one of the first cost-effective wearable detection devices for syncope that can help to increase the quality of life and prevent secondary injuries in people with syncope.

Project Mentor: Matthew Williams, Department of Biomedical Engineering, Case School of Engineering School of Medicine

Page 54: ENZ Materials via Photonic Crystal Dirac Cones

Nicholas Burkart (Engineering Physics), Department of Physics, CWRU

Photonic crystals exhibit distinctive optical properties derived from their band structures. By adjusting the parameters, a Dirac cone degeneracy can form where the bands intersect at a critical point. This makes the crystal a zero-refractive index material with an infinite phase velocity. Among these materials are the Epsilon-near-zero (ENZ), where the permittivity approaches zero at a certain frequency. In essence, the photonic crystal can filter frequencies, and prior research has hoped to find these optical properties in the visible spectrum. The setup is based on prior papers that explored an accidental degeneracy at the gamma point of the Brillouin Zone. This study replicates the six hexagonal Si pillars on a thin Si3N4 substrate in both 2D and 3D simulations. The 2D simulations examine a cross-section, while 3D simulations require consideration of the pillars' height and substrate thickness. Earlier undergraduate work attempted COMSOL but found Meep (MIT Electromagnetic Equation Propagation) faster with better parameter control. Now, Python, Meep, and MPB (MIT Photonic Bands) are used to investigate both 2D and 3D scenarios. Expected results include numerical comparisons within the Brillouin Zone and an analysis of band frequency ranges. Once results are obtained, the project will shift to fabrication and experimentation, with most work beginning next semester.

Project Mentor: Professor Giuseppe Strangi, Department of Physics, CWRU

Page 55: CampusFin

Jonathan Burton (Computer Science and Business Management)**, Sanchit Gupta** (Computer Science), **Ritvik Sajja** (Computer Science and Economics), and **Aneesh Gadgil** (Computer Science and Economics)

College students face unique financial challenges—ranging from shared expenses with roommates to limited credit history and uncertainty about budgeting and investing. CampusFin addresses these challenges through an integrated web platform designed specifically to improve financial literacy and independence among undergraduates. Unlike general-purpose finance apps such as Mint or Splitwise, CampusFin combines multiple tools into one cohesive ecosystem tailored to the student experience.

The platform provides five key modules: expense tracking (with manual entry and OCR-based receipt scanning), customizable budgeting templates, a shared wishlist and group expense manager, a credit card "Fit" tool that recommends beginner-friendly cards, and an AI-powered investment literacy tool that summarizes stock insights for educational purposes. CampusFin's architecture integrates a Next.js 14 frontend with a FastAPI backend and PostgreSQL database, ensuring scalability, modularity, and secure data management through JWT authentication and encrypted storage.

Development followed clean architecture principles, with emphasis on responsive UI/UX design using Tailwind CSS and React. Early usability feedback from student testers highlighted the system's intuitive dashboard and visual budgeting tools as particularly effective for financial engagement. Ongoing work focuses on integrating live financial data and enhancing the AI literacy component to provide context-based explanations rather than investment advice.

Ultimately, CampusFin seeks to bridge the gap between financial complexity and student accessibility, empowering undergraduates to make confident, informed, and responsible financial decisions during their formative years.

Project Mentor: Shuai Xu, Computer Science and Data Science

Page 56: Relative Vulnerability to Natural Disasters: Economic Impacts Across Developed and Developing Countries (Japan, New Zealand, Philippines, Indonesia)

Qiyi Pan (Economics), **Xiaoyue Ji** (Economics), **Yeva Butovska** (Computer Science and Economics)

This research investigates the differential impacts of natural disasters on developed and developing countries through a comparative analysis of Japan, New Zealand, Indonesia, and the Philippines between 2002 and 2021. Focusing exclusively on storm-related events, the study explores how national income levels and institutional preparedness shape vulnerability, recovery, and long-term resilience. Data are drawn from the EM-DAT International Disaster Database and supplemented with World Bank indicators on population and GDP per capita. Key variables include the number of fatalities, total affected population, and economic damages expressed in U.S. dollars. To enable cross-country comparison, these variables are standardized by population and GDP per capita, thereby capturing relative rather than absolute disaster impacts. We hypothesize that, despite facing similar meteorological hazards, developing economies such as Indonesia and the Philippines experience disproportionately higher social and economic burdens relative to their national wealth, reflecting structural inequalities in disaster preparedness and recovery. The findings aim to contribute to the broader discourse on climate change and climate justice by illustrating how the intersection of geography and economic capacity determines the true cost of natural disasters in an unequal global system.

Project Mentor: Professor David Clingingsmith, Department of Economics, CWRU

Page 57: Ligand Efficiency of Novel Compounds Containing N-Acetyl Hydrophobic Fragments and Hydrogen Bond Acceptors on Antibacterial Resistant Bacterial CjLT

Lucy Candeub (Biochemistry)**,** Department of Biochemistry

The rise of antibacterial resistance poses a substantial global health risk with its annual death rate reaching an estimated 1.9 million by 2025[1]. The detriment of continued antibiotic misuse and the lack of sufficient intervention cannot be understated. An alternative approach to developing new antibiotics is to develop avenues to restore the efficacy of existing antibiotics, including beta-lactam antibiotics. One common approach is to inhibit beta-lactamases. A second approach is to inhibit lytic transglycosylases which cleave peptidoglycan strands. Earlier research has shown that inhibition of these later enzymes potentiates beta-lactam antibiotics, yet the field has not advanced beyond having only one modest inhibitor, bulgecin A[2]. Because the scaffold of bulgecin A makes it difficult to optimize, our lab takes a fragment-based approach to develop novel inhibitors by starting with weak-binding small molecules which are then linked to improve affinity. One subsite active site region of interest is the -2 saccharide subsite where bulgecin A positions a GlcNAc moiety, mimicking the peptidoglycan substrate. Our crystallographic evidence in *Campylobacter jejuni* lytic transglycosylase points to that DMSO and DMSO analogs can also bind in this region; such fragment-sized compounds could thus be used as starting compounds for the fragment design approach. We explored the binding of these molecules using computational molecular dynamics (MD) simulations. We also explored whether other bioisosteres could bind to this active site region using MD and differential scanning fluorimetry. This latter technique probes changes in protein stability as evidence for ligand binding. Our efforts could lead to discovering novel fragments binding to the -2 subsite that we aim to link to other fragments we designed for the +1 subsite to develop novel lytic transglycosylase inhibitors.

Project Mentor: Focco Van den Akker, Department of Biochemistry, CWRU

Page 58: Public-Health Policy Levers to Improve Depression Treatment Access and Outcomes among Low Socio-Economic Status Populations in the United States

Mindy Cao (Psychology)**,** Department of Psychological Sciences

Depression remains one of the most pervasive and disabling mental health conditions in the United States, yet individuals with low socioeconomic status (SES) face various structural barriers to accessing effective treatment and achieving favorable outcomes. Certain factors, including medical insurance /subsidy policy, health infrastructure availability, evidence-based practices (EBP) mandates, and social determinants of health (SDoH) initiatives, play critical roles in causing this treatment gap.

This narrative review synthesizes the current U.S. policy-relevant literature to examine how public-health policies (insurance/subsidy, health infrastructure, EBP policies, SDoH-related policies) influence (1) access to depression treatment and (2) treatment outcomes for low-SES populations.

According to the peer-reviewed literature, policy analyses, and grey-literature reports published in the last decade, insurance expansion and subsidy policies (e.g., Medicaid, the Affordable Care Act) reduce untreated depression rates and improve outpatient treatment use. Yet disparities persist due to limited provider availability, low reimbursement rates, and inadequate mental-health infrastructures. Incentives for EBP (e.g., integrated collaborative-care models) have potential but require sufficient funding to reach low-SES populations. Finally, upstream SDOH policies (e.g., housing stability, food security, transportation access) mitigate the social-environmental burdens that undermine clinical treatment effectiveness among the low SES group. Tackling SDOH barriers is therefore important for ensuring that policies lead to actual and sustainable treatment gains for this group.

Overall, the results suggest that truly reducing treatment gaps across different SES groups requires multi-faceted strategies that combine coverage and infrastructure reforms, enforce EBP mandates, and integrate social-policy action. The policymaking should move from access alone toward sustained improvement in remission, functioning, and well-being.

Project Mentor: Rachel McClaine, M.A., Department of Psychological Sciences

Page 59: Functional and Microbial Analysis of *Candida albicans* Colonization in Women from Stockholm, Sweden

Delphine Casper (Biology), Department of Biology; Adam Burgener, Department of Pathology, CWRU; Kristina Broliden, Department of Medicine, Karolinska Institutet

Candida albicans is a common yeast species found in the human gastrointestinal and genitourinary tracts. Under certain conditions, it may become pathogenic, leading to long-term complications and heightened vulnerability to other infections. Chief among these are vulvovaginal candidiasis (VVC) and recurrent vulvovaginal candidiasis (RVVC). These infections affect millions worldwide, causing chronic pain, stigma and lost productivity. An estimated 75% of women globally will experience VVC in their lifetime, and 5-8% will experience RVVC, defined as three or more episodes within a year. Treatment is lengthy and often unsuccessful, as guidelines dictate more than six months of antifungal therapy, yet over half relapse. To better understand the mechanisms by which *Candida albicans* disrupts mucosal homeostasis and predisposes individuals to secondary infections, we looked at immunohistological analysis of vaginal biopsies from a cohort of Swedish women and profiled epithelial junction proteins and immune cell infiltration to compare two treatments: fluconazole, the gold standard oral azole, and chlorhexidine, an emerging novel compound used in antiseptics. We hypothesize that *C. albicans* may alter mucosal integrity and immune responses, and these treatments may reduce *C. albicans* presence, leading to an overall healthier vaginal microbiome and recovery of mucosal integrity and immune balance. Using metagenomic and shotgun sequencing, we aim to identify functional and microbial pathways and determine which specific species perform these functions. By integrating host and microbial datasets, we seek to reveal key molecular signatures associated with treatment response and mucosal health. This will allow us to identify how antifungal treatments modulate host–microbe interactions and guide the development of more effective, targeted therapies for VVC and RVVC.

Project Mentors: Dr. Adam Burgener, Department of Pathology, CWRU and Kristina Broliden, Department of Medicine, Karolinska Institutet

Page 60: The Effect of Light Heterogeneity on Plant Biomass Allocation Strategy of Three Understory Herbaceous Plant Species

Daniela Cawley, Biology

Light is one of the most critical factors influencing plant growth. In natural environments, light availability is rarely constant across space or time, especially in forest understories where canopy architecture is highly variable (Helbach et al., 2022). This variability, known as light heterogeneity, can occur spatially, temporally, or as a combination of both. Plants often adjust their biomass allocation strategies in response to heterogeneous environments (Ikegami et al., 2008). However, few studies have quantified how understory herbaceous plants allocate resources under conditions that combine spatial and temporal light heterogeneity. This study investigates how spatio-temporal light heterogeneity affects biomass allocation between aboveground and belowground structures in three understory herbaceous plant species. Four light treatments varying in heterogeneity and mean light level were implemented: (i) high heterogeneity/high mean, (ii) high heterogeneity/low mean, (iii) low heterogeneity/high mean, and (iv) low heterogeneity/low mean. A control treatment with no heterogeneity was also included. Temporal heterogeneity was introduced through a split-plot design in which half of each treatment received morning light and the other half received evening light. Five genotypes per species were used to examine genotype × environment (G × E) interactions in biomass allocation patterns.We hypothesized that under high light heterogeneity and low mean light, plants would allocate a greater proportion of biomass to aboveground structures to maximize light capture, while under low heterogeneity and high mean light, biomass allocation would shift toward belowground structures to enhance nutrient and water acquisition. The clonal nature of these species may also lead to species-specific differences in their responses (Ikegami et al., 2008).

Project Mentor: Dr. Jean Burns, Department of Biology, Case Western Reserve University

Page 61: Relationship Between Trauma and Polycystic Ovary Syndrome

Pihu Chandra, Psychology and Cognitive Science

Polycystic Ovary Syndrome (PCOS) is one of the most prevalent endocrine illnesses among women of reproductive age, with symptoms including metabolic and hormonal imbalance as well as severe psychological discomfort. Recent research reveals that early life adversity, such as childhood trauma and neglect, may have a significant impact in the development and maintenance of PCOS. This literature review summarizes current studies associating adverse childhood experiences (ACEs) to dysregulation of stress-response systems, namely the hypothalamic-pituitary-adrenal (HPA) axis, and investigates how these changes contribute to PCOS pathogenesis. According to research, trauma-related changes in emotional regulation and attachment patterns worsen anxiety, sadness, and body image issues that are frequent in PCOS populations. This study advocates for a trauma-informed approach in PCOS diagnosis and management by combining data from endocrinological, psychological, and qualitative perspectives. Such an approach would treat not just hormonal and metabolic dysfunctions, but also the underlying psychological causes, resulting in more holistic and long-term health benefits. However, many previous studies are restricted by small sample numbers, cross-sectional designs, and dependence on self-reported trauma histories, which limits causal interpretations. The study continues by underlining the importance of longitudinal, interdisciplinary investigations and clinical models that combine trauma screening and psychotherapy therapies with standard medical treatments.

Project Mentor: Joshua Wilt, *Psychological Sciences*

Page 62: Soft Swimming Robot

Marc Chang (Mechanical Engineering)

Soft swimming robots face challenges in efficiency due to limited actuation control and low thrust generation. Inspired by eels, fish, and tadpoles, this project develops a 40 cm long soft robot that uses HASEL actuators to generate a traveling wave along its body. The robot features a bulky head connected to a thin polymer strip acting as the body. Planar HASEL actuators are arranged in pairs along either side of the body, with each pair mechanically synchronized. The head is connected to the body via a hinge controlled by two Peano-HASEL actuator strings, which initiate lateral motion that propagates as a sinusoidal wave along the body. Each planar actuator pair is expected to achieve bending angles of 40–50°, while the neck can bend 35–40°, producing approximately one wave along the body. Based on analogous research and preliminary calculations, the robot is anticipated to swim at 5–15 mm/s in still water.

Project Mentors: Dr. Yi Jin, Department of Mechanical & Aerospace Engineering and Dr. Chase Cao, Department of Mechanical & Aerospace Engineering

Page 63: Macroscale Particle Motion Modeling in a Stirred Tank

William Chang (Chemical Engineering), Department of Chemical and Biomolecular Engineering

Incineration is a commonly used method that utilizes high temperatures (1000°C or higher) for clearing solid waste from landfills. However, the emission of pollutants makes this method undesirable. One potential alternative for gasifying polymer waste is Wet-Thermal Catalytic Oxidation (WTCO), a low temperature (300 - 350°C) fuel-producing process that consists of three parallel reactions: oxidation of polymers, water-gas shift, and the Sabatier reaction. However, the reacting environment of WTCO consists of a three-phase slurry system where the interaction of solid waste, catalysts, liquid water, and gaseous oxygen need to be promoted. This makes developing homogeneity to maximize the reaction rate and conversion of WTCO challenging. In this study, we model the behavior of a spherical particles in a liquid environment within a stirred tank in 2D. Modeling the dynamics of these particles in a stirred media will better identify optimal mixing configurations and operation settings for different substrates. This will ensure WTCO is not limited by the fluid dynamics of the particulate system and associated transport phenomena.

Project Mentor: Dr. Jorge E. Gatica, Department of Chemical and Biomedical Engineering

Page 64: In Vitro Cytotoxicity Analysis of a Synthetic Collagen Surface for Dental Implants

Brian Chang (Biomedical Engineering), Department of Biomedical Engineering, Leena Polomo, Ashman Department of Periodontology & Implant Dentistry, NYU

About half of all dental implants develop problems associated with the interface between the soft tissue of the gums and the titanium abutment. We are addressing these problems by developing an implant coating intended to recapitulate the supracrestal fiber attachment found at the dentogingival interface in natural teeth. This coating involves grafting collagen fibrils that project perpendicularly from the abutment surface. Our process for creating these fibers involves two non-biological components: oxy-amine terminated silanes and collagen monomers in which the terminal carboxy groups have been converted to ketones. We hypothesize that these components, when grafted to a surface, are no more cytotoxic than clean glass. To test this hypothesis, we modified glass coverslips with our synthetic modifications. We then used the MTT metabolic assay and various fluorescent assays to assay the health of 3T3 fibroblasts seeded onto our synthetic surfaces. This in vitro data on the cytotoxicity of our synthetic surface will provide information allowing us to move on to animal and/or human studies using the treated implants.

Project Mentor: Prof. Steven Eppell, Department of Biomedical Engineering, Case Western Reserve University

Page 65: Analysis of Diabetes Risk Factors for Pima Indians

Daniel Chase (Economics), **Alora Patel** (Economics), **Siya Motwani** (Economics)

The Pima Indians have a significantly higher rate of Type 2 diabetes than the general population due to a combination of genetic and environmental factors. This makes them a better population to analyze due to the extensive data points available, which allows tracking of the disease progression over time. The population's homogeneity also allows isolation of genetic factors that contribute to Type 2 diabetes risk. Examining this population will contribute to our understanding of the risk factors involved with being diabetic, as well as medical predispositions that can affect an individual's likelihood to be diabetic. We will do a comprehensive analysis of each risk factor's ability to predict diabetes by generating visualizations using R. Overall, by studying trends in this population, we can get insight into similar trends appearing in other populations worldwide.

Project Mentor: David Clingingsmith

Page 66: Project WHEELS: Ride-On Car Therapy Gaming Platform for Children With Neurological Impairments

Sanika Chaturvedi, Electrical Engineering and **Ethan Kwabia**, Computer Engineering; Yeonjin Kim; Leyi Yu; William Kozak; Anthony Calabro; Matthew Beckwith; Kimberly Bodner; Janie Rapp; Norah Tinsley; James Suzler; Michael Fu

Children with cerebral palsy or traumatic brain injury often face challenges with both movement and thinking skills, making it harder to stay active, social, and engaged in therapy. Traditional programs like short clinic sessions or home exercises can be repetitive and hard to sustain, leaving much of a child's week without meaningful practice. Modified ride-on cars can encourage mobility and fun, but most are limited to outdoor use and can't adapt to children with more complex needs. To help fill this gap, we created a modular ride-on therapy and gaming system that turns rehabilitation into a playful, personalized experience. The platform includes: (1) a 3D-printed library of interchangeable hand controls (push, pull, twist, touch, squeeze, joystick) designed to promote different grasp and wrist motions; (2) a set of adaptive driving games that support skills like attention, memory, problem solving, and hand coordination; and (3) a haptic feedback system that recreates the realistic feel of driving. The system can attach to a standard ride-on car, allowing smooth transitions between indoor gaming and outdoor mobility. It's low-cost, open-source, and easily customizable to match each child's strengths and therapy goals. Developed by a team of engineers, therapists, game designers, and families, the current prototype features ten hand controls and six games. A pilot study will soon test the system with children who have moderate to severe motor and cognitive impairments. We expect the program to boost engagement, improve hand and thinking skills, and reduce caregiver stress, making therapy more enjoyable and meaningful for children with neurological disabilities.

Project Mentors: Michael Fu, Department of Electrical, Computer, and Systems Engineering James Sulzer, Department of Physical Medicine and Rehabilitation

Page 67: MRI-Compatible 3-Axis Orientation Sensor for Interventional Catheters

Katherine Chen, Computer Engineering; **Maxine (Xinru) Meng**, Electrical Engineering; **Yaodan Zhang**, Electrical Engineering

Magnetic Resonance Imaging (MRI) provides excellent soft tissue contrast for guiding minimally invasive procedures, but real-time estimation of catheter orientation within the scanner often relies on imaging-based methods that are slow, computationally expensive, and limited in precision. This project aims to design and prototype a compact, MRI-compatible, three-axis orientation sensor that can be mounted on an interventional catheter to directly measure its spatial orientation. The sensor utilizes three orthogonally arranged linear Hall-effect sensors to detect changes in magnetic flux within the MRI field, enabling continuous orientation tracking without interfering with imaging sequences. Our approach combines mechanical, electrical, and software integration. A SolidWorks 3D model was developed to refine sensor alignment and verify catheter compatibility, while a preliminary printed circuit board (PCB) was drafted in KiCad for the sensing and signal-conditioning circuitry. The system's differential analog outputs will be amplified and digitized by a microcontroller located outside the MRI bore for real-time angle computation. Preliminary bench tests verified electrical connectivity and signal stability of the soldered Hall sensors, which use a 2-input, 2-output configuration per axis. Once calibration and integration are complete, the prototype will be validated using strong static magnetic fields to ensure linearity, stability, and MRI safety. The ultimate goal is to provide a lightweight, low-cost, and MRI-safe sensing system that improves catheter navigation accuracy and streamlines interventional workflows.

Project Mentors: Dr. M. Cenk Cavusoglu, Department of Electrical, Computer, and Systems Engineering, and Dr. Vira Chankong, Department of Electrical Engineering and Computer Science, CWRU

Page 68: Hormone Therapy Considerations During Menopause

Ify Chidi, Anthropology.

Menopause marks the permanent end of menstrual cycles and is characterized by declining estrogen and progesterone levels that impact sexual and reproductive health, bone density, and cardiovascular function. Hormone therapy (HT) is commonly used to relieve symptoms such as hot flashes and mood swings; however, findings from the 2002 Women's Health Initiative trial raised concerns about increased risks of breast cancer, stroke, and heart disease associated with HT, leading to decreased use. Despite this, evidence suggests a potential "window of opportunity" in which initiating HT within ten years of menopause may oMer benefits with fewer risks. The effects of starting HT earlier, during perimenopause, remain less understood and warrant further study. This research aimed to evaluate the impact of hormone therapy initiated during perimenopause on the risk of breast cancer, myocardial infarction (MI), and cerebrovascular accidents (CVA), compared to hormone therapy initiated after menopause and no hormone use. A retrospective cohort analysis was conducted using electronic health record data from the TriNetX database (accessing over 120 million patient records in the United States). Three cohorts were defined using ICD codes: perimenopausal women who began HT within ten years before menopause, menopausal women who began HT at menopause onset, and menopausal women who had never used HT. Propensity score matching was used to reduce selection bias and ensure comparability between cohorts. Findings suggest that early initiation of hormone therapy during the perimenopausal transition does not have a statistically significant difference in the incidence of MI or CVA when compared to later initiation. Hazard ratios for perimenopausal HT initiation (as compared to no HT initiation) were 1.827 for breast cancer, 1.167 for MI, and 1.112 for CVA. In comparison, the hazard ratios for menopausal HT initiation (as compared to no HT initiation) were 2.07 for breast cancer, 0.944 for MI, and 0.918 for CVA. These results indicate that the timing of hormone therapy initiation may not substantially alter long-term health outcomes; however, this study can only establish associations and is unable to infer causality. Further clinical research is needed to confirm these findings and to explore the physiological and age-related mechanisms underlying these outcomes.

Project Mentor: Dr. Rachel Pope MD, MPH; UHCMC/CWRU Department of Population and Quantitative Health Sciences

Page 69: Atheist & Agnostic Reactions to Incontrovertible Proof of God's Existence

Aileen Choi, Departments of Psychology & Sociology; Tina Fong Departments of Psychology, Medical Anthropology, Chinese, Asian Studies; and Sydney Smith, Departments of Biology & Psychology, CWRU

How might atheists and agnostics respond to clear evidence for the existence of a God? This project presents the results of an exploratory study examining this question. Atheists and Agnostics (N=571) recruited by Qualtric research firm were asked an open-ended question about their reactions to incontrovertible evidence proving the existence of a God or higher being. The purpose of this being to gauge various emotional, behavioral, and cognitive responses. Independent coders categorized the reactions into 6 different categories that encompassed a large amount of variety in reactions: positive (happiness, relief, support, acceptance, amusement), negative (anger, betrayal, fear, distress, sadness, shame, guilt, remorse), other emotions (indifference, enlightenment), cognition (confused, shocked, disbelief, curious, skepticism, concern). Two broader categories integrated into the coding scheme were specific reactions/behaviors toward God (approaching God, existential questioning, disengagement), and life turnaround (increasing spirituality, humility, openness, efforts to change behavior). The most common answers were ranked as confusion, joy, loss of freedom, fear, then anger, demonstrating a vast array to be examined in future research. A specific participant's example expressing confusion stated, "Confusion. I would need a lot of time alone to think things through and figure everything out," demonstrating the complexity surrounding religion. From this, Kappa reliability analysis determined that reliability was generally slightly below acceptable, and therefore we initiated efforts to revise the coding scheme to achieve higher levels of reliability. Our goal is to refine the coding scheme to account for these discrepancies in order to provide evidence that nonbelievers' responses to divine evidence are diverse, and may reveal various emotional, cognitive, and behavioral dimensions.

Project Mentor: Professor Joshua Wilt, Department of Psychological Sciences, CWRU

Page 70: Correlation between total polyphenol content and antimicrobial activity against Escherichia coli measured during the 7-day ripening stages of a Musa acuminata

Seonghoon Choi (Chemistry Major, Case Western Reserve University)

This study aims to investigate the relationship between total polyphenol content (TPC) and antimicrobial activity during the seven-day ripening stages of Musa acuminata (bananas). Polyphenols are naturally occurring plant compounds known for their antioxidant and antimicrobial properties. Previous studies have demonstrated that the concentration of polyphenols in fruits changes significantly during ripening, which may influence their ability to inhibit bacterial growth. However, little is known about how these changes occur in bananas or whether polyphenol levels are correlated with antimicrobial strength against Escherichia coli.

This investigation is divided into three parts. Part I will measure TPC (in mg/L gallic acid equivalents) during different ripening stages using the Folin-Ciocalteu (FC) spectrophotometric assay at 756 nm. Part II will evaluate antimicrobial activity using the well diffusion method (WDM), in which banana extracts are applied to agar plates inoculated with E. coli, and the resulting zones of inhibition (ZoI) will be measured using ImageJ software. Part III will assess the correlation between TPC and antimicrobial activity using Pearson's correlation coefficient to determine whether a statistically significant association exists.

This study is expected to identify the ripening stage of bananas with the highest polyphenol content and strongest antimicrobial activity. Establishing a positive correlation between TPC and antibacterial effect could have valuable implications for both the food and pharmaceutical industries. Polyphenol-rich extracts from bananas could serve as natural preservatives or as potential sources for developing new antimicrobial agents. Ultimately, this project aims to contribute to the growing body of research exploring naturally derived compounds that may reduce reliance on synthetic antibiotics and chemical preservatives.
Project Mentor: Dr. Petersen, Department of Biology, Case Western Reserve University

Page 71: Contactless Sleep Stage Classification System

Je-Yu (Leo) Chou, Computer Science, **Jason Zheng**, Computer Science, **Rick Ning,** Computer Science, **Haoxuan Weng,** Computer Science.

Sleep detection and tracking have become increasingly important in people's lives, from monitoring how well one rested to using sleep detection to find the optimal wake-up time. However, one of the major drawbacks of current sleep tracking systems is the need for a device to be worn on the body, typically in the form of a watch. This presents a problem where the wearer might not be as comfortable during sleep, defeating the initial hope of gaining a better insight into how to sleep better, as well as requiring charging. Thus, we hope to use contactless radar technology to detect the users' sleep patterns and incorporate them into a sleep user interface along with an alarm clock. Specifically, we propose to use the Shenzhen Hi-Link LD6002 60GHz FMCW radar for sleep sensing. The radar's onboard sensor is capable of transmitting data, including breathing rate, heart rate, and total phase, at a 50Hz frequency to another device for user input and data processing. For the sleep detection, we used a Long-Short Term Model (LSTM) with inputs from the radar to classify the sleep stages, taking advantage of the model's ability to remember previous results, crucial in time-series data. Finally, a UI is created with Qt6. With publicly available datasets (primarily the Sleep Heart Health Study) and an initial tuning of the radar and the model, we were able to achieve a 55% accuracy rate, which is close to the industry standard. With more fine-tuning, we hope to achieve a 65-70% accuracy and further improve our radar and app communication and interface.

Faculty Mentor: Shuai Xu, Department of Computer and Data Science, Case School of Engineering

Page 72: Attachment, Family Rejection, and Body Image in Gay Men: A Therapeutic Adaptation of Emotionally-Focused Family Therapy

Shubham Choudhary, Psychology

Among gay men, body image disturbance is a major psychological concern that often emerges at the intersection of appearance-based cultural pressures, internalized stigma, and familial rejection. Based on a literature review, this project discusses how an attachment-oriented therapeutic model called EFFT can be adapted to address specific body image issues among gay clients. The goal of the present study is to consider how strengthening damaged attachment bonds within family systems may facilitate self-acceptance and decrease appearance-related distress among gay men. Drawing on the work of Smith et al. (2022) and related empirical and clinical research, this narrative review synthesizes findings from psychology and family therapy literature to identify the emotional, interpersonal, and cultural dynamics underlying body dissatisfaction in gay men. The adapted EFFT framework puts emphasis on the re-creation of secure parent–child attachments, reframing of familial conflict, and open emotional communication as a means to heal. A clinical vignette by Smith et al. describes how this approach can replace appearance-driven validation with deeper emotional attunement and unconditional acceptance. Findings indicate that in cases where the families engage in emotionally corrective interactions, clients enjoy an enhanced body image, reduced feelings of shame, and increased resilience. Nevertheless, limitations include a lack of longitudinal data and the cultural competencies required by the therapist for intersectional factors such as religion, race, and HIV status. The implications of this project spotlight the necessity for adaptation of systemic and attachment-based interventions for marginalized populations whose body image struggles are framed within both internalized ideals and relational trauma. At the same time, integrating family-based therapeutic models like EFFT offers promise in holistic treatment, filling the gaps between LGBTQ+ mental health, family dynamics, and clinical intervention. Faculty Mentor/Capstone

Project Mentor: Dr. Joshua Wilt, Department of Psychological Sciences

Page 73: Modeling the Neutrophil Oxidative Burst to Assess Impacts on Ex Vivo Tau Seeding

Ashley Chow, Biology; Danielle F. Bytnar, Department of Pathology;

In Alzheimer's Disease, pathogenic tau proteins induce healthy tau proteins to misfold and self-propagate (tau seeding), eventually forming insoluble aggregates that lead to widespread neuronal cell death and cognitive decline. Due to previous studies demonstrating hypochlorous acid's (HOCl) effectiveness in eliminating prion protein seeding activity and infectivity, this has led to further investigation into tau seed susceptibility to HOCl and HOCl-producing cells. In particular, neutrophils are white blood cells that clear pathogens through phagocytosis and oxidative burst, a process in which myeloperoxidase combines hydrogen peroxide and chloride ions to produce the microbial compound, HOCl. Prior studies in the lab have observed an increased oxidative burst response in neutrophils exposed to tau seeds, but the underlying cellular mechanism remains unclear. As such, the overall objective of this study is to not only replicate the oxidative burst process using another HOCl producing cell model but also to investigate the impact of cell-derived HOCl on tau seeding activity. Data from dichlorohydrofluorescein diacetate assay (DCF-DA) indicates increased HOCl production when Human-Leukemia (HL-60) cells are first differentiated into neutrophil-like cells and then exposed to ex vivo tau seeds from primary age-related tauopathy and early and late stage Alzheimer's Disease cases. Despite this increased oxidative burst response, the hypothesized reduction in tau seeding activity is not observed using tau Real-Time Quaking-Induced Conversion (RT-QuIC) assays, which semi-quantitatively detect tau seeding capacity using log10 endpoint dilution analysis. However, brain homogenate samples and ex vivo tau seeds from these cases exhibit multi-log reduced seeding activity after HOCl solution incubations across multiple time points using tau RT-QuIC assays. Preliminary data from FRET Tau biosensor assays (another tau seed amplification assay) suggests a more linear-scale decrease in seeding activity, but further investigation is necessary to better understand cell-derived HOCl's impact on tau seeds and seeding activity.

Faculty Project Mentor: Dr. Allison Kraus, Department of Pathology

Page 74: Zonal System-Level Model for the Zero Boil-Off Tank Experiments

Osi Chukwuocha (Mechanical Engineering)**,** Department of Mechanical & Aerospace Engineering

Cryogenic propellants are important for long-duration space missions, but they slowly absorb heat from their surroundings in space, causing them to evaporate and build up pressure. The present passive propellant tank pressure control is based on venting the boiled-off vapor to prevent a dangerous tank pressure rise. But this passive strategy leads to costly fuel losses. The Zero Boil-Off Tank (ZBOT-1) investigated self-pressurization and pressure control of cryogenic propellants under ventless tank conditions in microgravity. In the present work, to complement ongoing experimental efforts and reduce reliance on costly testing and CFD simulations, a zonal system-level model was developed using a control volume approach and application of fundamental conservation laws for mass and energy. The model breaks the ventless tank into four different nodes: the tank wall, the vapor region, the liquid region, and the interface. The model simulates the liquid and vapor temperature evolution over time by solving ordinary differential equations for the rate of temperature in the vapor and liquid regions. The vapor pressure evolution is evaluated from the temperature calculations using the ideal gas law. The model was validated with 1g tests from ZBOT-1. In these tests, the model showed good agreement and significant improvement from the previous thermodynamic model. The present model can be used to quickly and accurately generate pressurization data to aid the design of improved tank thermal insulation systems for microgravity applications. Future developments will also include enhancing the model to simulate cryogenic tanks that contain non-condensable gases, allowing support of the future Zero Boil-Off Tank Non-Condensable Gas (ZBOT-NC) microgravity experiment.

Project Mentor: Dr. Mohammad Kassemi, Department of Mechanical & Aerospace Engineering, CWRU, NASA

Page 75: Remembering Lists of Words

Emily Cichocki (Psychology, Business Management)

This experiment tested people's memory and their recognition of words they have seen before. Participants first observed a list of 70 words shown one at a time. They then completed a memory test with 60 questions, where each question showed two words: one word from the list (called an "old" word) and one word not from the list (called a "new" word). In one half of the test, participants chose the old word, and in the other half, they chose the new word. This setup was used to compare how different types of memory decisions affect how people remember words.

Project Mentor: Dr. Robert Greene, Department of Psychological Sciences, Case Western Reserve University

Page 76: A High-Precision, PC-Interfaced Motor Controller for a Split-Belt Research Treadmill

Shoma Yukawa, Electrical Engineering; **Ceci Cohen**, Computer Engineering; **Yixuan Yang**, Electrical Engineering

The Biologically Inspired Robotics Laboratory hosts a split-belt treadmill for researching robotic locomotion in quadruped robots. However, the existing treadmill system exhibits insufficient precision due to the limitations of the current off-the-shelf motor controller in use. This lack of precision prevents researchers from executing experimental protocols that require specific speed profiles and real-time force feedback integration, which are critical for studying gait adaptation, inter-limb coordination, and bio-inspired control strategies in quadruped systems. This project's central purpose is to develop a new, high-fidelity motor control system to replace the existing one. The new system is designed to provide precise, closed-loop control over the treadmill's two brushed DC motors via an Arduino Mega 2560 interfacing with a Pololu G2 high-power motor driver. A software interface was also developed to facilitate serial communication between the controller and a host PC with functionality to execute sequential speed commands. The primary result of this work is a functional, dual-axis motor controller. The system successfully executes speed commands sent from a host PC and reads and returns force feedback data from the treadmill's existing onboard strain gauges. This integration of command and feedback creates a closed-loop-capable system that was not previously possible. This new controller system successfully addresses the precision gap of the original hardware, enabling more sophisticated locomotion studies. The system's validated performance and modular design position the laboratory to conduct advanced research in adaptive gait control and biomechanical analysis of quadruped locomotion.

Project Mentor: Will Nourse, Department of Mechanical and Aerospace Engineering

Page 77: Control and Optimization of Clean Solvent Recovery Systems

Ryan Coneway, Systems and Controls Engineering

Paint manufacturing systems rely on solvent recovery systems to recover cleaning solvents used in equipment cleaning and maintenance. These systems rely on operator involvement to operate valves and pumps manually. Heavy reliance on operators increases avenues for risk while also limiting the system's overall efficiency. This project seeks to address these problems through the implementation of automation and process modeling. Utilizing Rockwell Automation's FactoryTalk and Studio 5000 environments, a Programmable Logic Controller (PLC) and Human-Machine Interfaces (HMIs) were developed to emulate and display the full solvent recovery process. The PLC allows for real-time control of the clean solvent system while also allowing for data collection on key process variables within the system, such as flow, tank levels, and alarms. The HMIs allow for real-time visualization of the system as it carries out the different steps needed to recover the cleaning solvent. Concurrently, a dynamic simulation model is to be built using MATLAB Simulink. This model will replicate the system behavior and provide insight into areas for possible optimization. The completed system will demonstrate how integrated automation, and simulation can enhance solvent recovery efficiency and provide a baseline for future control applications.

Project Mentor: Oliver Tiber and Riva Chankong

Page 78: CFTR Dysfunction Promotes Intestinal Barrier Defects and Pathogenic E. coli Expansion in Controlled Microbiota Mouse Models

Megan Cua, Biology; Zaria Johnson, Brian Chang,

Cystic fibrosis (CF) is a genetic disorder caused by mutations in the cystic fibrosis transmembrane conductance regulator (Cftr) gene, resulting in multisystem complications, particularly affecting the respiratory and gastrointestinal tracts. Individuals with CF have shown reduced gut microbiota diversity, including a notable rise in E. coli linked to greater inflammation and shorter infant growth. The goal of this study was to use germ-free, Cftr-null, and intestine-specific knockout mouse models with precisely introduced and controlled microbiota to eliminate confounding microbial influences from previous research and demonstrate that Cftr dysfunction directly drives reduced microbial diversity and E. coli overgrowth, leading to harmful effects in the CF gut. We used Cftr S489X (CF) and Cftr Flox/Flox × Villin-Cre+ (intKO) mice, along with controls, colonized with the defined 8-member Altered Schaedler Flora (ASF) to simplify the microbiota. ASF normalizes many facets of the germ-free intestine and does not induce colonization resistance, allowing direct observation of interactions between host genotype and the E. coli strain SWW33. We assessed intestinal barrier function using a FITC-dextran assay and quantified E. coli by CFU counts on MacConkey agar. We found that neither germ-free nor ASF-colonized CF or intKO mice showed increased barrier permeability compared to controls. However, when colonized with ASF plus E. coli, both CF and intKO mice showed significantly higher serum FITC-D levels and E. coli CFUs in colon contents, indicating an impaired intestinal barrier. These findings demonstrate that intestinal Cftr expression is essential for preserving barrier integrity.

Project Mentor: Dr. Adeline Hajjar, Department of Cardiovascular and Metabolic Sciences, Cleveland Clinic Lerner Research Institute

Page 79: Democracy and Effective Environmental Policies

AJ Curcio, Political Science & Sociology

This study examines how politicians' personal economic interests influence the adoption of environmental laws that could potentially threaten those interests. Existing research suggests that the more democratic a regime, the stronger the accountability mechanisms that make personal enrichment less appealing. We hypothesize that the higher the level of democracy in a country the greater number of effective environmental policies adopted because stronger accountability mechanisms make politicians more willing to adopt environmental laws costly to their business interests. Using cross-national democracy data from the Varieties of Democracy project and environmental policy data from the Climate Policy Database (CPD), and Climate Change Laws of the World (CCLW), we test the relationship between level of democracy and the adoption of environmental laws.

Project Mentor: Dr. Kelly McMann

Page 80: Transient and Steady-state Analysis of Dense Suspensions

Alessandro d'Amico (Chemical Engineering), Chemical and Biomolecular Engineering Department, Case School of Engineering

Our understanding of soft matter systems is limited due to these system's immense complexity. One such system of great interest to the scientific community is the shear-thickening dense suspension (ST-DS), where viscosity can increase by orders of magnitude with onset stress. ST-DSs have recently been successfully simulated and these simulations have revealed that the interparticle frictional contacts are the cause for the observed increase in viscosity. These frictional contacts form system spanning networks at high stresses. Following our previous work where a single network parameter capable of characterizing the network in a way that correlates with reduced viscosity was found, this work is extended to transient systems following shear reversal. After shear reversal, the viscosity collapses and then slowly rebuilds. Our analyses further sheds light on the network as the viscosity rebuilds.

Project Mentor: Abhinendra Singh, Department of Macromolecular Science and Engineering, Case School of Engineering

Page 81: Cell Type-Specific Anatomical Mapping of Medial Septum Neuron Connectivity

Ethan Daley (Neuroscience), Department of Neurosciences and Department of Psychology

The hippocampus is an area located in the limbic system mainly associated with functions of learning, memory processing, and spatial navigation. It can be divided into multiple regions, including CA1, CA2, CA3, the dentate gyrus, and subiculum. The flow of information through these regions can be modeled by the trisynaptic circuit, which has been shown to play an important role in Long-term Potentiation. This process is modulated by neurons in the medial septum, an area located in the basal forebrain with functions including orchestration of various oscillatory neuronal activities. There are three main populations of neurons found in the medial septum: cholinergic neurons that can be stained by Choline Acetyltransferase (ChAT), GABAergic neurons that comprise parvalbumin-expressing (PV) neurons and other GABAergic neurons, and glutamatergic neurons that can be represented by VGlut2. The purpose of this study was to determine the upstream brain regions that monosynaptic project to cholinergic, PV, and glutaminergic neurons in the medial septum. This was accomplished by using a pseudotyped rabies retrograde tracer, which utilizes a modified rabies virus with the glycoprotein removed to prevent the virus from traveling polysynaptically. First, 300 nL of the Cre-dependent helper virus was injected into the medial septum in ChAT-Cre, PV-Cre, and VGlut2-Cre mice, respectively; two weeks later, the pseudotyped rabies virus was injected into the same coordinates. A week after the second injection, the mice were sacrificed through cardiac perfusion. After sectioning of the mice's brains at 45 μm, they were stained using a 2-day immunohistochemistry protocol. The slides were analyzed with a BZ-X800 fluorescence microscope, and cells were counted using ImageJ.

Project Mentor: Dr. Qian Sun, Department of Neurosciences

Page 82: Post Stroke Upper Arm Support

Vo Linh Chi Dao, Biomedical Engineering; **Cataldo Strangi**, Biomedical Engineering; **Joseph Chacon**, Biomedical Engineering; **Annie Yonas**, Biomedical Engineering; **Raunak Chawla,** Biomedical Engineering

Stroke is one of the leading causes of death in the United States, with over half of stroke survivors sustaining lasting disabilities. Abnormal synergy for hemiplegic stroke survivors is among the common disabilities, which manifests as uncontrollable elbow, wrist, and finger flexion associated with arm abduction. This greatly disrupts a stroke survivor's ability to do activities of daily living (ADLs), as their fine motor control is compromised. Studies have found that when assistance is provided in the abduction and adduction motion, the resulting synergistic flexion is greatly reduced. Studying an effective mechanism to assist partial motor control in affected individuals, we are developing an adjustable shoulder sling that acts as an artificial deltoid for the hemiplegic arm. The device architecture is based around a motorized pulley mechanism, which converts the mechanical output of the motor into tension in the wire. The wire is guided along the patient's medial deltoid and back to supply additional torque at the glenohumeral joint. By reducing the amount of force produced by the medial deltoid when performing these motions, the resulting flexion synergies are reduced, allowing improved control of the lower extremity of the arm. The sling will be adjustable to fit a range of users and remain comfortable for extended wear. To verify the mechanism of the pulley-based device, we will determine the assistive force required for arm abduction, evaluate the mechanical efficiency in translating motor torque to arm elevation under static support and dynamic lifting conditions using a fake arm model, and measure the system's energy consumption. If this device is successful, we expect to see reduced deltoid activation in the affected user and a subsequent decrease in abnormal synergies, which will increase affected patients' abilities to perform ADLs.

Project Mentor: Professor Matthew Williams, Department of Biomedical Engineering, CWRU

Page 83: In Sickness and in Health: Exploring the Co-evolutionary Relationships Between *Gephyrocapsa huxleyi* and Giant Viruses

Cecilia Dapino (Biology)

Marine phytoplankton are responsible for nearly half of global primary production, and are key drivers of global ocean ecology and nutrient cycling. Gephyrocapsa (formerly Emiliania) huxleyi is a globally distributed coccolithophore known for its ability to form large blooms in the open ocean, playing a significant role in the marine carbon cycle. G. huxleyi is known to be infected by Nucleocytoviricota viruses, which ultimately regulate their ecology and distributions. For example, viral infections are thought to be important in the termination of G. huxleyi blooms. Yet, the host-virus relationship between G. huxleyi and its associated viruses remains comparatively understudied. Here, we systematically analyzed 62 Gephyrocapsa strains from 35 locations. We identified the eukaryotic infecting nucleocytoplasmic large DNA viruses (NCDLV) as a dominant phylum (4.5%, n=262) across the strains. Mimiviridae (44.2%, n=116) and Phycodnaviridae (37.4%, n=98) were the most abundant NCLDV families, with co-infections of these two families occurring in 55.0% (n=22) of our G. huxleyi strains. To contextualize the identified viruses within an evolutionary framework, we constructed a phylogenetic tree from viral genomes containing a conserved packaging ATPase nuclear marker gene. The ATPase phylogenetic tree resolved two distinct clades attributed to Mimiviridae and Phycodnaviridae. Furthermore, co-evolution analysis between viruses and hosts showed that viral diversity was shaped by numerous horizontal gene transfer events and losses. Together, our findings provide a window into Gephyrocapsa huxleyi-viral dynamics and their potential impact on marine productivity and nutrient flows.

Project Mentor: Sarah Bagby, Biology Department

Page 84: Optimization of an in-house Jaffe creatinine assay for kidney function assessment

Sanvi Daram (Biology), **Valerie Wijoyo** (Biology)

Chronic kidney disease (CKD) is characterized by the progressive loss of kidney function, with diabetes being the leading cause. Estimations of glomerular filtration rate (GFR), the rate at which kidneys filters blood, are an important clinical surrogate of kidney function. Creatinine is a subproduct of muscle metabolism with a relatively constant production rate. Near 90% of urinary creatinine originates from glomerular filtration. Therefore, the mass of creatinine excreted over time, together with its plasma concentration, provides the basis for calculating GFR. Objective: optimize an assay to measure creatinine accounting for glucose interference, a metabolite often elevated in serum and plasma from diabetic patients. Methods: we used the Jaffe method on a 96-well plate. Individual wells were added with 50 µl of creatinine standards (0-20 mg/dL) and 100 µl picric acid (17.5 mM). The reaction was started with 100µl NaOH (0.29M), and 492nm absorbance measured at multiple timepoints. Results: Protocol 1: end point reaction at 30min yielded a linear response (Abs = 0.2582X+0.1918; r^2=0.9999). Protocol 2: Protocol 1 was repeated adding different 4 amounts of glucose (0µg, 50µg, 125µg and 250µg); producing 4 parallel curves. Protocol 3: Protocol 2 was repeated at 3 extra timepoints (5min, 10min, 20min). The distance between parallel curves was reduced at lower reaction times; demonstrating that glucose kinetics are slower than creatinine. Protocol 4: a kinetic assay ($\Delta_{492nm}/\Delta_{4\text{-}1min}$) was implemented to measure GFR in 3 Zucker Diabetic Fatty rats, yielding results within normal range (0.89±0.34ml/min). Conclusion: The results confirm that the classical Jaffe method remains a viable approach for creatinine quantification when appropriately adapted to account for glucose interference in diabetic rats. Although the principles of this method are well established, our work provides a practical optimization for routine use, demonstrating accuracy comparable to commercial assays at a fraction of the cost.

Project Mentor: Augustin Gonzalez-Vincente

Page 85: Survey on Epidural Education and Social Media Influence

Haddy Dardir, Department of Psychological Sciences, CWRU

Epidural anesthesia is a neuraxial technique to manage labor pain in expecting mothers. Although a 2011 study revealed that 61% of laboring women undergo epidural anesthesia, women often decline this procedure because of needle phobia, fear of paralysis, and the pain associated with needle placement (Munro et al., 2018). Social media—consisting of many networking platforms in which an estimated 5.31 billion people communicate with each other, share personal experiences, and educate one another—has assumed a prominent role in health education on a global scale. Pros of using social media for health information include combating the spread of misinformation and allowing healthcare professionals such as anesthesiologists to reach a wider audience (Kanchan and Gaidhane, 2023). However, social media can act as a double-edged sword by spreading health misinformation to a large audience as well (Kanchan and Gaidhane, 2023). Conventionally, anesthesiologists explain the risks and benefits of epidural anesthesia upon the request of mothers admitted for labor pain (Cheng et al., 2020). Social media may be another common source of information on epidural anesthesia for these mothers, underscoring the need for further research on the relationship between social media and epidural education. The following study aims to investigate this relationship by determining which source of information—social media platforms or healthcare professionals—expecting mothers utilize the most when obtaining information on epidural anesthesia for labor pain management. Starting in early 2025, short surveys were offered to expecting mothers in the birthing rooms of Labor and Delivery at MetroHealth Medical Center. Since then, while it has been found that healthcare professionals may still have the greatest influence on expecting mothers' epidural education, a larger and more complete sample (n = 1000) is needed to determine the potential influence of social media and other information sources on expecting mothers' epidural education as well.

Project Mentor: Dr. Matthew Sikora, Department of Anesthesiology, MetroHealth Medical Center

Page 86: The Origins of Tonal Metric Hierarchy: Combined Mean Field Model of Musical Harmony and Rhythm

MG Davis (Physics)**,** Department of Physics, CWRU

In music, a combination of rhythm and harmony creates enjoyable patterns. The pitch and rhythm are coupled in music theory; in general, it can be observed that “weak beats” — that is, beats that are less likely to contain a pitch — has a wider variety of pitches than “strong beats”. Previous research found that, in a model where temperature and chemical potential parameters control the degree of randomness and the density of notes, respectively, music can be thought of as maximizing entropy and rhythmicity while minimizing dissonance. The phase transitions between “ordered” and “disordered” states have been studied for harmony and rhythm separately. In this project, however, we combine them into one mean field model and numerically calculate the pitch and rhythm distributions that occur for different temperatures and chemical potentials. When the models are put together, we find that the coupling of the two types of order leads to six different phases which are classified by the combination of pitch and rhythm orderings that occur. This combined model recovers the "tonal-metric hierarchy", or the idea that a smaller set of tonally significant pitches appear on the strong beats, and a wider variety of pitches appear on the weak beats.

Project Mentor: Dr. Jesse Berezovsky, Department of Physics, CWRU

Page 87: Analyzing Cost Disparities for Common Hospital Procedures Across the US

Tej Moradia, Mechanical and Aerospace Engineering; **Josh Rosen**, Mechanical Engineering; **Elijah Davis**, Neuroscience and Economics

The United States healthcare system displays significant variation in hospital procedure costs, even for the same treatment. This study investigates cost differences for a common procedure across U.S. hospitals and assesses which factors, such as hospital location, ownership type, or procedure category, most strongly predict variation in charges. We will analyze publicly available datasets from the Centers for Medicare & Medicaid Services (CMS), the Agency for Healthcare Research and Quality (AHRQ) Medical Expenditure Panel Survey (MEPS), the American Hospital Association (AHA), and more. The methodology includes identifying a frequently performed procedure, mapping costs by hospital and state, and conducting regression analyses linking average covered charges, total payments, and payments to hospital ownership, region, urbanity, and procedure intensity. We also explore whether cost variation for this procedure is greater than for other less common ones. Preliminary findings suggest that region and hospital ownership status are stronger predictors of cost variation than the procedure itself. Private for-profit and urban hospitals tend to bill more than public or rural counterparts. This research contributes to efforts in healthcare transparency and cost regulation by identifying which institutional and regional factors most significantly drive pricing differences for common hospital procedures.

Project Mentor: David Clingingsmith, Department of Economics

Page 88: Enhancement of LNP endosomal escape via engineering of PEG-lipid properties

Matt Davis (Biomedical Engineering)

Gene therapy is an emerging category in the field of oncology that has the potential to revolutionize cancer outcomes. Rather than indiscriminately damaging both cancerous and healthy cells, these modern therapeutics selective modulate the dysfunctional cell behaviors responsible for perpetuating cancer growth. However, cancer-targeted gene therapies must reach a diverse selection of cells spread across the body, so significant attention has been dedicated to engineering a drug delivery platform that is both capable of facilitating payload release to intracellular destinations and is resistant to clearance by the mononuclear phagocyte system (MPS), a system dedicated to identifying and destroying foreign particles in systemic circulation. Lipid nanoparticles (LNPs) have emerged as a promising vehicle for transfecting cells locally, but their rapid clearance by the MPS disables delivery to distant tissue. The MPS can be evaded by incorporating polyethylene glycol (PEG) on the surface of LNPs, which creates a hydrophilic stealth layer that prevents the binding of opsonizing proteins. However, once the LNPs reach their target cells, surface PEG inhibits release of the gene-therapy payload into the cytosol of the target cells. Therefore, a solution is needed that preserves the stealth granted by surface PEG during circulation while reducing PEG's interference with payload delivery upon arrival at the target site. One promising approach involves modulating the chemical characteristics of the PEG-conjugated lipids of LNPs. This study aims to determine how chemical modifications of PEG-lipids affect pharmacokinetics, cellular uptake, tumor targeting, and therapeutic efficacy when systemically delivering LNPs loaded withi immune-stimulatory gene therapeutics to a murine melanoma model.

Project Mentor: Dr. Efstathios Karathanasis, Department of Biomedical Engineering, Case School of Engineering

Page 89: Evolving Tolerance: Shifts in American Attitudes Toward Controversial Speech

Abigail Bergson-Conklin, Economics and Political Science; **Ella Bernstein**, Economics; **Alyssa Davitt**, Neuroscience and Economics

This project examines how Americans' attitudes toward allowing controversial political speech have evolved since the 1970s. Using data from the General Social Survey (GSS), which has tracked U.S. social attitudes and cultural participation since 1972, we analyze longitudinal trends in public support for free expression and First Amendment rights. Our study further explores how these attitudes vary across demographic factors such as gender, race, religion, and education. By identifying shifts in tolerance for controversial speech over time, this research aims to shed light on broader changes in the American political climate and public discourse.

Faculty Mentor: Professor David Clingingsmith, Department of Economics

Page 90: Left Ventricular Assist Device: Mechanisms of Failure

Havana De Celis (Biology), Department of Biology

Heart failure remains a leading cause of mortality worldwide. Left Ventricular Assist Devices (LVADs) provide improved survival and quality of life for patients with advanced heart failure, but their long-term use is limited by serious complications. This project examines the main physiological factors that lead to LVAD failure. The goal is to understand how these problems interact and to identify ways to improve device performance and patient outcomes. Driveline and bloodstream infections are frequent due to the external power source and driveline. Localized inflammation at the driveline can progress to systemic infection. Neurological complications, particularly ischemic and hemorrhagic strokes, are influenced by blood pressure regulation, pump flow dynamics, and anticoagulation management. Right ventricular failure often develops after implantation because of the change in loading and increased stress on the ventricle. Hematological complications require a specific balance between anticoagulation and hemostasis. Recent technological advances, such as magnetically levitated and fully implantable LVADs, show promise in reducing these risks and improving long-term results. A deeper understanding of the body's response to LVAD support and continued device improvement can help reduce complications, extend survival, and enhance quality of life for patients with advanced heart failure.

Project Mentor: Ronald Oldfield, Department of Biology, CWRU

Page 91: Firearm Access, Policy Shocks, and Gun Violence Across the U.S.

Andrew Dementiev, Mathematics and Economics, Case Western Reserve University **Maxwell Yuan**, Applied Mathematics and Economics, Case Western Reserve University **Anna Wang**, Statistics, Case Western Reserve University

This project examines how both historical differences and recent changes in firearm accessibility laws affect gun violence across U.S. states. Historically, states have taken different approaches to firearm regulation and in recent years, these divisions have deepened. Some states have expanded permitless carry, while others have strengthened background checks and complicated waiting period laws. These differences raise key questions about how these long standing state legal environments and sudden policy shifts shape public safety outcomes. Our research seeks to answer: How do accessibility and state policies correlate with firearm violence in those areas? Using data from the Centers for Disease Control and Prevention's National Violent Death Reporting System (NVDRS) and the RAND State Firearm Law Database, we observe a dataset of all 50 states from 2000 to the most recent information available. The unit of observation is state-year, allowing analysis of how policy shocks and legislative trends evolve over time. Key variables we want to observe specifically are firearm homicide and suicide rates, gun ownership estimates, and policy strictness indices, with controls for demographic, economic, and regional attributes. We analyze these relationships using fixed-effects as well as event-study models to better understand how policy differences and shifts such as the introduction of permitless carry or red flag laws affect firearm violence rates. By comparing states before and after major legislative changes, while also observing similar states with differing policies, the analysis provides a clearer picture of how both short term shocks and long term policy environments influence gun violence in the U.S. We expect to find that laws increasing firearm accessibility correlate with higher firearm death rates, while restrictive policies are associated with reductions in gun violence. These findings aim to clarify how policy choices influence outcomes in the ongoing national debate over gun regulation and public safety.

Project Mentor: David Clingingsmith, CWRU

Page 92: The Role of Glut1 in Rod Photoreceptors on Retinal Glucose Homeostasis and Diabetic Retinopathy

Vidhi Deshmukh, BS in Neuroscience

Diabetic retinopathy is characterized by reduced light-evoked retinal responses and increased oxidative stress and inflammation. Previous studies indicate that the systemic reduction of the glucose transporter Glut1 improves these abnormalities. This study investigates whether the selective reduction of Glut1 in rod photoreceptors is sufficient to prevent retinal dysfunction in diabetes. Conditional Glut1 inactivation in rod photoreceptors is achieved via Cre-LoxP recombination by crossing Glut1 flox mice with mice expressing Cre recombinase in Rhodopsin+ cells. Wild-type and conditional knockdown mice (Glut1 flox/+ RhoCre+) are rendered diabetic using streptozotocin (STZ) to ablate pancreatic β-cells. Retinal cellular and structural changes are assessed by immunohistochemical staining for GFAP, NeuN, Rhodopsin, and Cone Arrestin, and electroretinography (ERG) is used to evaluate light-evoked responses. It is anticipated that Glut1 reduction in rod photoreceptors will preserve retinal function and morphology in diabetic mice, exhibiting the expected protective effects of systemic Glut1 reduction. These findings suggest that glucose uptake by rod photoreceptors plays a critical role in driving early retinal dysfunction in diabetes. Modifying the metabolic activity of these cells may therefore represent a novel therapeutic strategy for preventing or treating diabetic retinopathy.

Project Mentors: Dr. Ivy Samuels, Department of Ophthalmology, Cleveland Clinic; Dr. Jon Niemi, Department of Neuroscience, CWRU

Page 93: Amphiregulin-Mediated Regulation of OCT6 in Schwann Cells: Insights Into Tumor-Supportive Reprogramming

Damanpreet Dhillon, Biological Sciences, University of Cincinatti

Schwann cells (SCs) are peripheral nervous system (PNS) glial cells that surround and myelinate axons. Despite being known to possess regenerative capability, recent evidence has revealed that SCs play a role in tumor promotion, particularly of oral cancers, through immune modulation and altered signaling. Amphiregulin (AREG), an epidermal growth factor receptor ligand, is responsible for triggering such tumor-promoting action. Among the key targets in such a process is Octamer-binding transcription factor 6 (OCT6), which is one of the transcription factors playing a critical role in SC identity and myelin control. Current research investigates the effect of recombinant human AREG (hrAREG) on OCT6 expression in cultured SCs as a tumor-associated reprogramming marker. RATIONALE: Does amphiregulin (AREG) regulate Schwann cell phenotype by influencing OCT6 expression, affecting their role in myelination and possible tumor activity? APPROACH: Human Schwann cells were seeded onto AlphaBioCoat - coated flasks in Schwann Growth Medium and were treated with hrAREG 5 ng/mL or 25 ng/mL. The protein lysates were collected on Days 2 and 6, and the Western blotting was performed to analyze the OCT6 expression using GAPDH as the housekeeping control. RESULTS: Although the results need to be validated through more robust experiments, preliminary observations demonstrate that AREG may control OCT6 in both a concentration and time-dependent manner. AREG control of OCT6 supports the hypothesis that Schwann cells can be reprogrammed toward oncogenic phenotypes, positioning OCT6 as a potential transcriptional association between Schwann cell plasticity and oncogenesis.

Project Mentor: Dr. Pushpa Pandiyan, Department of Biological Sciences, School of Dental Medicine

Page 94: Design & Fabrication of Coil for Differential Kerr Microscopy

Samuel Diener, Department of Physics; Eli Doyle, Department of Physics; Jesse Berezovsky, Department of Physics, CWRU

Using a Magneto-optical Kerr Effect (MOKE) microscope we can read the absolute magnetization of our samples in a static field, though this suffers from edge artifacts and vibrational noise. Thus, we can reduce these disturbances in our signal by utilizing differential measurements, which are MOKE images of the sample in an oscillating field. This project designed a modification to the current MOKE apparatus to create this oscillating magnetic field, external from the sample plate itself. Then, we fabricated, implemented, and tested the new stage for imaging magnetization of permalloy nanostructures. This can potentially be used in the future for imaging magnetic coupling of qubits.

Project Mentor: Professor Jesse Berezovsky, Department of Physics, CWRU

Page 95: Esophageal Protection Device for Atrial Catheter Ablation

Julia Cho (Biomedical Engineering), **Eliza Dixon** (Biomedical Engineering), **Pierce Justice** (Biomedical Engineering), **Anika Mittal** (Biomedical Engineering), **Mimi Seligman** (Biomedical Engineering)

Thermal injury to the esophagus is a common complication during atrial catheter ablation procedures used to treat atrial fibrillation heart arrhythmias. These injuries are driven by the heat generated by the ablation procedure itself damaging the esophageal wall. Occurring in up to 40% of patients, these injuries range from uncomfortable to deadly. Atrial-esophageal fistulas (AEF) are a rare but severe form of thermal injury that are almost always deadly to patients, creating an abnormal hole between the posterior wall of the left atrium of the heart and the esophagus. AEF's usually go undetected for a few weeks, until the patient begins to get symptoms such as fever, nausea, dyspnea, and painful swallowing. By the time an AEF is detected, there is a very small chance the patient will survive. Other thermal injury complications involve burning sensations, pain, and discomfort.

Current mitigation strategies, such as passive cooling, intermittent temperature monitoring, and repositioning the esophagus are limited because they provide slow, indirect, or incomplete protection. We present the design of an esophageal device that integrates active cooling with co-located temperature sensing to directly minimize thermal injury during ablation and enabling real-time monitoring of esophageal temperature conditions. Our device directly addresses these limitations through an active, closed-loop cooling system with integrated real-time temperature sensing. Unlike current methods, this approach maintains stable esophageal temperatures throughout the procedure, reducing the likelihood of localized overheating and tissue injury, to prevent AEFs, improving procedural safety without disrupting electrophysiological workflow.

Project Mentor: Prof. Matthew Williams, Department of Biomedical Engineering, CWRU

Page 96: The Impact of Particle Bidispersity in Force Chain Formation and Rheology of Dense Suspensions

Ria Duggal (Chemical Engineering)

Dense suspensions composed of non-Brownian particles dispersed in a Newtonian solvent are widespread in environmental and industrial systems. Their complex, non-Newtonian behavior, such as shear thickening and jamming, arises primarily from the formation and evolution of force chain networks within the suspension. The emergence of these networks is governed by particle-level characteristics, including size, shape, surface roughness, and interfacial chemistry, as well as interparticle forces. While recent studies have deepened our understanding of force chain dynamics in monodisperse systems (where particles are nearly uniform in size), many real-world suspensions involve bidispersity, comprising particles of two distinct sizes. A systematic understanding of how varying degrees of bidispersity influence suspension rheology is therefore critical for bridging the gap between idealized models and complex practical systems.

In this work, we employ Lubrication Flow–Discrete Element Method (LF-DEM) simulations, which couple lubrication hydrodynamics with particle-scale contact mechanics, to replicate experimentally observed steady-state rheology in dense suspensions. Our simulations reveal that increasing the degree of bidispersity reshape force chain topology and influence bulk flow behavior across a range of applied shear stress. These results offer new insights into the microstructural origins of rheological transitions and advance predictive modeling of dense suspensions in both engineering and geophysical applications.

Project Mentor: Abhinendra Singh, CWRU

Page 97: Wearable Biosignal System for Detection and Prediction of Recurrent Syncope

Ari Kefer (Biomedical Engineering), **Kaitlin Kim** (Biomedical Engineering), **Kanthi Karumbunathan** (Biomedical Engineering), **Michael Dumas** (Biomedical Engineering), **Rohan Bhushan** (Biomedical Engineering)

Fainting, clinically referred to as syncope, is a non-traumatic and transient loss of consciousness that affects up to 42% of individuals at least once in their lifetime. While an isolated episode is not always a cause for alarm, recurrent events often raise concern as they may point to underlying health risks. With those who have experienced syncope, 35% of these cases involve recurrent syncope. Beyond the immediate danger of falls and injury, repeated syncope can significantly reduce quality of life and complicate long-term clinical management. Existing monitoring tools are often invasive, costly, or impractical for long-term use, highlighting a need for improved diagnostic tools and more reliable, patient-friendly approaches to managing recurrent syncope. This project aims to design a wearable device to monitor and predict recurrent syncope events for patients in a clinical setting, supplementing physician diagnosis. We focus on implementation of continuous ECG and oxygen saturation monitoring as the most feasible indicators for a proof-of-concept prototype. Data collected by the device analyzes deviations from user-specific baselines to detect early signs of syncope and generate alerts. In the future, this approach may be even expanded for at-home use, with the addition of further biopotentials such as electrodermal activity to improve predictive accuracy.

Project Mentor: Matthew Williams

Page 98: Design of Wind Deflecting Structures to Enhance Turbine Power Output

Marc El Haddad (Mechanical Engineering)**, M. William DeYoung** (Mechanical Engineering)**, Kyler VanWey** (Mechanical Engineering), **Karl Assaf** (Mechanical Engineering)

Modern wind turbines are only 59.3% efficient, per the Betz Law, which places a limit on the maximum amount of power wind turbines can generate. However, the amount of power generated by wind energy is dependent on the equation P = where the variables 1 2 ρAv 3 represent density, area, and velocity. While density and area will remain largely constant, the velocity is something that can be changed. This project aims to develop a system that has theoretical potential to improve the amount of power wind turbines can generate by placing flow deflecting structures that accelerate airflow around the wind turbine. The system, composed of a scale model functioning wind turbine and two identical wind deflecting structures, will be tested in the controlled environment that is the large wind tunnel in a lab on the second floor of the Glennan Building. The experiment will be run at varying incoming wind speeds both with and without the wind deflecting structures. Simultaneously, the power output of the turbine will be measured by metering the voltage and current of a simple circuit composed of LED lightbulbs. This will give a basis for comparison of power production with and without the flow deflecting structures. The anticipated results of this experiment, based on theoretical calculations and computational fluid dynamics simulations, are that the deflecting structures will directly lead to some increase in the amount of power that the wind turbine model is able to produce.

Project Mentor: Majid Rashidi, Department of Mechanical and Aerospace Engineering, CWRU

Page 99: Effects of Temperature and Frog Presence on Slug Activity and Abundance

Chideraa Emma-Ugwuoke, Biology

Understanding the factors that shape invertebrate populations is crucial for predicting interactions within ecosystems. Slugs are important terrestrial invertebrates that serve as key sources of prey for many predators and act as major agricultural pests, damaging crops by feeding on plants and leaves. Previous studies have shown that higher temperatures can increase the rate of slug predation and affect slug survival, while predation by beetles can significantly reduce slug populations. By investigating how temperature and frog presence influence slug activity and abundance, this study builds on the importance of forest floor food webs from previous studies, where predator-prey interactions play a major role in shaping invertebrate populations and ecosystem interactions.Using 24 experimental outdoor pens with different temperature conditions and frog densities, hundreds of photographs were collected throughout the fall semester to determine slug activity, which was measured as the number of slugs per photo. We predicted that slug activity would be greater in warmer, moister environments and that predation of frogs will reduce the number of slugs in the pens, with predation effects increased under warmer temperatures. We expect that warmer conditions will be associated with increased slug activity, supporting the hypothesis that temperature affects slug behavior and predator-prey dynamics.These results are expected to demonstrate that more slugs are visible in pens with warmer temperatures than colder temperatures and that the presence of frogs in warmer temperatures will result in the largest reduction in slug activity due to an increase in predation.The expectations of these findings may provide insight into how changes in climate may alter predator-prey interactions and slug populations, along with ways to maintain stability in terrestrial ecosystems.

Project Mentor: Michael Benard, Department of Biology, CWRU

Page 100: The Efficacy of States' Film Tax Incentives

Zoe Epperson - Quantitative Economics and English **Ryan Gilmore** - Mathematics and Music **Tomas Jay** - Computer Science **Aleksandr Torr**a - Economics and Accounting Faculty

Abstract: States that have long been neglected as filming locations have, in recent years, produced new hubs in the motion picture industry. Examples include Atlanta and Oklahoma City – previously greatly outshone by LA and NYC – which today have proved to be increasingly desirable locations for film industry giants. Many attribute this trend to the major tax benefits and other policy incentives these states have given to large-scale productions. These benefits are detailed in policies enacted by individual state governments and can thereby be compared to the number of films produced per state and the economic impacts of these large-scale productions. In this paper, we intend to explore the effectiveness of these incentives against key metrics by state, using data from the National Conference of State Legislatures and SAG-AFTRA.

Project Mentor: David Clingingsmith, CWRU

Page 101: Cellular Correlates and Growth Patterns Underlying Functional Connectivity Loss During Glioblastoma Progression

Maryam Faisal (Neuroscience), Tenesha Connor

Glioblastoma (GBM) profoundly disrupts brain-wide communication through cellular remodeling and invasion-driven network disconnection. Our lab previously demonstrated progressive interhemispheric functional connectivity loss during GBM progression. Here, we integrate widefield GCaMP imaging with histopathological mapping to identify the cellular substrates underlying this network breakdown.

GCaMP-expressing mice received dorsal striatal injections of GBM cells and underwent longitudinal calcium imaging followed by perfusion and sectioning. DAPI staining revealed total cell nuclei, while native GCaMP fluorescence delineated neuronal populations. Sections were registered to the Allen Brain Atlas to quantify regional neuron density, fluorescence intensity, and tumor expansion patterns.

Tumors originated in the dorsal striatum and extended asymmetrically into motor, somatosensory, and cingulate cortices. Within and adjacent to the tumor core, DAPI staining showed dense cellular infiltration, whereas GCaMP fluorescence intensity decreased by ~45% relative to contralateral regions, indicating neuronal loss or displacement. Peripheral cortical regions exhibited neuronal layer distortion and reduced fluorescence gradients consistent with axonal or dendritic compression. Notably, these histological alterations co-localized with regions exhibiting reduced interhemispheric correlation strength in functional imaging data.

These results reveal that GBM progression induces spatially organized neuronal disorganization—characterized by local density loss, structural displacement, and diminished GCaMP signal—that parallels network-level communication deficits. By integrating histology, imaging, and behavior, this work establishes a multiscale framework to connect tumor invasion patterns to disrupted brain dynamics, paving the way for identifying structural biomarkers and therapeutic targets to preserve network integrity in glioma-bearing brains.

Project Mentor: Murat Yildrim, Neurosciences Department, CWRU

Page 102: Dyeing For Chemistry : An exercise in creating ancient colors from natural sources

Fish Fish (Classics), Department of Classics

This poster presents the results of a series of dyeing experiments designed to replicate the vibrant colors described on an ancient cuneiform tablet found in Sippar, Iraq, dating to the Neo-Babylonian period (circa 6th century BCE). The tablet contains instructions for dyeing natural wool in luxurious reds and purples achieved with inexpensive materials. However, the dye recipes are difficult to interpret due to the fragmentary nature of the tablet and the obscurity of its technical terminology. To reconstruct the dyes, we carried out a series of dye extractions from plants such as indigo, safflower, madder, beetroot, and tamarind, as well as from insects like cochineal and kermes. The wool was then dyed using these extracts, both with and without mordants. Additionally, we explored various combinations of over-dyeing with multiple colors, leading to some unexpected results.

Project Mentors: Rekha Srinivasan, Department of Chemistry; Maddalena Rumor, Department of Classics

Page 103: Selective Membrane Adsorbers For Lanthanide Separation from Toxic Phosphogypsum Waste

Deirdre Fitzsimons (Chemical Engineering)

A great environmental concern is the recovery of rare earth elements (REE's). They are currently mined and purified in other countries then imported here. Not only does this practice cause considerable harm to the environment, but it also means that there is no domestic supply of REE's. It is in the best interest of the U.S. to obtain a sustainable and reliable supply of REE's.Another great environmental concern is the existence of phosphogypsum stacks. Phosphogypsum is a byproduct of phosphorus rich fertilizer manufacturing. These stacks are rich in REE's, and they just sit in stacks waiting to be processed because processing them is very expensive. If we could find a way to extract these REE's from the stacks, we can create our own domestic supply of REE's while removing harmful waste from the environment and making the processing of this waste economically viable. For these reasons, there is interest in researching membranes that can be used for REE separation. The membranes in this project are specifically made for recovering lanthanides from these phosphogypsum waste streams. This project focuses on poly (allyl methacrylate-co-hydroxyethyl methacrylate) membranes that bind to a Lanmodulin peptide (PAMA-co-HEMA-LanM1). The success of the synthesis procedures will be judged using SEM, FTIR, and Raman spectroscopy. There is a continuous effort to improve the durability of these membranes. Adsorption and desorption experiments varying the concentration of the simulated waste streams will be run to test the capacity, affinity, and selectivity of the PAMA-co-HEMA-LanM1 membrane for select REE's. The goal is to see if the material has higher affinity for certain metals when they're combined in a mixture

Project Mentor: Christine Duval, CWRU

Page 104: Reconstructing Organelle Genome Structure and Characterizing Nuclear Insertions in the Stormont Cirrus Line of Flax

Quentin Flattmann, Department of Biology, Case Western Reserve University

The Stormont Cirrus line of flax exhibits rapid, heritable changes in its nuclear genome, shifting into L or S genotrophs under specific nutrient-inducing conditions. While this phenomenon is most pronounced in Stormont Cirrus, it provides an invaluable model for studying multi-generational genome plasticity in plants. This project focuses on assembling and characterizing the mitochondrial genomes of the plastic, L, and S genotrophs, as well as identifying variation in organelle genome insertions within their nuclear genomes. Using a combination of PacBio long reads and Illumina short reads, I will reconstruct the mitochondrial genome structures and visualize their configurations using assembly graph tools such as Bandage. Additionally, I am developing an algorithm to evaluate alternative structural connections based on sequencing support, enabling a more quantitative assessment of genome structural variation among the genotrophs.

Project Mentor: Dr. Christopher Cullis, Department of Biology.

Page 105: Voice Analytics for Pathology Monitoring

Analicia Flores, Biomedical Engineering; **Suyash More**, Biomedical Engineering; **Nathan Petranka**, Biomedical Engineering; **Creed Roschyk,** Biomedical Engineering; **Archer Stankowski**, Biomedical Engineering

Esophageal cancer affects approximately 21,000 people in the United States each year, with survival and quality of life often limited by complications that impact swallowing and speech. Even after successful treatment, patients frequently experience vocal changes due to surgical reconstruction, radiation, or scarring of nearby tissues. Altered vocal characteristics are common in these patients, reflecting changes in anatomy, healing, or treatment progression. These measurable shifts in voice provide a noninvasive means to monitor recovery and detect complications, as variations in validated acoustic parameters can reflect tissue inflammation, scarring, or altered vocal fold vibration. However, current assessments rely heavily on in-clinic acoustic testing, which limits accessibility and continuity of care.

Our project aims to create an at-home monitoring system that allows patients to record and track their vocal parameters using a simple, guided software interface. The system is being designed to process seven clinically established acoustic metrics: jitter, shimmer, harmonics-to-noise ratio, cepstral peak prominence, fundamental frequency, intensity, and spectral tilt. Our diagnostics display them in a patient-friendly format to support independent, longitudinal monitoring. To ensure the reliability of this system, we are also evaluating whether consumer devices such as laptops and smartphones can provide recordings comparable to those from clinical-grade microphones under standardized conditions. Ultimately, this project seeks to establish an accessible, low-cost framework for continuous voice-based monitoring in esophageal cancer patients, empowering them to follow their healing trajectory from home while enabling clinicians to identify early signs of complications or recurrence.

Project Mentor: Dr. Matthew Williams, Department of Biomedical Engineering

Page 106: Self-Monitoring Device for Progressive Glaucoma Telemedicine

Anastasia Byrkanova (Biomedical Engineering), **Heyda Flores Jimenez** (Biomedical Engineering), **Ayla Grabenbauer** (Biomedical Engineering), **Aryan King** (Biomedical Engineering), **Milena Lee** (Biomedical Engineering)

Glaucoma is the second leading cause of blindness worldwide, and the primary cause of blindness for individuals over the age of 60. Around 70 million people worldwide are affected by the disease, with the most common variant being open-angle glaucoma (OAG), which comprises approximately 74% of global and 80% of U.S. cases. Fortunately, the effects of OAG can be mitigated or prevented with early detection and treatment. Due to the prevalence of this condition and its significant impact on daily life, there is a need for a new, comfortable, and reliable way for frequent outpatient glaucoma monitoring and telemedicine to improve treatment decisions, ensure early action for preventable vision loss, and reduce overall patient discomfort and costs. This project aims to solve this problem by using retinal imaging compacted into a goggle-like device. Not only is this system of measurement noninvasive, comfortable, safe, and hygienic for patients, but it may also be less intimidating to use at home for telemedicine than eye-contacting procedures like the current Goldmann Applanation Tonometer system that measures intraocular pressure (IOP). Lenses for smartphone or digital camera adaptation to retinal imaging will be used, improving modularity and cost-effectiveness. The goggle-style frame of this system is adjustable, as it can be easily altered to fit the user's face, and is intuitive to use. It is easily stored and transported. In addition, the goggles are capable of blocking excess light from entering the camera field, a requirement for retinal imaging.

Project Mentor: Matthew Williams, CWRU and Colin Drummond, CWRU

Page 107: The Ends of a Cylindrical World

Vivian Ford, Physics and Philosophy, Department of Physics, Glenn Starkman, Department of Physics

In this project we are studying the shape of the Universe. Observations from the Cosmic Microwave Background are consistent with a Universe that is spatially flat, thus fulfilling the axioms of Euclidean Geometries. This property does not require that the Universe is infinite; instead, the universe could be finite in some directions due to spatial boundaries. The goal of this project is to consider the possibility of a boundary that exists outside the observable region of our universe. We examine a cylindrical boundary, which we live in the interior of. We cannot observe the universe as a whole, so the observable universe is chosen to be a cylindrical wedge. This choice was made to reduce the geometry mismatch between the observable region and the universe. We aim to test the detectability of the calculated correlations between modes on a cylinder wedge compared to the absence of correlation on the full cylinder. These correlations were derived analytically; code was then implemented to numerically evaluate them. Using the signal to noise statistic, we quantify the differences between modes of the standard cosmological model of the universe and the correlated model. We can only predict the probability of an observation based on statistical properties, such as correlations between two points. Due to the statistical nature of the standard model, there is theoretical uncertainty inherent in our calculations. This uncertainty doesn't accurately represent the noise of the observable universe. The experimental noise has yet to be included in the project. Even in the case of noise free observations we have found unclear behavior in this quantization of an observable region as a cylindrical wedge, so we are considering another approach.

Project Mentor: Craig Copi, Department of Physics, CWRU

Page 108: Virtue, Vanity, and the Vintage Trap: How Sustainable Fashion Messaging Enables Moral Licensing and Rebound Consumption

Anastasia Frank (Psychology, Sociology, and Political Science)

While sustainable fashion aims to reduce environmental harm, emerging evidence suggests that its marketing may unintentionally enable moral licensing and rebound effects. This capstone argues that messaging sustainable actions like thrifting, resale, or clothing donation as "fun," "affordable," or "trendy" can reduce consumer guilt and increase fast fashion consumption particularly among inexperienced or image-motivated shoppers. Drawing on moral licensing theory and spillover models, this presentation synthesizes literature from empirical articles and systematic reviews, with findings revealing that consumers often use prior sustainable behaviors as moral justification for subsequent overconsumption, especially when messaging focuses on self-expression or social identity rather than moral obligation. This effect is moderated by experience level, age, and internalized moral identity. Psychological mediators such as guilt, pride, and environmental self-concept further influence whether sustainability actions lead to consistency or moral backslide. I argue that for sustainable fashion to avoid fueling the very overconsumption it opposes, messaging strategies must shift from individual image signaling to collective, moral, and impact-focused appeals.

Project Mentor: Rachel McClaine, Department of Psychology

Page 109: Assessing SPPL2B as a Promising New Risk Factor in Parkinson's Disease

Elissa Frankel (Neuroscience)

Parkinson's Disease (PD) is a neurodegenerative disorder which causes tremors, difficulty of movement, and rigidity alongside many other non-motor symptoms. It is primarily hallmarked by the accumulation of toxic alpha synuclein (aSyn) aggregates and the death of dopaminergic neurons in the substantia nigra. Current treatments are unable to prevent long-term neurodegeneration, so more research is needed to improve long term outcomes. The multifactorial genetic nature of PD requires the identification of new risk factors and therapeutic targets. This project identified signal peptide peptidase like 2B (SPPL2B), a lysosomal aspartyl protease involved in regulated intramembrane proteolysis, as a promising potential risk factor in PD. We aim to determine the role of this factor in PD pathology specifically in relation to lysosomal and mitochondrial function. This project has primarily focused on cell culture of SH-SY5Y neuroblastoma cells. We find SPPL2B levels consistently upregulated in aSyn overexpressing dopaminergic cell models and in the dopaminergic neurons of A53T-aSyn expressing mice. In SPPL2B knockout (KO) SH-SY5Y cells generated via CRISPR-Cas9 gene editing, we find a consistent decrease in lysosomal protein levels, lysosomal activity, and total functional lysosomes. We find this lysosomal dysfunction to connect to dysfunction of mitochondria through reduced mitochondrial lysosomal contact spots in SPPL2B KO cells, pointing a decrease in mitophagy. We also find an increase in mitochondrial oxidative stress and changes in proteins involved with mitochondrial dynamics, indicating mitochondria are not working at full capacity. In addition, we find an exacerbation of aSyn pathology upon SPPL2B KO. These results together show a potential role for SPPL2B in the pathology of PD through lysosomal and mitochondrial dysfunction and provide new possible avenues for therapeutic treatment. In the future, we plan to identify the mechanism by which SPPL2B is impacting lysosomal and mitochondrial dysfunction in addition to testing a cell line overexpressing SPPL2B.

Project Mentor: Xin Qi, Department of Physiology and Biophysics, CWRU

Page 110: Community Implementation of the Produce Path Customer Portal in Cleveland

Jenny Fu, Department of Sociology, Department of Biology; Dr. Darcy Freedman, PhD, MPH, Department of Population and Quantitative Health Sciences, School of Medicine (CWRU*)*

Affordable access to fresh fruits and vegetables is vital for maintaining community health. This is especially important for communities in urban areas. Supplemental Nutrition Assistance Programs (SNAP) and Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) narrow gaps in disparities in food access for low-income individuals. It is important for those most in need to have knowledge of these programs and the benefits they offer, so they can access their benefits. This project aimed to explore techniques for implementing a farmers' market app, called Produce Path, in Cuyahoga County among young adults, with the goal of increasing accessibility to farmers' markets and healthy foods. The intended target group for the food assistance app, Produce Path, was college-aged students at Case Western Reserve University in Cleveland, Ohio. The defined group of 'college-aged' students in this study was individuals aged approximately 18 to 22 years, living or attending college in proximity to Case Western Reserve University campus. Each site was canvassed, and the age of individuals who signed up for the Produce Path app was noted. In total, nine sites were canvassed for both non-college-aged and college-aged individuals. The number of people surveyed across Cuyahoga County was greater than 200 (n=254). The highest public engagement occurred at 'Off-Campus, Non-food-related' outreach sites, where the layout encouraged foot traffic between multiple booths. Canvassing results indicate that the category with the highest conversion rate from engagement to app download was 'On-campus, Non-food related' outreach sites. Although the number of people canvassed was low for a county like Cuyahoga County, the results from the summer of 2025 indicate that offering incentives at sites with high foot traffic and booths led to the most engagement during in-person canvassing.

Project Mentor: Dr. Darcy Freedman, PhD, MPH, Department of Population and Quantitative Health Sciences, School of Medicine, CWRU

Page 111: Mediating and Moderating Effects of Disgust Responses on Prejudice

Lexi Fuxan, Psychology and Cognitive Science

Prejudice is an irrational hostile attitude that can lead to discrimination and the imposition of significant limitations on educational, occupational, and economic opportunities, ultimately resulting in the reduction in the overall quality of life of targeted individuals and groups. Previous research has shown that disgust, "a marked aversion aroused by something distasteful" (Merriam-Webster) is a factor in the development of prejudice. In particular, socio-moral disgust, an aversion to moral violations or social etiquette, and pathogenic disgust, an aversion to disease, appear to factor highly into the development and expression of prejudice. The purpose of this literature review is to synthesize and analyze existing research on the relationship between disgust in prejudice, particularly on the moderating and mediating effects disgust may have on prejudice. Search terms "disgust and prejudice," "moral disgust," "racial prejudice," "changes in disgust responses," and "changes in prejudice" were used to acquire relevant empirical articles from Google Scholar and Web of Science. In order to demonstrate the pervasive nature of prejudice and the role of disgust within prejudice, articles outside of the Psychology discipline, such as political science, were located with the help of Scite.ai, to which the same search terms were applied. Only empirical articles published in the last twenty years relating to prejudice and disgust were included in this review. I expect to find that altering disgust responses may result in a change in prejudicial attitudes. However, I also anticipate finding that while such change is possible, changes in prejudice may only affect a small number of targeted individuals as opposed to their entire group. Such findings could provide insight on how humans can improve relationships and policies previously tainted by prejudice, thereby increasing the quality of life of those affected by prejudice.

Project Mentor: Rachel McClaine, Department of Psychological Sciences

Page 112: Mapping the Torque Output of a Hydraulic Motor Dependent on Fluid Pressure

Graham Galts (Mechanical Engineering)

This project investigates the relationship between hydraulic motor torque and fluid pressure to support the development of a worm-based digging robot being designed in Professor Kathryn Daltorio's laboratory. The robot aims to provide a flexible and cost-effective alternative to conventional horizontal directional drilling methods, motivating the need for accurate and compact hydraulic actuation models. The objective of this work is to establish a baseline model that maps hydraulic motor torque as a function of input pressure. To achieve this, we will use a custom test apparatus consisting of a rigid lever arm and an S-beam load sensor to directly measure torque. The hydraulic motor will be driven by the laboratory's hydraulic cart, which provides controlled and adjustable input pressures during testing. Torque and pressure will be recorded simultaneously across a range of operating conditions, and the resulting data will be analyzed using regression techniques to characterize the torque to pressure dependence. With the completion of this project, we expect to obtain a validated empirical model describing hydraulic motor performance under varying pressures. These results will form the basis for comparing theoretical torque predictions, improving system design accuracy, and informing future component selection for the digging robot platform.

Project Mentor: Professor Kathryn Daltorio, Department of Mechanical and Aerospace Engineering, CWRU

Page 113: Does national spending on recreation affect medal count at the Summer Olympics?

Iris Gebby (Marketing), Department of Marketing; **Ramkarthic Ramanathan** (Biology), Department of Biology; **Alan Zhang** (Business Information Technology), Department of Business Information Technology

This research examines the relationship between national spending on sport and recreation and performance outcomes at the Summer Olympic Games, measured by medal counts. Using cross-country data, we analyze whether higher financial investment in sports correlates with greater athletic success on the global stage. In addition to funding, this study incorporates data classifying countries as generally active or inactive to explore cultural and lifestyle influences on Olympic performance. By combining economic and behavioral indicators, we aim to develop a more comprehensive understanding of the factors that drive athletic excellence. Our findings will offer insights into how both resource allocation and population activity levels contribute to a country's competitive edge at the Olympics. Project Mentor: Daving Clingingsmith, Department of Economics

Project Mentor: David Clingingsmith, CWRU

Page 114: Home Assistant Room MultiSensor

Trisha Ghosh, Electrical Engineering; **Wiktor Golczak**, Electrical Engineering; **Ethan Nelson**, Electrical Engineering)=

This project presents the design and implementation of an integrated smart home sensing device built on the ESP32 microcontroller platform. The device integrates multiple sensors, traditionally distributed across several individual nodes costing $20â€“$40 each, into a single compact and cost-effective unit. It features a DHT11 temperature and humidity sensor, an APDS ambient light sensor, a TSOP382 infrared receiver for remote input, and an LD2410C radar sensor for detecting human proximity. Power management is handled by a TI BQ buck charger circuit, which automatically switches between USB-C and Li-ion battery inputs while providing real-time charge-state feedback to the ESP32 for optimized power usage and LED-based battery indication. The device communicates over Wi-Fi using ESPHome firmware. It integrates with Home Assistant OS through a custom dashboard, allowing users to monitor environmental conditions and interact with connected systems. Designed primarily for homeowners and IoT enthusiasts, this prototype aims to reduce cost and installation complexity while improving multi-sensor integration in household automation. The unit achieves an estimated cost lower than $40 per device, with ongoing testing to validate its expected one-week battery life.

Project Mentor: Murat Cavusoglu, CWRU

Page 115: Tracing The Downstream Brain Regions of the Medial Septum Glutamatergic Neurons

Ritwika Ghosh (Neuroscience)

The medial septum (MS) is a key structure in the basal forebrain for learning and memory and pacing hippocampal theta rhythms. The MS comprises three major cell types, including cholinergic, GABAergic, and glutamatergic cells. While the physiological and behavioral functions of the MS cholinergic and GABAergic cells have been extensively studied, the connectivity and functions of glutamatergic cells remain relatively underexplored. This project aims to study the downstream areas by utilizing anterograde tracing, elucidating the projection targets of these neurons, and providing a mapping of their subsequent projections. Our tracing revealed that MS glutamatergic fibers project to a number of areas, including the periaqueductal gray, supramammillary nucleus, lateral hypothalamus, hippocampus, ventral tegmental area, and medial/lateral habenula. These findings advance our understanding of the MS-associated networks by defining the brain regions that receive information from MS. Knowing the circuitry associated with the MS glutamatergic neurons provides the basis for future studies to investigate the roles of these areas in the overall cognitive and behavioral functions of different brain networks.

Project Mentor: Qian Sun

Page 116: Analysis of Burnout in Trauma Care Workers in Rural vs Nonrural Communities

Joseph Gingeleskie (Psychology), Department of Psychology, CWRU

Burnout in the workplace is a condition characterized by high levels of chronic stress and often leads to symptoms which include insomnia, lack of motivation, and degradation of executive function. Burnout is seen to be higher in the medical field, especially among those who work in emergency medicine, as combination of the stress from having to perform potential life saving care and the long shifts emergency workers must face leads to more cases of burnout compared to the public. This is particularly dangerous in emergency workers, as loss in performance could lead to preventable injuries or death. This research looks at the differences in burnout rates among emergency workers in rural areas compared to their suburban and urban counterparts, as rural emergency workers must deal with significantly larger jurisdictions and typically face more life-threatening cases. Secondly, with the comparison between rural and non-rural emergency workers in mind, I compared the ways each type of medical system combats burnout, looking at both the changes made in the workplace proper and the debriefing tactics that rural hospitals or medical centers use. I expect rates of burnout in rural areas to be significantly higher compared to non-rural areas, due to the aforementioned reasons for more severe cases and larger areas. I also expect to see little differences in burnout prevention or recovery compared to non-rural areas. With this narrative literature review showing the severity of burnout, especially in rural emergency medicine, I will show the importance of dealing with these cases on an individual level, rather than relying on one broad treatment plan.

Project Mentor: Professor Rachael McClaine, Department of Psychology, CWRU

Page 117: Predicting MLB Prospects through Data and Usage Patterns

Alice Liu, Computer Science; **Ari Glockner**, Computer Science; **Bridget Gurin**, Computer Science; **Dominic Roberts**, Computer Science; **Kathryn Borkowski**, Computer Science; **Nikhila Juluri**, Computer Science; **Shruti Vasagiri**, Computer Science

Minor league baseball is an essential stage for player development, but predicting which athletes will succeed at the major league level remains a challenge. Traditional scouting often depends on subjective evaluations and raw statistics, overlooking how teams actually use players throughout a season. This project aims to create a data-driven model that predicts player potential by combining statistical performance with organizational usage patterns. We developed a Python-based backend that retrieves and processes data from multiple public baseball databases, including FanGraphs, Baseball Reference, and Prospect Savant. The system uses machine learning methods such as logistic regression, random forest, and gradient boosting to evaluate player performance and generate prospect rankings. A React-based frontend allows users to explore player data through sortable tables, filters by position or team, and interactive graphs comparing results to established prospect boards like Baseball America and Fangraphs. By integrating both performance metrics and usage information, this model provides a more comprehensive and objective assessment of player potential. The project demonstrates how computational tools can enhance baseball scouting and player evaluation, offering a framework that can be adapted for broader sports analytics applications.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences

Page 118: Microglial Phagocytosis of Extracellular Matrix Components Following Ethanol Abuse

Gabriele Glusauskas (Neuroscience), Evi Paouri,, Sarah Stanko, Nadia Gasmi, Valery Mao, Andrew Kwak, Sahar Sarmadi, Emily Huang, Courtney Hershberger, Quinn Watercutter, Hope Burton, Alexis Crockett, Anxhela Gjojdeshi, Megan R. McMullen, Richa M. Hanamsagar, Daniel M. Rotroff, Richard A. Prayson, Staci D. Bilbo, Saba Valadkhan,, Hod Dana, Laura E. Nagy

Alcohol use disorder (AUD) has widespread neurological effects, with resulting neurodegeneration contributing to the cognitive and behavioral impairments observed in affected individuals. While the direct effects of alcohol on neuronal function have been well studied, less is known about how alcohol affects microglial interactions with the brain's extracellular matrix (ECM). Using confocal imaging of fixed mouse brain tissue after acute and repeated ethanol abuse, we investigated the phagocytosis of ECM proteoglycans within microglia and their phagocytic pouches. Ethanol-treated mice showed increased ECM material colocalized within microglial pouches compared to controls, suggesting increased ECM degradation. These findings highlight a previously unexplored mechanism of alcohol-induced neurotoxicity and provide novel insights into how deficits associated with AUD may be linked to microglial-ECM interactions.

Project Mentor: Dimitrios Davalos, Department of Neurosciences, Cleveland Clinic Research

Page 119: Development of a Deployable Lithotripsy Funnel for Enhanced Stone Fragment Removal

Kojo Baffoe, Biomedical Engineering; **Grant Becker**, Biomedical Engineering; **Liam French**, Biomedical Engineering; **Aaditya Gokhale**, Biomedical Engineering; **Andrea Jing**, Biomedical Engineering

Kidney stones are a condition affecting 1 in 10 people in which small deposits develop within the kidney, causing blockages within the urinary tract and intense pain. Stones are usually treated through lithotripsy, in which an endoscope is inserted into the patient's urethra, up through the ureter, and into the kidney, where the stones are vaporized with a ureteroscopy laser. However, some kidney stone fragments are left in the kidney due to the inefficiencies in the suction removal mechanism, leading to possible urinary tract complications for patients. As a result, our project aims to design an improved access sheath that features a deployable and flexible funnel that can seal off the target calyx in order to enhance suction and prevent fragment escape. The system is made up of the base housing that holds all of the actuation controls, the access sheath, and finally, a silicone funnel that can expand and contract. The current scope of the project is to create a large-scale working prototype to test the expansion of the funnel system while also testing its stability under conditions within the kidney.

Project Mentor: Dr. Jose Salvado, Division Chief, Urinary Stone Disease

Page 120: Applications and Iterations of Variable Nozzles for Thrust Vector Control in Consumer-Based High Powered Rocketry

Alexander Goldman (Aerospace Engineering), Department of Mechanical and Aerospace Engineering

Thrust vector control (TVC) is an area well researched for rocket engines, generally referring to the technique of changing the direction of thrust of an engine, thus increasing the rocket's maneuverability. TVC is lacking in academic research for high powered rocketry, an amateur field, and existing research uses simpler gimbal-based designs that redirect the entire rocket motor. Rather than that, this research primarily seeks to analyze a TVC system by redirecting the exhaust from the motor using a system of connected paddles, creating a sort of variable nozzle, inspired by the experimental X-31 plane of the '90s. A prototype of such a system has been designed and manufactured, and experimentation is underway to analyze the performance of such a system, with these initial experiments being conducted by performing a test-fire and redirecting the exhaust across one axis. The thrust profile of the TVC is expected to have some asymmetry as the variable nozzle isn't fully circular, however this could likely be accounted for after sufficient analysis of experimental data.

Project Mentor: Dr. Bryan Schmidt, Department of Mechanical and Aerospace Engineering

Page 121: Determining the Impact of Different Levels of Pesticide Exposure on Parkinson's Disease in the Latin American Population

Hannah Goo, Biology Major, Case Western Reserve University

Parkinson's disease (PD) is a progressive neurodegenerative disorder that affects millions worldwide and is the second most common neurodegenerative disease after Alzheimer's. Although over twenty genes such as PARK2, PARK7, LRRK2, and SCNA have been linked to PD, genetic factors alone cannot account for the full variability in disease onset; increasing evidence suggests that environmental exposures, specifically pesticides, contribute significantly to PD risk. This project aims to investigate how varying levels of pesticide exposure influence the risk and clinical severity of PD among Latin American participants and to determine whether these relationships differ by sex. Data are drawn from the Latin American Research Consortium on the Genetic Parkinson's Disease (LARGE-PD), including over 4,000 participants from fourteen Latin American countries. Each participant completed a comprehensive questionnaire, and saliva samples were collected to extract DNA and confirm biological sex using a PCR-based TaqMan assay, ensuring data accuracy for genetic and sex-based analyses. This study is expected to clarify how varying levels of environmental pesticide exposure interact with biological and social determinants to shape PD risk. The project contributes to addressing the underrepresentation of Latin Americans in neurological research and provides insight into population-specific risk factors that could inform targeted prevention strategies and public health interventions. This study will enhance understanding of how environmental exposures contribute to susceptibility in PD, allowing for more equitable and representative research in global neurodegenerative disease studies.

Project Mentors: Dr. Ignacio Mata, Cleveland Clinic and Dr. Crown, Department of Biology, Case Western Reserve University

Page 122: A look into the effects of clinical expressive therapies on minimizing anxiety and depression symptoms for adolescent pediatric patients

Sarah Gordon, Psychology

Hospitalized pediatric cancer patients are often in the hospital domain for frequent or lengthy visits. The effects of being in an unfamiliar medical setting for an indefinite amount of time while navigating treatments that are mentally and physically demanding pose consequent negative effects on the overall well-being of the child. Symptoms of anxiety and depression are common in these young patients and their guardians/parental figures, and without proper resources provided, these symptoms could become exacerbated. One way to improve well-being has been the introduction of expressive therapies, which offer a chance for the child to use different creative art forms combined with therapeutic practices to engage in imaginative play that encourages autonomy. Looking further into the effectiveness of expressive therapies in the hospital setting, this project looks into the effects of the 3 most common types of expressive therapies (art, music, and horticultural) on improving child well-being by reducing symptoms of anxiety and depression. A literature review was conducted to assess what benefits expressive therapies offer to both the patient and parent by looking at a multitude of meta-analyses, quantitative empirical, and non-quantitative articles regarding different therapeutic creative art forms. The findings from this review help show how the effectiveness of expressive therapy stems from promoting a greater sense of control, an outlet of emotional expression, and the development of positive coping skills. Informed by the analysis of the literature review, a proposal design for an improved program model was made with specific consideration of adolescent-aged children. The hypothetical program design would explore combining common aspects of current art, music, and horticultural hospital-based programs. Additional items included would be measures to increase social engagement for patients, and establishing a recurrent feedback system between therapists and parents or caregivers, which could offer a more consistent communication link between both parties.

Project Mentor: Professor Faye Parrill, Department of Cognitive Science, CWRU

Page 123: Cellular and Molecular Mechanisms of 15-PGDH Inhibition in Idiopathic Pulmonary Fibrosis Treatment

Filip Goshevski[1, 2] (Biomedical Engineering), Mariana Fragoso [2], Lyannah A. Contreras [2], Rahul Chaudhary [2], Sanford Markowitz [2], and Amar B. Desai [2]

[1] **Biomedical Engineering**, Case School of Engineering

[2] Case Comprehensive Cancer Center, Case School of Medicine

IPF is a chronic lung disease of unknown etiology, characterized by interstitial remodeling, progressive lung scarring, and pulmonary dysfunction. Annually 50,000 Americans are diagnosed with IPF, while as many as 40,000 die from the disease. The pathogenesis of the disease is complex and involves environmental, age-related and genetic factors. Recent evidence suggests IPF develops after recurrent injury of the alveolar epithelium, followed by mild inflammatory response and dysregulated repair process. This results in the accumulation of myofibroblasts, resulting in exaggerated ECM deposition and decline of lung function. While treatment options have increased in recent years following the approval of the anti-fibrotic agents Pirfenidone and Nintedanib, both agents are only able to slow the rate of inevitable disease progression, with neither drug able to actually stop or reverse disease, demonstrating the need for the development of new promising drug candidates. Our team has identified a novel approach to treat IPF by upregulating Prostaglandin E2 (PGE2) and inducing lung repair. We achieved this by developing a small molecule that inhibits 15-Prostaglandin Dehydrogenase (15-PGDH), an enzyme that mediates the degradation of PGE2. In particular, our group was the first to demonstrate that 15-PGDH inhibition is an effective therapeutic strategy in murine IPF as evidenced by a reduction in pulmonary inflammation, collagen deposition, and lung injury scores, coupled with enhanced respiratory function and survival. We aim to establish two different preclinical models of IPF (the bleomycin-induced model and the inducible SFTPC-I73T model that recapitulate the IPF phenotype of human familial IPF) and demonstrate the efficacy of (+)’291 in reversing the disease in both models. The ultimate goal of our study is to determine the cellular and molecular mechanisms through which ’291 induces lung repair by identifying the cellular subtypes and signaling pathways that are key mediators of ’291 therapeutic effect using scRNAseq.

Project Mentor: Amar Desai, Case Comprehensive Cancer Center, Case School of Medicine

Page 124: Development of agarose-based intracortical glial scar tissue phantom for electrochemical impedance spectroscopy-based analysis of tissue state

Ayla Grabenbauer, Biomedical Engineering Major

For individuals with neuromusculoskeletal conditions (e.g. spinal cord injury, neurodegenerative disorders), intracortical microelectrode probes may serve to restore sensory, motor, and communicative function. However, these electrodes have short implantation lifespans due to chronic neuroinflammation and foreign body responses, limiting effective transmission of neural signals. Characterization of the extent of glial encapsulation and neuronal dieback can provide information about the reliability of received signals, health of the implant area, and necessity for further interventions (e.g. therapeutics or explantation). Using electrochemical impedance spectroscopy, which relates biochemical components to electrical properties, the relationship between tissue states and recording ability can be quantified and utilized for device analysis and clinical judgements. However, establishing these relationships may be difficult due to the limited number and time available for in vivo animal models; therefore, a representative PBS and agarose gel phantom was developed. Prior research has established these gels as a model for the poroelasticity and electrochemical behavior of the brain, although they are limited by their homogeneity and inability to recreate both tissue and electrode components of the impedance. Novel additions to the current models include multiconcentrational gel insertions to represent glial scar formation around implants and electrically active polymer microbeads to reflect neuronal presence. These models present different impedance profiles under Nyquist and Bode plot analysis and can be distinguished based on their EIS spectra. Ultimately, these models may be utilized to assess neural probes, establish links between impedance and cortical environment, and overall serve as a more comprehensive tissue phantom than those incorporating physical or electrical properties alone.

Project Mentor: Dr. Allison Hess-Dunning, Department of Biomedical Engineering; Department of Electrical, Computer, and Systems Engineering; VA Medical Center

Page 125: Microdrone

Kevin Harris (Electrical Engineering)**, Solomon Greene** (Electrical Engineering)**, Nathaniel Hahn** (Electrical Engineering)**, Department of Electrical, Computer, and Systems Engineering**

The Microdrone is a compact unmanned aerial vehicle designed around an ESP32 controller for system, sensor, and general testing by the Vertical Take Off and Landing (VTOL) club at Case Western Reserve University. The project addresses the need for a low-cost, open, and flexible drone platform that is suitable for experimentation, research, and educational purposes. While small drones are becoming increasingly relevant across professional and academic fields, most commercial options are closed-source, limited in programmability, or prohibitively expensive. The Microdrone aims to bridge this gap by providing a fully programmable, lightweight, and easily replicable open-source test platform that enables users to experiment with flight control systems, new sensors and sensor integrations, and embedded software development. Designed for accessibility, the system can be quickly assembled and flown with minimal setup, lowering the barrier to entry for hands-on learning in control theory, embedded systems, and wireless communication. In doing so, it supports the broader goals of the Case Western Reserve University VTOL club, promoting student innovation, collaborative research, and practical exploration of autonomous aerial systems. The drone is built on a custom PCB integrating three flight sensors: an IMU with 3 axis gyroscope and 3 axis accelerometer, a barometer for altitude estimation, and a 3 axis magnetic compass. The custom drone control loop uses state estimation and PID control for stable flight. The design is compact and lightweight, allowing it to operate on a single 1S Lipo battery, supported by onboard USB Type-C charging and battery protection circuitry for overcharge and low voltage safety. The system communicates using an off-the-shelf ELRS module and has accessible SCL, SDA, 3.3V, and Ground pins for new sensor integration. Space within the drone's frame allows for the integration of a variety of sensors or payloads, making it a flexible testbed for rapid development and experimentation.

Project Mentor: Christos Papachristou, Department of Electrical, Computer, and Systems Engineering

Page 126: Stochastic Implementation of a Homomorphic Encryption Algorithm

Andrew Chen, Computer Engineering, **Luke Dischiave**, Computer Engineering, **Evan Grover**, Computer & Electrical Engineering

Recent advances in fields requiring massively parallel computing have accelerated the development of stochastic computing. At the cost of accuracy, stochastic computing is able to compute basic arithmetic operations for a lower hardware cost than traditional computing. Similarly, the rise of cloud computing has created a greater need for fully homomorphic encryption algorithms, which allow arithmetic operations to be performed on encrypted data without decryption by the cloud provider. Unfortunately, fully homomorphic encryption remains computationally expensive with traditional computing methodologies. This presentation proposes stochastic computing implementations of two fully homomorphic encryption algorithms, TFHE and BFV. We present our stochastic implementations, demonstrate their application, and provide information about their speed, accuracy, and hardware cost. Implementations are programmed in synthesizable SystemVerilog, while proofs and simulations are offered to back up our accuracy claims.

Project Mentors: Dr. M. Hassan Najafi, Dept. of Electrical, Computer and Systems Engineering, CWRU, and Dr. Vira Chankong, Dept. of Electrical, Computer and Systems Engineering, CWRU

Page 127: Dynamical Survival Analysis (DSA) for SIR: Fitting COVID-19 Cases

Yitao (Flynn) Guo, Applied Mathematics, CWRU

This project evaluates Dynamical Survival Analysis (DSA) as a lightweight alternative to pathwise stochastic simulations for epidemic inference. DSA reframes SIR dynamics at the individual level: the infection hazard is $h(t) = \beta \cdot I(t)/n$, the cumulative hazard $H(t) = \int_0^t h(u)\,du$, and survival $s(t) = \exp(-H(t))$. From a deterministic SIR trajectory, I obtain expected daily infections $\Delta t = -\Delta S\_t$ and fit (β, γ, ρ) to observed daily cases via least squares, with robustness checks using binomial/negative-binomial likelihoods. I report $R_0 = \beta/\gamma$, peak timing/height error, RMSE, and rolling prediction on a hold-out period. Using the DSA "mass-transfer" sampler, I also reconstruct infection-time distributions and compare them to a Sellke-construction simulator for validation. I expect DSA to achieve accurate parameter recovery and peak prediction while remaining computationally efficient and interpretable, making it suitable for undergraduate research and rapid outbreak analysis.

Project Mentor: Matthew Wascher, Department of Mathematics, Applied Mathematics, and Statistics, CWRU

Page 128: Device to Aid With Stroke Leg Weakness

Aydin Gurudutt (Biomedical Engineering), **Ellie Phillips** (Biomedical Engineering), **Katherine Bryant** (Biomedical Engineering), **Daniel Batyrbaev** (Biomedical Engineering), **Onkaar Paul** (Biomedical Engineering)

Strokes are a leading cause of long-term disability, with over half of survivors experiencing persistent motor impairments that compromise independent mobility. Hemiparetic lower-limb weakness reduces muscular strength by approximately 34-62%, limits weight-bearing on the affected side to about 25-43% of healthy individuals, and leads to asymmetric gait, instability, and high fall risk. Current interventions such as ankle-foot orthoses (AFOs), knee-ankle-foot orthoses (KAFOs), functional electrical stimulation (FES), and robotic gait trainers can improve mobility. However, KAFOs specifically are often heavy, bulky, and purely passive. Most designs provide stance stability or assisting swing motion, but rarely achieve both. They typically lock only at full extension, restrict natural knee flexion, and force users to compensate with exaggerated movements, which limits comfort and independence outside clinical environments. This project aims to develop a lightweight, modular KAFO that supports both phases of gait through integrated mechanical and biomechanical control. The design introduces a drop-lock knee joint locking at angles between 0 and 60 degrees for stable stance and controlled motion during walking. An elastic band integrated into the structure stores energy during stance and releases it during swing to assist knee flexion and help lift the foot off the ground. A detachable hip strap anchors the device to the pelvis to improve alignment and load transfer across the hip and leg, while a modular backbone connects adjustable thigh and shin supports to keep it secure. Prototype testing will assess walking endurance through a six-minute walk test, gait symmetry stance tests, and joint-angle tracking. Iterative refinements will optimize locking precision, comfort, and explore donning and doffing mechanisms for hemiparetic users. Ultimately, this project seeks to create a patient-centered, adaptive orthotic system that bridges the gap between rigid, clinic-bound KAFOs and functional everyday mobility, empowering stroke survivors to walk safely, confidently, and with greater symmetry

Project Mentors: Dr. Williams, Department of Biomedical Engineering, Case Western Reserve University and Dr. Williams, Department of Biomedical Engineering, Case Western Reserve University

Page 129: RanKing (A Scalable Fashion and Image Ranking Application)

Jonathan Da Silva (Computer Science) **Damario Hamilton** (Computer Science) **Julian Kim** (Computer Science) **Lucas Smith** (Computer Science)

The RanKing project examines how user engagement and data-driven feedback can be used to understand fashion preferences in a digital context. The central research question asks how interactive image comparisons can reveal popular stylesic trends while supporting a scalable and inclusive platform. In today's online culture, fashion content spreads rapidly through social media, yet few systems provide structured ways to measure user preferences or identify emerging patterns of taste. RanKing addresses this gap by introducing a mobile application where users vote between two outfit images, generating comparative insights into collective fashion choices. The platform integrates a responsive mobile interface with a scalable back-end system that records and aggregates user votes. Collected data are analyzed to highlight popular looks and shifting style trends. Machine learning is incorporated primarily for unsafe image detection, ensuring that uploaded content remains appropriate and consistent with platform standards. This targeted use of ML supports safe participation without dominating the app's user-driven nature. Expected outcomes include high levels of user interaction, efficient performance across large datasets, and interpretable results reflecting real-world fashion dynamics. By combining social participation with responsible technology design, RanKing aims to create a fun, data-informed space for users to explore fashion trends and for researchers to gain insight into visual preference patterns.

Project Mentor: Shuai Xu, Ph.D., Department of Computer and Data Sciences, Case Western Reserve University

Page 130: Enhancing Robustness of Digital Systems Against Hardware Trojan Attacks Using Stochastic Computing

Andrew Han (Electrical Engineering), **Camden Larson** (Computer Engineering), **William Froass** (Electrical Engineering)

Modern digital systems are vulnerable to Hardware Trojan Attacks (HTA), which are manipulations of the inputs to these digital systems performed to cause data leaks or systematic failure. This vulnerability is largely due to the binary architecture of digital systems, which allows for certain combinations of inputs to cause adverse and potentially catastrophic outputs. As circuits become more complex, they become even more vulnerable to HTAs because these circuits become more difficult to manually inspect, making it harder to ensure that no harmful modifications are present. Our objective is to make digital systems more resilient against HTAs by designing and implementing a stochastic computing architecture to replace the traditional binary architecture of digital systems. Stochastic computing is a method where numbers are represented in uniform bit streams with their value being the probability of any bit equalling 1. The probabilistic nature of stochastic computing allows for computations to be successful even when manipulations are made to the bit streams. Thus, stochastic computing poses to be a superior method to current defense mechanisms against HTAs, which rely on both detecting and preventing HTAs. In order to evaluate the effectiveness of our stochastic computing architecture, we will be comparing the operational performance of digital systems implemented with stochastic computing against those employing current defense mechanisms. We will be testing simple binary operations, such as addition and subtraction, and a more complex operation involved in an algorithm called the Roberts Edge Detector. By implementing our stochastic computing architecture with digital systems, we aim for these digital systems to have an accuracy that is at least 25% higher than that of digital systems that use current defense mechanisms. The digital systems implemented with our stochastic computing architecture will produce accurate outcomes when facing HTAs without needing to detect or prevent the HTAs.

Project Mentor: Dr. M. Hassan Najafi, Department of Electrical, Computer, and Systems Engineering

Page 131: In Silico Network Medicine Approach Identifies Molecular Associations of Food-Derived Polyphenols with Endophenotypes in Alzheimer's Disease

Alyssa Hansraj (Neuroscience), Cleveland Clinic Genome Center and Case Western Reserve University

Alzheimer's Disease (AD) is a neurological disorder characterized by the accumulation of tau tangles and beta-amyloid plaques in the brain, which causes neurodegeneration to occur and Alzheimer's to progress. Previous research within the lab emphasizes the importance of the gut microbiome on brain health, and how the foods an individual eats can impact their risk of developing AD. Our lab previously developed a framework that used multi-omics approaches to pinpoint relationships between AD-related G-protein coupled receptors (GPCRs) and gut metabolites, demonstrating that certain targets such as phenethylamine and agmatine reduced tau hyperphosphorylation in iPSCs in AD patients. This study aims to expand on this and focus specifically on polyphenols, which are chemical compounds naturally found in plant-based foods with potential anti-inflammatory profiles. This project will use in silico network medicine based approaches to predict whether or not polyphenol interactions contribute to progression of Alzheimer's Disease and healthy aging, and map these physical polyphenol-protein interactions. We are currently obtaining polyphenol chemical information from Phenol Explorer and PhytoHub, and finding compound-protein information through Chembl. We will then use deep learning approaches to associate polyphenol compounds with relevant AD and healthy aging proteins and lastly look at network proximity of these polyphenol-associated anti-inflammatory genes with disease module under the protein-protein interactome network to identify anti-AD mechanism-of-actions of polyphenols. This project will allow us to develop more targeted prevention and treatment methods for Alzheimer's Disease and healthy aging from foodome (i.e., polyphenols) if broadly applied.

Project Mentors: Dr. Yunguang Qiu, Cleveland Clinic Genome Center; Feixiong Cheng, Cleveland Clinic Genome Center

Page 132: Astrocyte Association with Surface-in Gradient Pathology in Multiple Sclerosis

Joanna He (Neuroscience)[1,2], Priya Singh[1,2], Anthony Chomyk[1], Liane Najm[1], Yan Yang PhD[1], Bruce Trapp PhD[1]
[1]Department of Neurosciences, Cleveland Clinic Lerner Research Institute
[2]Department of Biology, Case Western Reserve University

Background: Multiple Sclerosis (MS) is one of the most prevalent inflammatory diseases in the central nervous system (CNS). Disability and progression have been linked to a surface-in gradient of neuronal loss, particularly in the outer layers of the cerebral cortex and the pial surface (Magliozzi et al., 2010). Objective: This project focuses on the pathology of intracortical astrocytes associated with vessels. We also look at the activation of pial surface-associated interlaminar astrocytes with apical processes extending to the pial surface and basal processes entering cortical layers II-IV (Verkhratsky and Nedergaard, 2018). Our preliminary data indicate a positive association between interlaminar astrocytes and vessels in MS brains. CSF components may induce interlaminar astrocyte activation, contributing to the surface-in gradient observed in MS. Methods: We conducted immunocytochemistry to investigate interlaminar astrocytes and vessel-associated cortical astrocytes using GFAP and CD44 antibodies. This analysis quantified vessel-associated CD44-positive cells in subpial and deep cortical regions. We used light and confocal microscopy to examine morphology and associations/interactions of interlaminar astrocytes. Results: We found that compared to control brains, the MS cortex has a 40% increase in subpial CD44-positive cells and a significant increase in intracortical CD44-positive cells. Both GFAP and CD44 antibodies stained the pial surface. Some GFAP-positive astrocyte apical processes seemed to enter the pial surface and CSF space, and CD44-positive astrocyte basal processes appeared to descend into the cortex, often terminating on CD44-positive astrocytes associated with vessels in cortical layers II-IV and showing signs of pathology/degeneration. Descending processes from interlaminar astrocytes are often fragmented and associated with deep CD44-positive astrocytes.

Project Mentors: Bruce Trapp, PhD, Department of Neurosciences, Cleveland Clinic Lerner Research Institute and Jon Niemi, PhD, Department of Neurosciences, School of Medicine

Page 133: The Effects of Word Frequency and Repetition on Recognition Memory Performance

Gu He Academic Major: Psychology

Participants completed a word frequency memory test. They first studied a list of words, some of which were shown once and others shown twice. When given the test, participants were shown 60 pairs of words, one that had appeared once and one that had appeared twice. Participants were instructed to either select the word shown once or the word shown twice in the first 30 pairs, and vice versa for the last 30 pairs.

Faculty Project Mentor: Robert Greene, CWRU

Page 134: Evaluating Toxic Gain-of-Function Mechanisms in VAPB-Linked Amyotrophic Lateral Sclerosis

Sophia Heo, Neuroscience; Joao Carrara, Department of Genetics and Genome Sciences

Amyotrophic lateral sclerosis (ALS) is a progressive motor neuron disease (MND) that involves the degeneration of nerve cells in the brain and spinal cord, affecting both upper and lower motor neurons. ALS typically begins with muscle weakness, followed by difficulties with speaking, swallowing, and breathing as the disease progresses. Mutations in the VAPB gene, particularly the missense mutation P56S, cause a rare, dominantly inherited form of ALS. Despite extensive research, it remains unclear whether VAPB-linked ALS arises from loss of normal VAPB function, toxic gain of function of the mutant protein, or a combination of both. Understanding this distinction is crucial for defining pathogenic mechanisms and developing targeted therapeutic strategies. To address this question, a series of isogenic human induced pluripotent stem cells (iPSC) lines was generated using doxycycline (DOX)-inducible expression systems. These lines include DOX-inducible VAPB WT and VAPB P56S overexpression in VAPB WT/WT backgrounds alongside uninduced VAPB WT/WT controls to investigate gain-of-function conditions. Following DOX induction, quantitative PCR (qPCR) will be performed to assess mRNA expression levels before protein analysis. The corresponding protein expression across these three lines will be compared by performing Western blot analyses using an anti-VAPB antibody to quantify total and relative protein levels. Subsequently, detergent fractionation will assess the solubility of VAPB species, distinguishing normally folded, soluble protein from aggregated or insoluble mutant forms. It is expected that the overexpression of VAPB WT will not produce cellular toxicity, whereas VAPB P56S expression will lead to insoluble protein aggregation, supporting a toxic gain-of-function mechanism underlying VAPB-associated ALS. Conversely, the absence of toxicity in the mutant line suggests that disease pathogenesis may involve more loss of VAPB function or complex, combined mechanisms. These findings will lay the groundwork for subsequent studies integrating loss-of-function and heterozygous patient-derived lines to dissect the contributions of VAPB dosage and mutation-specific toxicity.

Project Mentors: Dr. Helen Miranda, Department of Genetics and Genome Sciences and Dr. Ashley Nemes, Department of Neuroscience, CWRU

Page 135: Selective Inhibition of O-GlcNAcylated c-Rel by a Novel Peptoid Suppresses Proautoimmune Cytokine Expression in T Cells

Julia Hluck[1,3](Biochemistry), Corynn N Appolonia[1], Joshua Centore[1], and Parameswaran Ramakrishnan[1,2,3,4]
1 Department of Pathology, Case Western Reserve University
2 Case Comprehensive Cancer Center, Case Western Reserve University
3 Department of Biochemistry, Case Western Reserve University
4 Louis Stokes Veterans Affairs Medical Center

Type 1 diabetes (T1D) is a chronic autoimmune disease caused by T cell-mediated destruction of insulin-producing pancreatic β-cells. As a result, patients with T1D require lifelong exogenous insulin therapy to regulate blood glucose levels. The NF-κB subunit c-Rel is a critical regulator of T lymphocyte development and effector functions. We previously demonstrated that c-Rel O-GlcNAcylation at serine 350 is increased in diabetic mice and promotes transcription of interleukin-2 (IL-2) and interferon-gamma (IFN-γ), which are key pathogenic, proautoimmune cytokines produced by autoimmune T cells in T1D. Thus, selectively targeting O-GlcNAcylated c-Rel represents a promising therapeutic strategy to suppress T-cell mediated autoimmunity in T1D, as broad inhibition or complete deletion of c-Rel has deleterious effects. In our prior work, we developed a novel peptoid that specifically inhibits O-GlcNAcylated c-Rel. In this project, we aimed to study a variant of the peptoid with the goal of discovering if structural modifications could increase potency. We discovered that human Jurkat T cells have robust cellular uptake of peptoid V6 using flow cytometry. Additionally, using a biotin version of peptoid V6, we found that peptoid V6 binds directly to O-GlcNAcylated c-Rel. Functional analysis revealed that peptoid V6 inhibits the O-GlcNAcylation-dependent increase in GMCSF expression in T cells in a dose-dependent manner. Our ongoing studies are focused on examining the efficacy of peptoid V6 in suppressing T-cell mediated autoimmunity in diabetic mouse models. Altogether, this study validates a novel strategy for suppressing proautoimmune signaling in T cells by inhibiting O-GlcNAcylated c-Rel with a peptoid.

Project Mentor: Professor Parameswaran Ramakrishnan, Department of Pathology, CWRU

Page 136: The Integration of Western and Eastern Medicine: Building a Comprehensive Healthcare Model

Raymond Ho (Biology), Department of Biology

This paper seeks to prove how Eastern and Western medicine can together create a more ef- fective and comprehensive healthcare model through cultural acceptance, regulation, and standardization. Traditional Chinese Medicine, or TCM, emphasizes balance within body, pre- vention of unharmonious energy, and holistic benefits for the individual while Western medicine focuses on refined evidence and a technology-based approach of acute and aggressive inter- ventions. TCM differs from Western medicine's approach of isolating symptoms and targeting specific system parts. As time passes with increasing approval of TCM, more clinical practices such as acupuncture, herbal therapy, and cupping have created opportunities for better health while improving pain relief and circulation or immune system modulation. Recent research has shown the effectiveness of ginseng and licorice for treating rheumatoid arthritis, diabetic kidney disease, and coronary heart disease in patients with diabetes. National Certification Commis- sion for Acupuncture and Oriental Medicine and the World Health Organization both have done a great job in safety and professional overview of both TCM and Western medicine. As the gap closes between the philosophical and procedural aspects of TCM and Western medicine, a more holistic method of treating patients will emerge.

Project Mentor: Professor Ronald Oldfield, Department of Biology

Page 137: Characterization of Salt-Inducible Kinase 3 (SIK3) and its role in the flexibility of circadian circuitry to promote arousal in Drosophila Melanogaster

Andrew Hsiao1 (Neuroscience), Nanami Amafuji1,2, Natalia Pokaleva1, Alexa Zarjetskiy1, Dieu Linh Nguyen1, Makenzie Anne Hopkins1, Riho Kobayashi2, Yoshinori Suzuki2, Jun Tomita2, Kazuhiko Kume2, Masashi Tabuchi1

1Dept. of Neurosciences, Case Western Reserve University School of Medicine, Cleveland, OH

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The circadian rhythm is a highly conserved 24-hour biological clock that regulates physiological and behavioral processes. Despite its rigidity and stability, the circadian rhythm contains internal mechanisms that allow it to have flexibility in its effect in both physiological and behavioral ways. In the present study, we use a phosphorylation-deficient mutated salt-inducible kinase 3 (SIK3) with the conversion of serine to alanine in (SIK3-SA) to understand its role in controlling biophysical flexibility in the circadian network of Drosophila melanogaster. By analyzing membrane potential and synaptic properties of circadian neurons, we find that SIK3-SA induced changes in the maintenance of spontaneous burst-firing patterns in s-LNvs and spike irregularity in DN1ps to promote morning and midday arousal, respectively. When observing the effects of SIK3-SA under circadian neurons under patch-clamp, we found increased excitability of l-LNvs, a phenotype that leads to reduced arousal and impairment in circadian regulation. By measuring Ih channel gating properties in the circadian neurons with induced SIK3-SA mutations, we also provide mechanistic evidence that SIK3 produces its effects on the circadian network through its effect on the Ih channel. Furthermore, we found that SIK3-SA induced changes in the circadian neurons increased post-synaptic potentials compared to the control. Lastly, we found evidence that SIK3-SA induced changes beyond the brain and sleep, and changed heartbeat rhythms. Overall, our findings reveal how the SIK3 allows for flexible state changes in the regulation of the circadian network.

Faculty Project Mentor(s): Masashi Tabuchi, Department of Neuroscience, CWRU School of Medicine

Page 138: Uric acid production in the cockroach Periplaneta americana ganglia

Kelly Hsieh (Biology)

Nitrogen is vital in the production of various biological macromolecules. Nitrogen homeostasis must be maintained, and is accomplished through dietary intake, metabolism and excretion. A nitrogen waste product that is primarily utilized by insects is uric acid. This must be excreted, as large amounts result in toxicity and will threaten survival. For insects, uric acid is traditionally believed to be synthesized by the fat body, as it is the insect equivalent of the liver in vertebrates. However, data in the silkworm B. mori has demonstrated that this is not always the case. This research project aimed to investigate the possibility of uric acid excretion by the ganglia of the cockroach Periplaneta americana. Data has shown the ganglia can use glutamine as a source of carbons for gluconeogenesis, but the process of removing nitrogen waste has not been elucidated. This study aimed to fill this gap utilizing the Amplex Red Uric Acid Kit by life technologies. The data from this kit was quantitatively evaluated by measuring fluorescence of the samples containing ganglia (experimental), fat bodies (positive control), or muscle (negative control). By taking samples from cockroach ganglia explants over time, a time course for uric acid formation was established. To gain a better understanding of the mechanism involved in this formation, experiments were conducted to include glutamine and Febuxostat, a drug that blocks the enzyme xanthine oxidase. This would block the step immediately before the formation of uric acid in the proposed mechanism. Understanding of these mechanisms may lead to metabolism based strategies for cockroach control.

Project Mentor: Kathleen Hersheberger, CWRU

Page 139: Design and Implementation of a Dual-Layer Remote Control and Emergency Stop System for the Speedy Wheggs Robot

Sam Huang (Electrical Engineering), **Kyle Zhang** (Electrical Engineering), and **Harrison Zhang** (Electrical Engineering)

The Speedy Wheggs project focuses on improving the performance, safety, and reliability of a wheeled-leg robotic platform originally designed for high-speed mobility. Initial testing revealed that the robot's control system suffered from unstable signal input, inconsistent speed regulation, and the absence of a reliable emergency-stop mechanism. To address these issues, the team designed and implemented a dual-layer remote control and emergency-stop system combining both hardware and software safety features. The redesigned system centers around an Arduino-based controller paired with a FlySky FS-i6X transmitter and receiver, enabling real-time wireless control of throttle, steering, and safety signals. A dedicated failsafe channel automatically triggers a stop when signal loss is detected. Complementing the software layer, a hardware E-Stop circuit—built using logic gates, timing elements, and a relay driver—provides an independent hard power cutoff, ensuring safe operation even in the event of a software or communication failure. Breadboard prototyping, Multisim simulations, and bench tests verified PWM stability, E-Stop response times under one second, and signal latency below fifty milliseconds. The next stage involves full integration of the E-Stop circuit and performance validation at maximum speed. This project demonstrates an engineering design process that unites safety, performance, and reliability in mobile robotic systems.

Project Mentor: Dr. William Nourse Department of Electrical, Computer, and Systems Engineering Case Western Reserve University

Page 140: Cysteinyl Leukotriene Signaling in Human Epithelial Cells

Max Huang, Biology

Pseudo-leukotrienes, øLTC, øLTD and øLTE (øLTs) are lipid mediators that act like cysteinyl leukotrienes (CysLTs) and cause epithelial inflammation. This project examines the effects of øLT on human bronchial epithelial cells (16HBE) using a simple, reproducible qPCR workflow. Cells were treated with 500 nM øLTE for 0, 2, 4, and 8 hours at 37 °C. For each time point, we measured the expression of key inflammatory interleukins (IL-6, IL-8, IL-1β, MCP-1, IL-33, IL-25, IL-13) and leukotriene-related receptors. GAPDH served as the as the house-keeping control, and expression changes were calculated as 2^-ΔΔCt relative to 0 h. We converted these values to fold change relative to control, which revealed treatment-dependent differences for several leukotriene pathway receptors, supporting engagement of CysLT-linked signaling in 16HBE. GPR99 showed the highest increase at 8 h by 2.23 folds, CysLTR2 showed the highest increase at 8 h by 2.17 folds, IL-13 showed the highest increase at 8 h by 2.79 folds, IL-25 showed the highest increase at 8 h by 2.58 folds, and MUC5B showed the highest increase at 8 h by 2.05 folds. In contrast, other genes did not show a clear increase above baseline in this dataset. These data provide in vitro evidence that øLTs activate epithelial programs at the transcriptional level and align with recent data on leukotriene-like agonists. Limitations of this study include a single øLTE dose and transcript-only readouts. Next steps will test dose–response behavior, include pharmacologic antagonists to confirm pathway specificity, and extend to protein signaling readouts and challenge of additional epithelial cell models with øLTs.

Project Mentors: Mikhail Linetsky, Department of Chemistry, CWRU

Page 141: A Data-Driven Approach to Greek Organizations' Mentorship Initiatives

Emi Hutter-DeMarco (Computer Science), Department of Computer and Data Sciences, Case School of Engineering, **Lukas Beyerlein** (Computer Science), Department of Computer and Data Sciences, Case School of Engineering, **Maura Marston** (Data Science and Analytics), Department of Computer and Data Sciences, Case School of Engineering

This project focuses on designing and implementing an intuitive and accurate Big/Little matching system for all Greek Life organizations at Case Western Reserve University. Traditionally, chapters rely on a point person to manually match members, which can introduce human bias and inconsistency. Our system allows Littles and Bigs to submit their top three preferences through a user-friendly web interface. The backend utilizes Flask, which collects and processes the submitted data. A custom matching algorithm computes the optimal pairings to maximize mutual satisfaction. The system ensures that each member's preferences are considered fairly, relative to others in their group. Once matches are computed, the results are displayed to members through the web interface. This eliminates the need for manual calculation by chapter members. Chapter members can access the web-based platform from any device. This system is deployed by Render, which hosts the Flask app online and provides a public URL. Overall, this project provides a fair, transparent, and scalable approach to Big/Little matching that enhances the Greek Life experience at CWRU.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences, Case School of Engineering, CWRU

Page 142: System for Automated Magnetic Field Characterization of Magnetically-Actuated Robotic Catheter Prototypes

Lana Oglesby, Electrical Engineering; **Irene Bhunia**, Electrical Engineering & Biomedical Engineering; **Jacob Hyman**, Electrical Engineering

Novel robotic catheters have been developed to be steerable under the large magnetic fields of magnetic resonance imaging (MRI) for procedures such as cardiac ablation. These catheters contain sets of three small coils. When the coils are driven with current, they produce small magnetic fields that cause the catheter tip to move when under MRI. Due to the catheters being designed for use in human bodies, high sensitivity is needed in the coil magnetic field. Thus, it is critical that each catheter operates in an expected manner. The goal of our project is to design a portable, automated, and intuitive magnetic field characterization test for these catheters prior to use under MRI. Our proposed system uses four Hall effect sensors strategically placed around the catheter on a 3D-printed mount to measure the magnetic field of each coil. We designed a Python program that automatically provides current to each coil and plots the magnetic field sensor data in a graphical user interface. The user can run the test for multiple catheters to compare magnetic fields. This characterization test will aid researchers in improving catheter design and assist professionals in evaluating individual catheter performance.

Project Mentors: Dr. M. Cenk Cavusoglu, Department of Electrical, Computer, and Systems Engineering and Dr. Vira Chankong, Department of Electrical, Computer, and Systems Engineering

Page 143: Ctrl + Think: How Generative AI Rewrites Human Cognition

Robin Igwe, Department of Psychology, CWRU

As AI tools such as ChatGPT, image generators, and other digital assistants become deeply embedded in daily academic and personal routines, concerns have arisen about potential over-reliance and the resulting decline in essential cognitive skills. Through a comprehensive literature review, this project examines current studies on AI-assisted cognition to identify emerging patterns in mental engagement, decision-making, and learning behaviors among young adults. The research is grounded in existing literature on cognitive offloading and digital dependency, which suggest that frequent use of intelligent systems may alter the ways individuals process, analyze, and retain information. The methodology involves synthesizing peer-reviewed research on technology use, educational psychology, and neuroscience to assess how reliance on AI might reshape cognitive development over time. Preliminary findings suggest that while AI can enhance productivity and expand access to knowledge, it may also reduce opportunities for deep reflection and autonomous problem-solving. The anticipated conclusion emphasizes the importance of promoting mindful and balanced AI use, utilizing the technology as a supportive cognitive tool without diminishing the capacity for independent thought. By addressing this emerging challenge, the study contributes to the broader discussion on digital literacy, ethical technology integration, and the preservation of human cognitive autonomy in an increasingly AI-driven world.

Project Mentor: Rachel McClaine, Department of Psychological Sciences

Page 144: The Cost of Victory: Measuring Financial Efficiency in Competitive Performance

Muhtadi Islam, **Viraj Rao**, **Manav Thakkar**

This project analyzes how efficiently professional sports teams convert payroll spending into on-field success. Using data from MLB, NBA, and the Premier League between 2000 and 2024, we will compare each team's payroll relative to its league's yearly average and visualize spending efficiency through scatterplots and heatmaps in R. Our goal is to identify whether higher spending consistently leads to more wins and to highlight teams that outperform expectations despite smaller budgets.

Project Mentor: David Clingingsmith, CWRU

Page 145: Crosstalk Between PI3K/AKT and STAT5 Pathways in B-cell Acute Lymphoblastic Leukemia

Siya Iyer, Biochemistry, Linda Chan, Department of Cancer Biology, Lerner Researcher Institute

B-cell acute lymphoblastic leukemia (B-ALL) is an aggressive hematologic cancer driven by dysregulated signaling pathways that promote proliferation and survival. In Philadelphia chromosome-positive (Ph+) B-ALL, the BCR-ABL1 fusion constitutively activates tyrosine kinase signaling and downstream STAT5, enhancing transcription of oncogenic genes while repressing tumor suppressors. Although targeted tyrosine kinase inhibitors (TKIs) such as ponatinib have improved outcomes, relapse and therapeutic resistance remain major challenges. Emerging evidence suggests that oncogenic signaling networks exhibit "pathway incompatibility," where simultaneous activation of different oncogenic pathways results in reduced cell health. Prior studies have shown incompatibility between RAS and STAT5 signaling (Chan et al., 2020), and preliminary data from our lab indicates a similar negative interaction between the PI3K/AKT and STAT5 pathways in B-ALL. We hypothesized that persistent activation of AKT in combination with STAT5 inhibition would decrease Ph+ B-ALL cell viability. Using SUP-B15 cells, we tested the effects of ponatinib (STAT5 suppression), SC79 (AKT activation), and their combination. Cell viability was quantified via CellTiter-Glo assays, and cell death was assessed by propidium iodide staining and flow cytometry. We expect ponatinib to reduce viability, SC79 to have moderate or minimal effect alone, and combination treatment to enhance cell death synergistically, consistent with signaling incompatibility. These findings would suggest that co-activation of PI3K/AKT and inhibition of STAT5 can be leveraged therapeutically, providing a potential strategy to overcome TKI resistance in Ph+ B-ALL. Future work will extend these studies to additional B-ALL cell types to test the validity of this approach.

Project Mentor: Dr. Linda Chan, Department of Cancer Biology, Lerner Researcher Institute, Cleveland Clinic, OH

Page 146: Analyzing Trends in Medical School Admissions Over Time

Akshay Iyer, Data Science and Economics; **Tanmay Kapoor**, Biology; and **Prasil Patel**, Neuroscience, CWRU

This project analyzes how academic and socioeconomic indicators among U.S. medical school applicants and matriculants have changed over time. Using AAMC datasets on applicants and matriculants, we examine trends in average MCAT scores, GPAs, demographics, socioeconomic indicators, and more. We explore whether admissions have become increasingly competitive and whether socioeconomic disparities have widened. The findings aim to illustrate how the path to medicine has changed and what that reveals about equity and opportunity in medical education.

Project Mentor: Professor David Clingingsmith, Department of Economics, CWRU

Page 147: A Fundamental Asymmetry in Recognition Memory: Framing Alters Retrieval Accuracy

Rohan Jain (Psychology)

This project investigates whether the framing, which is how a cognitive task is introduced or structured, of the retrieval task in a recognition memory test affects subsequent accuracy. This study asks whether logically equivalent recognition instructions—identifying "old" items versus identifying "not-old" (new) items—are processed differently by the mind. We investigate whether these superficially interchangeable cues engage distinct cognitive mechanisms, resulting in asymmetric memory performance. Our methodology starts with participants first viewing a rapid slideshow of 70 individual words (one per second). They were then assigned to complete one of two recognition test procedures. In Procedure A, participants viewed 60 slides each containing one previously shown ("old") word and one unstudied ("new") word. For the first 30 trials, participants identified the old word; for the final 30 trials, they identified the new word. In Procedure B, this order was reversed, with participants identifying the new word first and the old word second. Accuracy in selecting the correct item on each trial served as the primary dependent variable. Based on prior evidence suggesting that familiarity-based retrieval may benefit from initial old-item framing, an asymmetry is expected. This project's findings may broaden understanding of how the mind distinguishes stored information from novel input, revealing that memory acceptance and memory rejection are not mirror images. Faculty

Project Mentors: Robert Greene, Department of Psychological Sciences, CWRU and Robert Greene, Department of Psychological Sciences, CWRU

Page 148: Wound Sensing Bandage

Anna Avila (Biomedical Engineering), **Aaron Brula** (Biomedical Engineering), **Darcy Chew** (Biomedical Engineering), **Mobai Jiang** (Biomedical Engineering), **Ian Ridlehoover** (Biomedical Engineering)

Diabetic foot ulcers currently affect 1.6 million people in the United States. Common risk factors include diabetes complications, neuropathy, peripheral artery disease, foot deformities, and obesity. Around 50-60% of diabetic foot ulcers develop infection, and 20% lead to amputation, which is why it is critical to monitor wound conditions. Biomarkers, such as wound temperature and oxygen levels, provide information about the status of the wound and can be indicators of infection. The current practice of monitoring diabetic foot ulcers consists primarily of constant on-site inspection of the ulcer which is both labor intensive and increases the risk of infection. Our solution to address this problem is a wound sensing bandage. The bandage incorporates a thermometer and pulse oximeter to provide a comprehensive monitoring system that informs the clinician of the healing stage and infection status of the wound, while also ensuring a proper environment for wound healing. To evaluate the technical performance of the bandage, colored, temperature-controlled solutions will flow through a mannequin arm, and the bandage's readings will be compared to known reference values to confirm performance. In summary, the proposed project explores a way to address impaired healing with diabetic foot ulcers which provides physicians with specific biometrics for improved evaluation of the wound condition.

Project Mentor: Matthew Williams, CWRU

Page 149: From Chaos to Character: Building Philosophies for Unpredictable Times

An Jiang (Philosophy)

This paper explores the way individuals can engage in constructing flexible and adaptive philosophies of life. The traditional coping strategies that focus on control or prediction may often prove to be inadequate in dynamic contexts. This study is centred around Nassim Nicholas Taleb's concepts of the Black Swan and Antifragility in the realm of personal philosophy and psychological well-being. A synthesis is carried out based on existentialism, Stoicism, pragmatism, and complexity philosophy, to ensure that crucial theories form the base of exploring the way individuals can shift disruption into personal growth. Given the adoption of a philosophical-methodological approach, this study combines the researcher's experiences of anxiety, depression, and recovery with theoretical synthesis. Therefore, the central outcome of this study is 'The Antifragile Compass', which is intended for use in diverse contexts, with specific cultural sensitivity and awareness. It will assist users in developing antifragile philosophies of life, which are capable of adapting in dynamic situations and are not rigid. The Compass works by reframing volatility and adversity as resources rather than threats, and it offers a practical framework for cultivating authenticity, adaptability, and personal growth in uncertain situations.

Project Mentor: Anthony Jack, Department of Philosophy, CWRU

Page 150: SmartSpend: A Geolocation-Based Personal Finance Management Web Application

Nikhil Jindal (Computer Science), **Grace Park** (Computer Science), **Chris Lozinak** (Computer Science), and **Tola Oshomoji** (Computer Science)

Managing multiple credit cards and maximizing rewards remains a complex challenge for consumers, who often miss optimal cash back opportunities due to a lack of awareness about which card offers the best benefits at their current location. This project addresses the research question: How can real-time geolocation data be leveraged to provide actionable credit card recommendations that maximize consumer rewards? SmartSpend represents a significant advancement in personal finance technology by combining geolocation services with comprehensive credit card rewards data to deliver immediate, context-aware financial guidance. Our methodology integrates multiple technologies into a unified web application. We implemented Google Maps and Places APIs to capture user location and identify merchant categories in real-time. A comprehensive credit card database containing 20+ major credit cards with detailed reward structures was developed through web scraping and manual data curation. Plaid API integration enables secure bank account linking and transaction aggregation with automatic categorization. The backend architecture utilizes Node.js with Express.js and Amazon Aurora PostgreSQL database, while the frontend is built with React.js and TypeScript. A custom matching algorithm maps merchant categories to optimal credit card benefits, providing ranked recommendations based on maximum cash back potential. Expected results include a production-ready web application featuring real-time geolocation-based card recommendations, multi-account transaction tracking, interactive spending analytics dashboards, and budget monitoring capabilities. The system will deliver personalized financial insights through an intuitive, mobile-responsive interface with secure authentication. By automating reward optimization decisions, SmartSpend aims to help users maximize their credit card benefits effortlessly while gaining deeper insights into their spending patterns.
Project Mentor: Shuai Xu, Department of Computer and Data Sciences

Page 151: Engineering Epsilon-Near-Zero Metamaterials for Enhanced Photon Upconversion in Perovskite Nanocrystals

Zachariah Jones, Biophysics and Engineering Physics; Dr. Giuseppe Strangi, Department of Physics, Case Western Reserve University

Photon upconversion (UC) is a process in which two or more low-energy photons are effectively combined to produce a higher-energy emission. UC can be achieved in perovskite nanocrystals (PNCs), through nonlinear optical mechanisms such as two-photon absorption or exciton–exciton annihilation (EEA). However, these processes exhibit high nonlinearity and occur only at elevated excitation intensities, resulting in low quantum efficiency under conventional illumination and dielectric environments. UC can be enhanced through carefully engineered photonic environments that strengthen excitonic interactions and promote efficient energy transfer pathways. Typically, PNCs, upon photon absorption, form a delocalized electron-hole pair or free exciton (FE) within the crystal lattice. These excitons may undergo self-trapping due to coupling with the surrounding media or interfaces, or surface-trapping at lattice defects, the latter contributing to nonradiative recombination losses. Two FE can interact in a process called exciton–exciton annihilation (EEA), a process that can produce radiative upconverted emission or nonradiative losses depending on the energy transfer dynamics. This project explores UC enhancement by coupling perovskite nanocrystals to an epsilon-near-zero (ENZ) metamaterial, a material characterized by near-zero effective permittivity at specific optical frequencies. This near-zero characteristic results in extreme field confinement, enhanced photonic density of states, and reduced group velocity, all of which have been documented to amplify exciton–exciton interactions and nonlinear optical response. By engineering frequency-dependent ENZ modes, the photonic environment can be tailored to enhance UC efficiency in specific exciton systems. The experimental approach combines optical characterization and spectroscopic analysis to guide the design and fabrication of ENZ metamaterials via physical vapor deposition. Ultrafast spectroscopy, such as transient absorbance spectroscopy (TAS), is leveraged to effectively study the exciton dynamics.

Project Mentor: Dr. Giuseppe Strangi, Department of Physics, Case Western Reserve University

Page 152: Calibrated Preseason Prediction of NFL Team Win Percentage with Beta Regression

Paul Jones — Economics & Statistics; MAcc (Accounting), Case Western Reserve University

Can regular-season win percentage be predicted using only preseason information? Significance: A preseason-safe pipeline avoids information leakage and yields reproducible, policy-neutral insights for sports analytics. Methodology: We assembled a multi-source team-season panel for 2002–2024 and engineered features available before Week 1: prior-season point differential and EPA metrics (lagged), Elo ratings before Week 1, composite offensive/defensive roster indices and year-over-year deltas, QB and starter continuity indicators, and preseason strength-of-schedule summaries. The target is wins as a proportion of games (p_wins), which supports season-length invariance (16 vs 17 games). Distributional diagnostics using fitdistrplus indicate p_wins is well modeled by a Beta distribution; we then fit Beta regression (betareg) with calibration and residual checks, and ran a binomial GLM on wins as a robustness comparison. Preliminary results: p_wins shows good PP/QQ agreement with a Beta fit, and the strongest single-variable signals are Elo_pre, lagged point differential per game, and offensive roster strength, with continuity and schedule factors providing additional but smaller lift. Negative binomial models on raw win counts are less natural because the outcome range shifts with season length. Outcomes: A fully documented deliverable (features, plots, and model diagnostics) enables mentor-guided model selection and validation; we expect to report cross-validated calibration and out-of-sample performance and to generate 2025 preseason predictions in collaboration with the faculty mentor.

Project Mentor: Anirban Mondal, Associate Professor & Director of Graduate Studies, Department of Mathematics, Applied Mathematics, and Statistics, Case Western Reserve University

Page 153: Democratizing and Accelerating Medical Chart Review: A Clinician-Operable Prompt Design System for LLM-Enabled Electronic Medical Record Data Extraction

Rishi Jonnalagadda, Systems Biology

Electronic medical records contain rich clinical data, but much of it is in unstructured, free-text notes that require labor-intensive chart review to utilize for research. This process is needed for any clinical research project, but remains slow, long, error-prone, and infeasible at larger scales. Large Language Models (LLMs) show promise in automating chart review, but current setups require programming expertise to construct prompts and workflows, limiting accessibility to non-technical users and physicians. Additionally, hallucinations and a lack of easy verification methods cause significant inaccuracies in LLM-generated datasets. To address these gaps, we developed the Parse-EMR Prompt Design System, a clinician-facing, no-code web platform that allows clinicians to conduct their own LLM-enabled data extraction. The system enables users to visually design LLM prompt sets with conditional logic to determine the order of questions asked (minimizing hallucinations), apply EMR filters to specify the specific patient data they want to pull, test prompt sets on sample patient notes, and export executable configuration files for large-scale use without any programming experience. In early development within urologic oncology and 20 active users, clinicians with no programming background successfully built and executed projects that captured and accurately chart reviewed cohorts of thousands of patients, including the reconstruction of a 25-year-old cystectomy database within 24 hours and the creation of a prostate cancer database with high accuracy (Cohen's $\kappa \geq 0.93$). Adoption has expanded to multiple research domains, with interactive prompt refinement yielding progressive improvements in accuracy, helping to accurately build many databases, each with several thousand patients, to support dozens of clinical research projects. The Parse-EMR Prompt Design System transforms chart review from a months-long, manual process into an AI-driven, accessible, scalable, accurate, and reproducible workflow, achievable in hours or days, broadening the reach of the Parse-EMR system and the potential of AI-driven clinical research.

Project Mentor: Dr. Nicholas Heller, Department of Urology, Cleveland Clinic

Page 154: Responsiveness and Mechanisms of TCR and IL-15 Stimulation by CD101+ and CD101- CD57+ CD8 T cells

Vikhyath Jonnalagadda, Department of Biochemistry; Katelyn O'Hare, Division of Infectious Diseases and HIV Medicine; and Michael L. Freeman, Division of Infectious Diseases and HIV Medicine

Terminally-differentiated CD8 T cells that express the immunosenescence marker CD57 have been linked to cardiovascular disease risk. Our group has previously shown that the inflammatory cytokine interleukin-15 (IL-15) maintains CD57+ T cell viability and ability to proliferate, whereas T cell receptor (TCR) engagement drives CD57+ T cells toward activation-induced cell death. A substantial proportion of CD57+ CD8 T cells express the inhibitory glycoprotein CD101, but the function of CD101 expression on these T cells remains unclear. Here, we evaluated the proliferative responses of human peripheral blood mononuclear cells (PBMCs) following antigenspecific (TCR) or antigen-nonspecific (IL-15) stimulation. Donor PBMCs were labeled with CellTraceViolet proliferation dye and cultured in vitro with either plate-bound anti-CD3 plus soluble anti-CD28 (TCR stimulation) or IL-15. The cells were harvested after 7 days, and proliferation and phenotypic markers were quantified using flow cytometry. In addition, we used the mTOR inhibitor rapamycin to assess the role of mTOR activity in these stimulations. We found that TCR engagement elicited significantly more proliferation from CD101+ CD57+ CD8 T cells than it did from CD101- CD57+ CD8 T cells. In contrast, IL-15 elicited similar levels of proliferation regardless of CD101 expression. Blocking mTOR signaling with rapamycin inhibited IL-15- induced proliferation but not TCR-induced proliferation. Interestingly, rapamycin exposure during TCR engagement resulted in a substantial reduction in the proportion of CD57+ T cells overall. This effect was driven not by TCR stimulation-induced death of CD57+ T cells, but rather by an increased proliferation of CD57- CD8 T cells in the presence of rapamycin. Taken together, our findings demonstrate differential responsiveness of CD101+ and CD101- T cells to TCR stimulation, and identify differential roles for mTOR signaling in antigen-specific and antigennonspecific responses of CD57+ and CD57- CD8 T cells. These results may have implications for the immunopathogenesis and treatment of cardiovascular disease.

Project Mentor: Dr. Michael L. Freeman

Page 155: GasderminD (GSDMD)-tagged Mitochondrion Propagates Neuroinflammation in Parkinson's Disease

Eshita Kadiri[1], B.S. Neuroscience and B.A. Psychology; Rafaela Oliviera[1], B.S. Neuroscience; Amanda Serapiglia[2]; Nikhil Panicker[2,3]

1 Case Western Reserve University
2 Case Western Reserve University School of Medicine
3 Cleveland Clinic Lerner Research Institute

Parkinson's disease (PD) is a neurodegenerative disease characterized by progressively impaired motor deficits due to the death of dopaminergic neurons in the ventral midbrain. Neuron death, mitochondrial dysfunction, and increased brain inflammation are hallmarks of PD. In the brain, microglia exist as resident immune cells that initiate and regulate inflammation. It is known that alpha synuclein (α-syn) aggregates contribute to the activation of the Nod-like Receptor Protein 3 (NLRP3) inflammasome, an innate immune pathway. However, the mechanisms by which it accelerates the disease course remain under-characterized. Though α-syn does not inherently cause inflammatory cell death of microglia, it provokes an inflammatory cascade that may contribute to the progressive nature of PD. Specifically, α-syn expedites mitochondrial dysfunction, serving as a damage-associated molecular pattern (DAMP) to activate the NLRP3 inflammasome. Subsequently, NLRP3 activation triggers the secretion of pro-inflammatory cytokines and the proteolytic activation of an enzyme known as caspase-1 (casp1). Casp1 cleaves the pore-forming protein, gasdermin-D (GSDMD), which canonically induces inflammatory cell death by forming pores in the cell membranes. However, GSDMD activation does not cause inflammatory cell death in α-syn-treated microglia. Rather, our work aims to assess the method by which GSDMD translocates to other membrane-bound organelles and escalates the spread of neuroinflammation in PD models. We predict that GSDMD translocation and pore-formation at the mitochondria may result in the spillage of mitochondrial DNA into the cytosol, thus triggering the cGAS/STING pathway, another innate immune pathway that detects double-stranded DNA within the cytosol. Our hypothesis aims to elucidate the roles of GSDMD and mitochondrial dysfunction that increase neuroinflammation in PD models. Exploring the mitochondrial roles of GSDMD within the brain is an emerging field where limited research has been conducted. Overall, deducing these mitochondrial roles of GSDMD in microglia can establish therapies that target GSDMD-induced inflammation in PD patients.

Project Mentor: Amanda Serapiglia, PhD Candidate

Page 156: Analysis of circRNA Expression in Temozolomide-treated GBM Cells

Raghav Kalbhor, Biology; Dr. Andrew Dhawan, Department of Cancer Sciences, Cleveland Clinic Research

Glioblastoma (GBM) is the most aggressive tumor of the central nervous system, accounting for nearly half of all primary brain tumors in adults. Tumors rapidly evolve resistance to therapies, increasing the need for a molecular biomarker of treatment response. Circular RNAs (circRNAs) are non-coding RNA molecules that play a key role in cancer development and progression. Their covalently closed loop structures are particularly stable and resistant to degradation by linear RNA decay mechanisms, making them promising candidates for use as a biomarker. In this study, we looked at circRNA expression and biogenesis by culturing and treating two samples of patient-derived HW1 GBM cells: one with a DMSO control, and the other was treated with DMSO and temozolomide (TMZ) to simulate chemotherapy. Both samples then underwent RNA extraction, followed by RNase R treatment to enrich for circRNA. Next, the samples underwent total RNA sequencing. After results are analyzed, the data will be compared to studies and databases containing GBM circRNA expression data. We will determine which circRNA levels change following treatment with TMZ and are potentially involved in resistance. Based on these analyses, we expect to identify specific circRNAs that may be candidate biomarkers for temozolomide resistance.

Project Mentor: Dr. Andrew Dhawan, Department of Cancer Sciences, Cleveland Clinic Research

Page 157: Investigating Biomechanical Factors that Influence Power Generation in Functional Neuromuscular Stimulation Cycling via Musculoskeletal Modeling

Kanthi Karumbunathan[1,2]; Musa Audu[1,2]; Ronald Triolo[1,2]
Case Western Reserve University, Department of Biomedical Engineering[1]
Louis Stokes Cleveland VA Medical Center[2]

For individuals with spinal cord injury, functional neuromuscular stimulation (FNS) is an essential therapy used to mitigate secondary complications of paralysis such as muscle atrophy, cardiovascular deconditioning, and bone demineralization, while also supporting mental well-being. FNS works by applying low level electrical pulses to motor neurons in order to elicit contraction of paretic or paralyzed muscles. Through the controlled modulation of stimulation patterns, contractions can be used to recruit muscles in coordinated, functional movements such as walking, rowing, or cycling. In both clinical and community settings, cycling is one of the most common exercise modalities for FNS therapy. However, FNS cycling faces two primary limitations: minimal power output and rapid onset of muscle fatigue. Optimization of muscle excitations across various biomechanical configurations may provide insight into the influence of body positioning on FNS cycling performance.

This study investigates the effect of hip height on mechanical power output during FNS cycling through musculoskeletal modeling and optimization in OpenSim. Optimal muscle excitation patterns were identified through forward-dynamics simulations that iteratively minimized tracking error to reproduce target cycling motion across multiple hip height configurations. Muscle fiber lengths were obtained from simulated muscle states, and mechanical power was computed via inverse dynamics to characterize relationships between hip position, gluteal and quadriceps operating lengths, and power output. Study outcomes provide insight into the impact of biomechanical configurations on power production in FNS cycling. By bridging computational modeling with translational application, these findings will inform future clinical trials aimed at validating model predictions and improving FNS efficacy and therapeutic outcomes.

Faculty Project Mentors: Musa Audu[1,2]; Ronald Triolo[1,2]

Page 158: Investigating the role of WNK1 in Acute Myeloid Leukemia

Emily Katoni, Biochemistry; Jordan Cress, Department of Pathology; Dr. Parameswaran Ramakrishnan, Department of Pathology and Biochemistry

Acute Myeloid Leukemia (AML) originates from the malignant transformation of myeloid progenitor cells, resulting in impaired differentiation and unchecked proliferation. Not only is AML the most common acute leukemia in adults, it has high rates of relapse and chemoresistance, leading to a relatively poor survival rate. Overcoming differentiation arrest has shown promise in treating AML patients. Current therapies include activation of hematopoietic differentiation as exhibited by All-Trans Retinoic Acid (ATRA). However, its success is limited and has only been shown to positively impact a small subset of AML patients. Previous studies have shown pre-clinical success in enhancing ATRA efficacy in ATRA-resistant patients through combination with kinase inhibitors such as FLT-3 inhibitors. Therefore, further studies need to identify other kinase targets that exert pro-leukemic effects and could be used in a combination therapy to boost ATRA efficacy. Our study explores the role of With-no-Lysine(K) kinase 1 (WNK1) in mediating AML cell differentiation, survival, and proliferation. We aim to investigate WNK1 kinase activity in AML and its influence on downstream signaling. Thus far, we have found that WNK1 expression is elevated in AML patients, correlating with worse prognosis and survival rates. Crucially, when we inhibit WNK1 and concurrently administer ATRA, the combined treatment synergistically enhances the beneficial effects on inducing cell cycle progression, differentiation, and proliferation. Our data indicate that the anti-leukemic effects of WNK1 are regulated by C/EBPβ activation and the subsequent increase in its target genes, which are further enhanced by ATRA. These findings suggest an inherent role for WNK1 signaling within AML. Moving forward, we aim to elucidate the downstream signaling of WNK1 activity that drives AML.

Project Mentor: Dr. Parameswaran Ramakrishnan, Department of Pathology, CWRU

Page 159: The role of lipocalin-2 in ferroptosis in glioblastoma

Sehaj Kaur (Neuroscience)

Glioblastoma (GBM) is a lethal brain tumor that develops rapidly and leaves patients with limited options after diagnosis. The standard treatment, surgical resection followed by radiation and temozolomide chemotherapy has not changed for two decades. These treatments aim to induce apoptosis in tumor cells, but GBM is often resistant to apoptosis through the upregulation of anti-apoptotic proteins. Clinical trials targeting the BCL-2 family, XIAP, PARP, and TRAIL receptors have failed to prevent tumor growth, primarily due to tumor resistance. In searching other avenues of tumor progression, researchers have explored ferroptosis, an iron-dependent, lipid peroxidation–driven form of cell death. Lipocalin-2 (LCN2), a secreted glycoprotein with high-affinity iron-binding siderophores, is essential for iron homeostasis and is upregulated during inflammation, where it promotes tumor growth and metastasis in other cancers. Yi et al studied ferroptosis and demonstrated that inhibition of glutathione peroxidase 4 (GPX4) via dihydroartemisinin (DHA) induced ferroptotic death in GBM cells. The Lathia lab also demonstrated that GBM proliferation depends heavily on iron, and disruption of iron-handling proteins such as ferritin, transferrin, and HFE reduces tumor growth and increases survival in preclinical models. This study combines the knowledge of previous studies with LCN2. Knockdown of LCN2 increased GPX4-induced ferroptotic death. It also reduced phosphorylation of receptor tyrosine kinase AXL, suggesting a pathway involving LCN2, pAXL, and GPX4 that suppresses ferroptosis and supports tumor survival.

Project Mentor: Sabrina Wang, CWRU

Page 160: Biomimetic Design and Testing of Advanced UAV Propellers for Enhanced Aerodynamic and Aeroacoustic Performances

Servet Azra Kaya, Mechanical and Aerospace Engineering

The purpose of this study is to develop a new propeller design that incorporates semi-circular tubercle features into the leading-edge chord length equation while retaining the cicada wing–inspired planform and owl feather–inspired surface structure. These features are intended to improve aerodynamic efficiency while simultaneously reducing noise generation. The propeller prototypes were designed using SolidWorks. The span length of the propellers was fixed at 6 inches, and the pitch angle was fixed at 15 degrees to prevent flow separation. We utilized the NACA 8412 airfoil. All prototypes were fabricated using an Anycubic Photon Mono M7 resin 3D printer and Rigid 100 Resin (Anycubic) and evaluated through a combination of experimental testing and numerical simulations to validate their aerodynamic performance and design effectiveness. The aerodynamic performance was evaluated using a TYTO Series 1585 Thrust Stand equipped with an optical RPM probe. We developed a custom API code to automate data collection. The code steps ESC in 25 steps from 1000 μs to 2000 μs, then averages 20 samples per data point and repeated each measurement three times for accuracy. For acoustic characterization, the initial system was supplemented with a microphone. Measurements were performed using REW software at a sampling rate of 48 kHz. This study is significant since this bioinspired and engineering-optimized approach provides a promising pathway toward the development of quieter and more sustainable propeller technologies. The findings so far have demonstrated that incorporating a greater number of tubercles delays stall and results in a higher lift-to-drag (L/D) ratio. All prototypes produce elevated noise levels compared to the commercial design. Future work will aim to enhance aeroacoustic performance by exploring adaptive morphing structures and employing computational simulations.

Project Mentor: Dr. C. Chase Cao, Department of Mechanical and Aerospace Engineering, CWRU

Page 161: It Starts with Attachment: How Early Bonds Shape the Self and Our Relationships

Anvi Kesarwani, *Psychology*

Experiences of childhood attachment play a significant role in psychological and emotional development, influencing perception of the self and others. This literature review examines the impact of childhood attachment on self-esteem and the subsequent impact on emotional and relational distress. Existing studies largely focused on correlations between pairs of the three variables. Further, research has not addressed the potential mediating role of self-esteem in the relationship between attachment and distress. Drawing from attachment theory and evolutionary perspectives, the review synthesizes findings from various peer-reviewed studies identified through sources such as PubMed, Jstor, Sage, Wiley, Springer Nature, and PsycINFO, using keywords such as self-esteem, childhood attachment patterns, relational distress, and emotional distress. The findings suggest that secure early attachments relate to the development of a positive sense of self, which in turn predicts greater emotional and relational well-being. As the review contributes to our understanding of how early attachment behaviors influence self-concept, it highlights the need for targeted early interventions that strengthen caregiver-child relationships to promote healthier emotional and relational outcomes. The conclusions, however, are limited by reliance on correlational data and variability in attachment assessment methods. Overall, this literature review emphasizes the importance of secure attachment and positive self-esteem as foundational elements for lifelong psychological well-being, and it highlights the need for secure parental care and early attachment in the construction of the self that guides emotional and relational functioning.

Project Mentor: Joshua Wilt, Psychological Sciences

Page 162: Characterizing the maternal immune landscape upon prenatal Oropouche virus infection

Anushka Kesavan, Department of Biology; Dr. Débora Familiar-Macedo, Infection Biology Program, Cleveland Clinic Lerner Research Institute; Dr. Suan-Sin Foo, Infection Biology Program, Cleveland Clinic Lerner Research Institute

Oropouche virus (OROV) is a re-emerging orthobunyavirus endemic to the Americas with an ongoing outbreak since 2023. Most infections present as acute febrile illness, though severe neurological complications have been reported. Recent reports indicate that OROV can be vertically transmitted during pregnancy, leading to miscarriage, stillbirth, and congenital abnormalities such as microcephaly. However, the maternal immune mechanisms underlying prenatal OROV infection remain largely unexplored. Here, we aim to evaluate the maternal immune response elicited during acute OROV infection at different trimesters of pregnancy using an in vitro whole-blood infection model that closely recapitulates natural infection during pregnancy. Briefly, peripheral blood mononuclear cells (PBMCs) are susceptible to OROV infection, and higher viral loads were observed in the first and second trimesters of pregnancy. To identify trimester-specific immune signatures associated with OROV infection we performed integrated analysis of high-throughput NGS-based proteomics and global transcriptomics. Collective findings indicate that OROV infection triggers strong pro-inflammatory responses in early pregnancy (T1/T2), characterized by increased transcriptional activation and elevated viral load. In the third trimester (T3), viral load decreases and the immune profile shifts to a more regulatory state. Integrated analyses revealed distinct clustering of T3 samples and potential post-transcriptional regulation of immune pathways, highlighting a unique late-pregnancy immune landscape that may limit viral replication and excessive inflammation.

Project Mentor: Dr. Suan-Sin Foo, Infection Biology Program, Cleveland Clinic Lerner Research Institute

Page 163: Functional Analysis of PARP2 WGR Domain Residues through Site-Directed Mutagenesis

Angela Khurana (Biochemistry)

Poly(ADP-ribose) polymerase 2 (PARP2) is a DNA damage–responsive enzyme that attaches chains of poly(ADP-ribose) to itself and to other proteins to coordinate the repair of broken DNA. It contains a WGR domain that plays an important role in activating the enzyme after DNA damage occurs. This activation involves communication between the WGR domain, which binds damaged DNA, and the catalytic domain, which carries out the repair reaction. The exact residues that enable this communication are not well understood.

Understanding how the WGR domain transmits the DNA damage signal will provide insight into how PARP2 coordinates DNA repair. This information could also improve the design of PARP inhibitors, which are widely used in chemotherapy for ovarian, pancreatic, and prostate cancers.

To investigate this, I am using site-directed mutagenesis to alter conserved amino acids in the WGR domain of PARP2. Several residues have been substituted with alanine to test their functional importance. Each mutant is created through primer design, PCR amplification, Dnpl digestion, bacterial transformation, overnight culture growth, and plasmid DNA isolation using mini-preps. The plasmids are then expressed in bacteria, and the proteins are purified for biochemical analysis. Additionally, DNA was purified and assembled into nucleosomes and a nick site was introduced. Two main assays are used: an electrophoretic mobility shift assay (EMSA) to measure DNA binding, and a PARylation assay to assess catalytic activity.

Comparing the mutant and wild-type proteins will show how individual WGR residues affect PARP2's ability to sense DNA damage and activate catalysis. I expect that mutations disrupting key residues will reduce catalytic activation without significantly affecting DNA binding, suggesting those residues are important for communication between domains.

Faculty Project Mentor: Tae Hun Kim, Department of Biochemistry, CWRU

Page 164: Sex Chromosome Complement Shapes Endothelial Cell Fate and Atherosclerotic Disease Progression

Ellin Kim[1]; Junyoung Hong[2], Junchul Shin[2], Irene Krokovets[2], OA. Cherepanova[2]

[1]Department of Biology and Department of Sociology, Case Western Reserve University, Cleveland, Ohio

[2]Department of Cardiovascular and Metabolic Sciences, Lerner Research Institute, Cleveland Clinic, USA.

Atherosclerosis is a chronic inflammatory disease of arteries and is responsible for about 50% of all deaths in westernized society. Although biological sex differences in atherosclerosis are well documented, these differences have often been attributed to gonadal hormones. Recent studies suggest that sex chromosome complement (XX vs. XY), independent of gonadal sex (testes or ovaries), may also play a significant role in atherosclerosis (*Alsiraj et al*. 2019; PMID: 31201301). We recently found that female vascular endothelial cells (ECs), key drivers of atherosclerosis, have higher cellular ROS levels and lower angiogenic potential *in vitro* and *in vivo* within the atherosclerotic plaques than male ECs (*Shin et al*., 2024; PMID: 38031841). In light of these findings, we investigated the impact of sex chromosome complement on ECs by utilizing the Four Core Genotypes (FCG) mouse model to dissociate the effects of chromosomal sex from gonadal sex. FCG mice have been crossed to an atheroprone *Apoe*$^{-/-}$ genetic background and subsequently fed a high-fat Western diet for 18 weeks to induce advanced atherosclerosis. Sudan IV staining of the aorta showed that XY female mice had a decreased susceptibility to plaque formation compared to XX female mice. In parallel, single-cell RNA sequencing of atherosclerotic aortas showed that ECs from XX female mice exhibited higher expression of genes associated with inflammation, as well as lower expression of angiogenesis- and Endothelial-to-Mesenchymal Transition (EndoMT)-related genes compared to XY males. However, the XY chromosome complement reversed EC gene expression in females toward less inflammatory and more angiogenic and EndoMT profiles. *In vitro,* aortic ECs showed that XY chromosome complement improved cell viability, mitochondrial functions and angiogenic potential of the female ECs. These findings, for the first time, demonstrate the critical role of the X-chromosome complement in ECs and may contribute to the identification of novel sex-dependent treatment for atherosclerosis.

Project Mentor: Dr. Barabara Kuemerle, Department of Biology, Case Western Reserve University

Page 165: Untargeted Metabolomics as a Platform for Identifying Gut Microbially Produced Metabolites

Sean Kim, Department of Biology; Manish Kumar, Cardiovascular & Metabolic Sciences, Cleveland Clinic; Kelley Carr, Cardiovascular & Metabolic Sciences, Cleveland Clinic; Ina Nemet, Cardiovascular & Metabolic Sciences, Cleveland Clinic

Gut microbes play an important role in host physiology. They interact with the host through production of a wide range of small molecules that can casually influence complex diseases such as cardiovascular disease, diabetes, or inflammatory bowel disease. However, the majority of gut-derived metabolites remain unidentified.

To identify new disease-related, gut-microbially produced metabolites, we performed untargeted metabolomics on fecal extracts from mice treated with or without a broad-spectrum antibiotic (Abx) cocktail. Data analysis revealed that certain spectral features were upregulated, while others were downregulated following Abx treatment. Costunolide was among the annotated metabolites that was significantly reduced by the Abx-induced microbial suppression. Its structure was further validated through comparison of high-resolution collision-induced dissociation (CID) spectra and retention time alignment between a pure standard and the corresponding metabolite in the fecal extract. Additionally, an unknown feature (m/z 491.31345) was also significantly reduced by the Abx treatment. Using MicrobeMasst, a publicly available mass spectrometry repository of microbial cultures, this feature was matched to compounds produced by Escherichia coli, further validating its microbial origin.

In future studies, we will quantify selected metabolites in human samples available in our lab, as well as in publicly available datasets, to establish their relevance to host health.

Faculty Project Mentor: Ina Nemet, Department of Cardiovascular & Metabolic Sciences, Cleveland Clinic

Page 166: 15-hydroxyprostaglandin dehydrogenase inhibition attenuates graft-versus-host disease progression

Tae Eun (Mia) Kim, B.S. in Biology

Hematopoietic stem cell transplantation (HSCT) is a life-saving treatment for patients with blood cancers and other hematologic disorders, but it carries the serious risk of graft-versus-host disease (GVHD), a complication that damages multiple organs and contributes to significant morbidity and mortality. This project investigates SW033291, a small-molecule inhibitor of 15-PGDH, as a potential therapeutic strategy to reduce GVHD severity. By elevating prostaglandin E2 levels, SW033291 enhances tissue repair and modulates immune responses. Results from a mouse model demonstrate improved survival and recovery in treated mice, which support the potential of SW033291 to improve post-transplant outcomes.

Project Mentor: Dr. Amar Desai, Case Comprehensive Cancer Center

Page 167: Untangling the Matrix: Exploring Tenascin C Organization in Extracellular Matrix of Embryonic Frontal Bone Primordia

Rachel Kim, Department of Biology, CWRU

During mouse skull bone development, dispersed bone progenitor cells in cranial mesenchyme(CM), located in the supraorbital arch above the eye, initially condense, express and form a distinct rudiment that gives rise to frontal and parietal bones. Disrupted condensation will lead to dysregulations in subsequent bone development and skull bone defects. Extracellular matrix(ECM) components, particularly fibronectin(FN1) and tenascin-C(TNC), form a fiber network in the primordia before and during condensation, suggesting their regulatory role in calvarial bone progenitor cell condensation. Deletion of FN1 in CM leads to decreased frontal bone size and changes in bone progenitor cell shape. However, how the cell-FN1 adhesion modulator TNC regulates calvarial bone cell condensation remains unknown. We hypothesize that FN1 deletion in CM disrupts TNC fiber organization in frontal bone primordia(FBP). I obtained images of TNC protein expression in coronal view sections of E12.5 CM from control and CM-FN1 mutant mouse embryos. I compared TNC fiber organization between the medial region of FBP, adjacent to meninges, with the lateral region, near dermal cells, in control and CM-FN1 mutants. TNC fiber network appeared qualitatively different after conditional FN1-deletion in CM. I used The Workflow Of Matrix BioLogy Informatics(TWOMBLI) algorithm to quantify TNC fiber network architecture by measuring fiber length, alignment, and number of branch points and endpoints. TWOMBLI results show slight differences in distribution of fiber alignment between control and CM-FN1 mutant in the medial basal region. Distribution comparison between medial and lateral regions within control showed a significant difference. Similarly, medial and lateral regions of CM-FN1 mutants showed a significant difference in distribution of alignment. My study provides an objective assessment of TNC fiber architecture and organization in calvarial bone cell condensation, which may offer clinical insights into how ECM protein topography can contribute to skull bone defects.

Project Mentor: Dr. Radhika Atit, Department of Biology, CWRU

Page 168: Characterization of Arthritis in TNFΔARE Mice in Germ-Free and Specific Pathogen-Free Conditions

Jayden Kim, B.A. Chemical Biology, Case Western Reserve University; Secondary Author: Fiona Brooks

Inflammatory bowel disease (IBD) is a chronic autoimmune condition characterized by intestinal inflammation and frequent extra-intestinal manifestations (EIMs), including arthritis and uveitis. While intestinal inflammation is known to depend on the microbiome, the mechanisms driving EIMs such as arthritis remain less understood. The TNFΔARE mouse model, which overexpresses tumor necrosis factor-alpha (TNF-α), provides a useful system for investigating these processes. Mice raised in germ-free (GF) environments develop arthritis without ileitis, whereas specific pathogen-free (SPF) mice exhibit both intestinal and joint inflammation. This project aims to characterize the type and severity of arthritis in TNFΔARE mice across these two microbial conditions to clarify the role of the microbiome in modulating extra-intestinal inflammation. Histological analysis was performed on joint samples collected from GF and SPF TNFΔARE and wild-type mice. After euthanasia, limbs were fixed, decalcified, embedded in paraffin, sectioned, and stained with hematoxylin and eosin (H&E) and Safranin O. Joints were scored for inflammation, pannus formation, cartilage erosion, and bone destruction based on established criteria. Preliminary histology of GF TNFΔARE mice revealed synovial hyperplasia and narrowing of the joint space, consistent with inflammatory arthritis despite the absence of microbial stimuli. Future work will include parallel analysis of SPF mice to identify microbial influences on joint pathology. Understanding how arthritis persists independently of microbial triggers may illuminate the mechanisms underlying EIMs in IBD patients whose joint symptoms remain active despite remission of intestinal inflammation. This study contributes to the broader understanding of gut-joint immunopathology and may inform new therapeutic strategies for autoimmune diseases.

Project Mentors: Fabio Cominelli, MD, PhD, Department of Medicine, Division of Gastroenterology, Case Western Reserve University and Bianca Islam, MD, PhD, Department of Medicine, Division of Gastroenterology, Case Western Reserve University

Page 169: Control of progesterone receptor type B in human myometrial cells: Steady state levels are affected by degradation in the 26S proteasome.

Ellen Kim, Nutritional Biochemistry and Metabolism

In uterine myometrial cells, progesterone (P4) acting via its type B nuclear receptor (PR-B) blocks labor, and loss of this P4/PR-B signaling induces labor. Understanding the dynamics and regulation of PR-B abundance in uterine smooth muscle cells (myometrial cells) may provide insight into how the P4/PR-B block to labor is removed to initiate labor in women. This knowledge may reveal novel therapeutic targets and strategies to prevent P4/PR-B withdrawal as a way to prevent preterm labor and preterm birth, which is the leading cause of neonatal morbidity worldwide. The steady state level of PR-B is affected by its processing/degradation through the 26S proteasome. We hypothesize that in myometrial cells the steady state level of PR-B is determined by the balance between synthesis and degradation of PR-B protein by the 26S proteasome. This hypothesis was tested in a human myometrial cell model, hTERT-HMA/B, in which synthesis of PR-B can be experimentally controlled and held constant. hTERT-HMA/B induced by express PR-B in the presence and absence of the 26S proteasome inhibitor carbobenzoxy-L-leucyl-L-leucyl-L-leucinal (aka: MG-132) for 24h. Abundance of PR-B protein was assessed by immunohistochemistry (IHC) using a PR-B-specific primary antibody. In hTERT-HMA/B cells MG-132 increased the abundance (indicated by the intensity of IHC staining) of the PR-B protein per cell and a proportion of cells in which PR-B is detectable by IHC. Similar effects of MG132 were detected in a breast cancer epithelial cell line (T47D). The data show that MG-132 increases the accumulation PR-B in the cytoplasm and nucleus of myometrial cells. These studies reflect the complexity of PR-B protein dynamics and how P4/PR-B activity may be modulated in myometrial cells to control pregnancy and parturition.

Project Mentor: Sam Mesiano, Department of Reproductive Biology

Page 170: Ideological Asymmetries in Campus Speech Climate: Visualizing Self-Censorship and Free Speech Across U.S. Universities

Anna Sarfalvi: Psychology & Economics B.A. ; Master of Supply Chain Management, **Alexander Klautky**: B.S. in Economics, **David Chang**: B.S. in Statistics

Our study examines how perceptions of free speech and ideological bias vary across U.S. university campuses, paying particularly attention to differences between conservative and non-conservative students. Prior research has suggested that political ideology shapes comfort levels in expressing controversial opinions and perceived openness on campuses (Ryan et al., 2020). Building on this work, the proposed analytical work investigates whether conservative-identifyig students report lower comfort speaking in public and higher self-censorship compared to their non-conservative peers. We would further like to look at how this differs across space and time; considering region, degree of urbanization, university size and institution type. Using recent large-scale datasets (FIRE and Heterodox Academy OpenMind Survey) our analysis will employ longitudinal and multilevel modeling with students nested in their institutions. Key variables will include political identity, comfort expressing views, perceived institutional climate, reported self-censorship, and free-speech indices. Supplementary analysis will look at potential moderators such as gender, age, race or ethnicity. Visualizations will be done in R to map any relevant trends and asymmetries over time. Overall, the project seeks to better understand how students' political identity interacts with institutional factors to shape their sense of expressive freedom on U.S. university campuses.

Project Mentor: David Clingingsmith, CWRU

Page 171: Caught Off Guard: How Theory of Mind and Culture Shape The Experience of Surprise

Lili Kong, Cognitive Science

This literature review focuses on the element of surprise, using the theory of mind as a variable in social prediction across cultures. How individuals' mental states can be predicted depends on various factors, but more importantly, this paper draws on how ToM interacts with cultural norms to shape prediction violations—drawing on previous research in cognitive psychology of the computer metaphor, treating mental processes as internal/universal but independent of cultural context, which challenges the paper's assumption that ToM and emotion are culturally context-sensitive. Surprise serves as a feedback signal, which in this context occurs when mental predictions are violated. The review will involve analyzing tighter/looser cultures that either tolerate deviant behavior or do not. The goal at hand is to evaluate different pieces of research articles to integrate how people's Theory of Mind (ToM) traits and cultural background (tight vs. loose norms) shape surprise when outcomes do or do not violate social predictions. This will allow for a better understanding of how people react to social norms and interactions. This literature review works to fill in research gaps, such as culture shaping cognitive features through individuals' experiences of surprise. By synthesizing evidence, the review will ultimately be able to evaluate patterns of surprise across different cultural backgrounds and ToM traits to provide a deeper understanding of how individuals react to social norms.

Project Mentor: Professor Vera Tobin, Department of Cognitive Science, CWRU

Page 172: Analyzing the Impact of Team Payroll on Regular and Postseason Performance in the NBA

Phillip Kornberg, Department of Computer and Data Sciences; **Muyu Lei**, Department of Economics; **Oghenekeno Oki,** Department of Biomedical Engineering

In recent years, the debate surrounding the implementation of salary caps across professional sports has resulted in extensive research being done to determine whether success is driven by financial spending. This raises the question of whether the correlation between team payroll and success only emerged in the modern era, or if it has been a consistent trend throughout history. In this project, we aim to examine the validity of salary cap arguments in the NBA. Using team data from the past ten NBA seasons, specifically the win rate of teams, we will analyze whether a team's payroll is significantly related to its regular season and postseason performance. Additionally, we want to identify if there exists a threshold level of spending that increases a team's likelihood of making the playoffs and whether this threshold falls near the league average team salary or aligns with the highest spending teams.

Project Mentor: David Clingingsmith, Department of Economics, CWRU

Page 173: Assessing the Impacts of Green Walls on Indoor Microbiomes

Caroline Kreutzberg, Department of Mechanical and Aerospace Engineering; Dr. Bridget Hegarty, Department of Civil and Environmental Engineering, CWRU

The indoor environment is home to diverse microbial communities that influence human health. While most attention focuses on harmful microorganisms such as pathogens, a growing body of research highlights the potential health benefits of microbial exposure, particularly from environmental sources. This study investigates whether indoor plants and green walls (vertical structures densely planted with vegetation) alter the composition and types of microbes in indoor spaces. The central hypothesis is that green walls contribute to a more diverse indoor microbiome, which may improve occupant health. Specifically, this study investigates if microbial taxa associated with green walls are indeed detectable within settled dust and indoor air, offering insights into how these installations may influence microbial exposure for occupants. By completing our own sampling, as well as using existing, publicly available amplicon sequencing data, we are investigating whether indoor environments that have more plants have more microbial diversity and biomass. By bridging environmental microbiology, sustainable architectural design, and human health, this research aims to explore whether green walls can serve as more than decorative elements, potentially becoming active contributors to healthier indoor ecosystems.

Project Mentor: Dr. Bridget Hegarty, Department of Civil and Environmental Engineering, CWRU

Page 174: Boredom and Mental Health in College Students.

Andrew Kwak, Chemistry and Psychology Major, Case Western Reserve University.

Surveys conducted among university students have found that feelings of boredom rank high among the emotions that students experience regularly and even surpass those of sadness or frustration (Eastwood et al., 2012; Vodanovich, 2003). Although it is common among students, there is still little known about the emotional experience of boredom and its profound effects on the mental well-being and motivation of students in colleges. Among the avenues that this thesis aims to explore is its potential to be a motivational force among students. By utilizing a literature review method, this paper combines empirical and theoretical work to investigate the opposing nature of boredom as both a risk and a motivating factor for behavior. While there is evidence like that given in Zhao et al. (2024) to suggest that high levels of boredom proneness and behavioral inhibition correspond to increased levels of anxiety and avoidance, there is also evidence like Elpidorou (2018) to suggest that it can precipitate reflection and re-engagement with one's surroundings. From the results, it is evident that the experience of boredom is not only negative in nature but a multifaceted psychological process that can have both harmful and useful effects. This aspect can have implications for the formulation of programs such as mindfulness initiatives that can counter the harmful effects associated with boredom and leverage its motivational aspect to improve the well-being and academic performance of students in learning institutions.

Project Mentor: Joshua Wilt, Psychological Sciences

Page 175: PrintBot - Autonomous Mobile Robot to Operate 3D Printers

Amos Langsner, Mechanical Engineering

3D printing is a powerful tool for both rapid prototyping and low volume production. Traditional plastic FDM printers deposit layers of molten plastic filament in specific geometries to build a part of virtually any geometry. 67% of American manufacturers currently own at least 1 3D printer, and the 3D printing market is growing at a CAGR of 15% YoY. However, many users are frustrated with the slow speed of 3D printing relative to other manufacturing methods. While printer OEMs' efforts to increase print speeds have been helpful, they fail to address a fundamental issue with 3D printers - they require a person to operate. If an engineer starts an 8 hour print at 4pm, the printer will sit idle from midnight until 9am the next morning, when the engineer will return to the office to empty the finished print and start a new one. I found that this is a widespread problem for startups and mature manufacturers alike, and that the current solutions such as belt style printers or custom automation solutions don’t fill customers’ needs. I am designing a mobile robot capable of removing the build plate of FDM 3D printers with magnetic build plates, primarily the popular Bambu Labs X1C. The robot will be composed of a differential drive train, a scissor lift, and a 6 DOF robotic arm to allow for build plate manipulation across a variety of setups and sizes. When instructed by the print management system (pre-existing software), PrintBot will drive to the idle printer, open it, remove its build plate, deposit the build plate with the finished print in a bin, install a fresh build plate, and then signal the print management system to begin the next print. This will enable 24/7 autonomous printer operation, significantly increasing production throughput for users.

Project Mentor: Will Hasting PE, CEO of Angel Aerial Systems

Page 176: When Coping Becomes Coping with Cannabis: Examining Psychological Distress and Protective Strategies in Young Adults

Xitlalic Lara Anguiano, Cognitive Science

Marijuana use among young adults is becoming increasingly common, yet the reasons behind its use—and how these reasons connect to mental health—are still not fully understood. This study aims to explore the relationship between psychological distress, motives for marijuana use, and the protective strategies young adults use when consuming cannabis. Specifically, it focuses on whether using marijuana as a coping mechanism for stress or negative emotions is linked to higher levels of distress, and whether protective behavioral strategies can help reduce that risk. Participants between the ages of 18 and 30 who have used marijuana in the past 30 days will complete an online survey measuring their frequency of use, motives for use, protective behaviors, and mental health indicators such as depression and anxiety. The data will be analyzed using correlational and regression analyses to identify patterns between coping motives, psychological distress, and protective strategy use. By better understanding these relationships, this study seeks to highlight how harm reduction strategies and mental health awareness can support safer marijuana use among young adults.

Project Mentor: Fey Parrill

Page 177: Blocking astrocyte reactivity using traditional Chinese herbal medicines

Ayano Lavine, Department of Neurosciences; Dr. Ashley Nemes, Department of Neurosciences, Case Western Reserve University

Neurodegenerative diseases significantly reduce both the quality and duration of life worldwide and are closely linked to astrocyte dysfunction. Under inflammatory conditions, astrocytes adopt a reactive phenotype that contributes to neuropathology by losing homeostatic functions, secreting inflammatory cytokines, and withdrawing their processes from other central nervous system cells. Targeting this reactive state represents a promising therapeutic approach. Traditional Chinese Medicines (TCMs), which have been used for thousands of years to manage a diverse array of diseases, are emerging as novel modulators of cellular inflammation. This research investigates whether TCM extracts can block cytokine-induced astrocyte reactivity and maintain normal cellular function rather than switch to a reactive phenotype. Primary astrocytes are pre-treated with selected extracts prior to cytokine exposure to determine whether the extracts can prevent the transition of these cells to the reactive state. Preliminary screening has identified fourteen extracts that significantly reduce markers of reactivity. The compounds are being ranked by efficacy using molecular and functional assays to determine their relative efficacy. The findings from this research may identify natural compounds capable of modulating key inflammatory pathways to restore astrocyte function and allow for the treatment of neurodegenerative diseases.

Project Mentor: Dr. Benjamin Clayton, Department of Genetics and Genome Sciences, Case Western Reserve University

Page 178: Bimanual Robotics Control using Vision Language Action Model

Junsu Lee, Computer Science; **Ore Bajela**, Data Science and Analytics; **Christopher Danner,** Computer Science; **Matthew Dennee**, Computer Science; **Hirshi Hari**, Computer Science

Advances in vision-language-action (VLA) foundation models have enabled robots to interpret and execute natural language instructions by integrating multimodal information from text, vision, and motion. This project explores language-guided robotic control through fine-tuning and deployment of NVIDIA's Isaac GR00T-an open VLA model-on dual LeRobot SO-101 robotic arms. We develop an end-to-end system that allows users to issue natural language prompts that are translated into robot actions through a software-driven multimodal pipeline encompassing computer vision, natural language processing, and data engineering. The system integrates multiple components: (1) a React/Three.js-based simulation interface with an interactive 3D editor; (2) an iOS LiDAR scanning application for real-world scene reconstruction; (3) a GR00T policy server fine-tuned with Low-Rank Adaptation (LoRA) using both teleoperation and synthetic data; and (4) a robot execution layer for synchronized control and feedback. A controlled physical environment ensures reproducible multimodal data collection, enabling robust cross-domain transfer between simulated and real environments. Analytical evaluation frameworks quantify task success, latency, and generalization to cluttered scenes, applying statistical and visualization techniques to assess performance improvements from LoRA fine-tuning. By integrating GR00T's multimodal reasoning capabilities with a reproducible robotic manipulation pipeline, this work advances toward scalable, language-driven control systems that bridge the gap between human intent and robotic action.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences, CWRU

Page 179: Analyzing the Impact of Team Payroll on Regular and Postseason Performance in the NBA

Phillip Kornberg, Department of Computer and Data Sciences; **Muyu Lei**, Department of Economics; **Oghenekeno Oki**, Department of Biomedical Engineering

In recent years, the debate surrounding the implementation of salary caps across professional sports has resulted in extensive research being done to determine whether success is driven by financial spending. This raises the question of whether the correlation between team payroll and success only emerged in the modern era, or if it has been a consistent trend throughout history. In this project, we aim to examine the validity of salary cap arguments in the NBA. Using team data from the past ten NBA seasons, specifically the win rate of teams, we will analyze whether a team's payroll is significantly related to its regular season and postseason performance. Additionally, we want to identify if there exists a threshold level of spending that increases a team's likelihood of making the playoffs and whether this threshold falls near the league average team salary or aligns with the highest spending teams.（In this research, the salary cap of each team in NBA in past 10 seasons had been obtained, and had been tested and regression based on the win rate.)

Project Mentor: David Clingingsmith, Department of Economics, CWRU

Page 180: Length Characterization of Grafted Type I Collagen Fibrils for Improved Soft Tissue Integration of Dental Implants

Nicholas Leonard, 1 Leena Polomo,2 Steven J. Eppell1 1Department of Biomedical Engineering, Case Western Reserve University 2Ashman Department of Periodontology & Implant Dentistry, NYU

Traditional titanium dental implants lack significant integration at the Ti/gingival interface. This often results in peri-implant mucositis at the soft tissue interface causing discomfort and likely being associated with future peri-implantitis at the hard tissue interface. We address this by grafting type I collagen fibrils so they project normal to the implant surface. This may improve soft tissue integration and mechanical fixation after implantation. The purpose of this project is to characterize the distribution of these fibril lengths. We accomplished this by measuring the fracture strength of two fibril grafted surfaces separated by stainless steel shims of varying thicknesses and then crosslinked together. By determining the separation distance at which the fracture strength diminishes, the distribution of fibril lengths can be determined. We expect that as shims increase in thickness, shorter fibrils won't be able to crosslink causing the fracture strength to decrease. The work presented here describes the design, manufacture, and testing of jig allowing these fracture strength measurements to be made.

Project Mentor: Prof. Steven Eppell, Department of Biomedical Engineering, Case Western Reserve University

Page 181: Memory for Words

Angela Li, Psychology

This study tested participants' memory recall using a word recognition task. Participants were first shown a list of 70 words. They were then presented with 60 two-choice questions, each containing one word from the original list and one new word. For 30 of these questions, participants were instructed to select the word that was not on the original list, while for the other 30, they were asked to choose the word that was on the list. The goal of this experiment was to determine whether there is a difference in memory performance between recognizing previously seen words and identifying new ones.

Project Mentor: Robert Greene, CWRU

Page 182: Temperature and Visitor Influences on Captive Animal Activity and Visibility

Christopher Lim (Biology), Department of Biology

Understanding how environmental factors shape animal behavior is essential for improving exhibit design and welfare for display animals. This project combines a review of literature on wild animal behavior and their captive counterparts with observations conducted at the Perkins Wildlife Center to examine how temperature and visitor presence affect animal activity and visibility. Over seven observation sessions, the river otter, raccoon, gray fox, red fox, bobcat, coyote, and North American porcupine were scored for activity and visibility, along with ambient temperature and visitor counts. Activity peaked between 60–70°F but dropped sharply at 80°F. Visibility was not significantly affected by visitor density except for the red fox, which showed a strong pattern of increased visibility with increased visitors, although it remains uncertain whether visitor presence stimulated animal activity or whether active animals attracted more visitors. Further analysis will explore additional environmental variables such as precipitation and sky cover to better understand how external conditions influence animal behavior and welfare. Overall, these results provide valuable information that may aid in improving animal care and exhibition practices at zoos and wildlife centers.

Project Mentor: Professor Ronald Oldfield, Department of Biology

Page 183: Novel Mechanism and Therapy of Anthracycline-Induced Cardiotoxicity (AIC)

Claire Lin, Department of Biology, CWRU; Jianjun Zhao, Department of Cancer Biology, Lerner Research Institute; Qingzhu Wang, Department of Cancer Biology, Lerner Research Institute

Anthracycline is a class of chemotherapy drugs derived from the Streptomyces bacterium that is commonly used to treat breast cancer, sarcomas, lymphomas, and leukemia. These chemotherapeutic agents, such as Doxorubicin and Daunorubicin, inhibit topoisomerase II alpha (TOP2A). While they are effective and widely used, the complementary Anthracycline-Induced Cardiotoxicities (AIC) remain a major clinical challenge. In cardiomyocytes, Anthracyclines can bind off-target to topoisomerase II beta (TOP2B), leading to the overexpression of TOP2B and ultimately causing cardiotoxic effects, such as congestive heart failure and dilated cardiomyopathy. Currently, it is uncertain how TOP2B poison affects heart function when Anthracycline-bound DNA–TOP2B complexes are formed. Past research has also shown that TOP2B interacts with SMYD1, a muscle-specific histone methyltransferase that's crucial for cardiac muscle function. Dysfunction in SMYD1 is linked to genetic variants in human cardiomyopathy cases, suggesting a more in-depth understanding of the underlying AIC mechanisms and treatment options that can prevent anthracycline-related heart damage. Therefore, the project aims to examine the cardiotoxicities of Anthracycline using my research lab's AIC and human TOP2B transgenic mouse models. Our research investigates the mechanism behind doxorubicin-induced cardiotoxicity and finds that doxorubicin causes an initial surge in the expression of the TOP2B protein in heart muscle cells. The cardiomyocyte-specific, tamoxifen-inducible TOP2B transgenic mice demonstrate pathophysiological features consistent with Doxorubicin-induced cardiotoxicity, even without prior or continued drug exposure. In addition, disruptions in SMYD1 cause cardiomyopathy and heart failure in humans; a loss of SMYD1 in mice, similarly, leads to phenotypes resembling AIC, suggesting that TOP2B's overexpression affects the function of SMYD1 in cardiomyocytes and is a key driver of AIC. These findings highlight TOP2B as a potential therapeutic target for preventing cardiac complications in cancer patients, and it can be achieved by the use of antisense oligonucleotides (ASO) in delivering cardioprotective strategies.

Project Mentor: Jianjun Zhao, Department of Cancer Biology, Lerner Research Institute

Page 184: Linking Personality Traits to Pain Perception Through Pain Catastrophizing

Madeline Liu, Psychology

Chronic pain is one of the most widespread health issues around the world. New evidence shows that its effects go beyond just physical injuries; psychological and personality factors also play a role. This literature review looks at how personality traits, especially neuroticism and optimism, affect pain perception by influencing the cognitive-emotional process of pain catastrophizing. Based on the biopsychosocial model of pain, the project combines findings from ten studies, both experimental and clinical, to uncover how personality and pain are connected.

Sources were gathered from PsycINFO and Web of Science using terms like “pain catastrophizing,” “personality” and “trait.” Only peer-reviewed studies from 2006 to 2025 were included. Across the research, both experimental methods and clinical studies consistently showed that catastrophizing mediates the link between personality and pain outcomes. In particular, people high in neuroticism and low in positive traits like hope and optimism tended to catastrophize more, leading to greater pain intensity, disability, and emotional distress.

These findings support a clear framework in which pain catastrophizing serves as a key psychological factor linking personality to pain experiences. Understanding this relationship highlights the need for approaches that consider personality in pain management and cognitive-behavioral treatments. Future studies should use long-term designs to better understand the causal links among personality, catastrophizing, and pain outcomes. This could improve treatment strategies for individuals dealing with chronic pain.

Project Mentor: Joshua Wilt, Psychology

Page 185: A Multiplex Quantitative Analysis to classify maturation stages of Tertiary Lymphoid Structures in Dedifferentiated Liposarcoma

Eric Liu, Biology; **Dijana Bjelivuk**, Health Sciences (Cleveland State University); Dr. Gary Schwartz, Case Comprehensive Cancer Center; Dr. Rebecca Obeng, Pathology

Dedifferentiated liposarcoma (DDLPS) is an aggressive form of adipocytic cancer that lacks robust patient prognostic factors. Tertiary lymphoid structures (TLS) are lymphoid aggregates that form within cancers. Previous studies have demonstrated that mature TLS formation within solid tumors is associated with improved patient response to immune checkpoint therapies. However, the predictive role of immune aggregates in dedifferentiated liposarcomas has not been fully established. Peripheral node addressins (PNAd) are a biomarker group of particular interest. PNAd refers to a group of glycoprotein[1] s expressed on high endothelial venules (HEVs), blood vessels associated with lymphocyte trafficking into lymphoid organs. Our goal is to systematically characterize the maturation stages of immune infiltrates, and determine whether PNAd are a defining biomarker of mature TLS. In this project, we are examining digitized tumor biopsies and resection sections received from NCT05694871. Human tumor resections were formalin fixed, embedded in paraffin, and sectioned onto glass slides[2] . Fluorescent staining was performed[3] on an automated stainer with the following antibody-conjugated fluorophores: CD11b (Opal 480), CD3 (Opal 520), CD11c (Opal 540), PDL1 (Opal 570), CD14 (Opal 620), MDM2 (Opal 650), PNAd_MECA79 (Opal 690), and CD20 (Opal 780), along with DAPI nuclear counterstain[4] . Using QuPath, a digital pathology software[5] , we have manually identified TLS within tumors, performed cell segmentation using a StarDist model, and trained a QuPath machine-learning classifier to identify cell phenotypes. Preliminary data suggests that PNAd is frequently expressed across many TLS independently of maturation stages, but PNAd is not expressed in all TLS[6] . We believe PNAd expression to be a predictive biomarker of tumor response to immunotherapy for DDLPS.

Project Mentor: Dr. Rebecca Obeng, Department of Pathology

Page 186: CD80 Expression on Microglia in Human Spinal Cord and Cerebellum: a Comparative Study in Sporadic and C9ORF72 ALS Patients

Christy Liu, Biochemistry; Elizabeth Woidke, Pathology; Josephine Waliszewski, Biochemistry; Matthew Evans, Pathology; Anna Dudziak, Pathology; Dr. Aaron Burberry, Pathology

Amyotrophic Lateral Sclerosis (ALS) is a progressive and fatal neurodegenerative disease marked by the degeneration of upper and lower motor neurons in the motor cortex, brain stem, and spinal cord. ALS has an estimated 2.1 new cases per 100,000 population per year and has no known cure to date. The most common genetic contributor of ALS is a GGGGCC hexanucleotide repeat expansion in the first intron of the C9ORF72 gene on Chromosome 9. While approximately 10% of ALS cases are familial, the remaining 90% are sporadic. The C9ORF72 repeat accounts for 20 to 40% of familial cases, and 2 to 8% of sporadic ones. Despite the variety of symptoms, neural inflammation consistently occurs before or during disease onset. This includes activated microglia, increased expression of proinflammatory cytokines, immune cell infiltration, and neuronal damage. Previous post-mortem human spinal cord analyses have shown elevated CD80 expression on activated microglia in the spinal cord of C9ORF72-linked ALS. However, further investigation across different tissue regions is needed to determine whether this is a generalized ALS feature or specific to C9ORF72 pathology. In this study, we performed blind staining, imaging, and quantification of gray and white matter from the cervical spinal cord and cerebellum of 22 patients across three groups (non-ALS, sporadic ALS, and C9ORF72 ALS) to assess whether CD80 enrichment on microglia is conserved across all ALS cases or specific to C9ORF72-linked cases.

Project Mentor: Dr. Aaron Burberry, Department of Pathology

Page 187: Event Compass

Michelle Lo, Computer Science and Data Science; **Laura Zhang**, Data Science, **Siyeon Park,** Data Science, **Franklin Wang**, Computer Science, **Kent Nishizawa**, Computer Science

Student-led organizations play a central role in shaping campus culture and enhancing the student experience by creating opportunities for entertainment, relaxation, and community building outside the classroom. Yet with such a wide range of student interests and often limited budgets, planning events that appeal broadly can be challenging. On top of that, managing logistics, vendors, and finances adds another layer of complexity.

One example is the University Program Board (UPB) at Case Western Reserve University. UPB is one of the largest student organizations on campus and is well known for hosting major events such as the annual Spring Comedian, and large-scale off-campus trips to destinations like Kalahari and Cedar Point. Drawing on this experience and event-planning expertise, our team aims to make these best practices accessible to other student organizations, empowering them to host successful events even with smaller budgets and teams.

We are developing Event Compass: an interactive platform that leverages data-driven insights and large language model (LLM) recommendations to streamline and enhance event planning.

The vision of *Event Compass* is to transform the way student organizations and event planners design, organize, and execute events by providing a data-driven, intelligent, and user-friendly planning platform. By integrating Data Science and Computer Science, *Event Compass* empowers organizations to create events that resonate with their target audience while optimizing resources and streamlining logistics.

Through survey-driven insights and advanced analytics, *Event Compass* will enable planners to streamline planning with an intuitive chatbot interface that guides users step by step, leverage data-driven insights to recommend venues, caterers, and vendors based on past performance, real-time availability, and cost considerations, and enhance decision-making by predicting guest preferences, optimizing budgets, and forecasting attendance with actionable analytics. Our ultimate goal is to help event planning organizations, particularly student-led groups, deliver meaningful, engaging, and well-executed events—regardless of budget or size.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences

Page 188: Music For You Abstract

Caio Albuquerque - Computer Science, B.S., **Izaiah Caston** - Computer Science, B.S., **Ryan Irizarry** - Computer Science, Economics, B.A., **Michael Lopez** - Computer Science, B.S.

Music For You is a web application developed to curate and generate personalized music playlists by interpreting natural language prompts. The project's purpose is to enhance the music discovery experience by allowing users to request playlists on services with intuitive queries. We aim to bridge the gap between human intuition and computing technology by creating a tool that understands and responds to user prompts moving beyond traditional genre-based and artist-based suggestions. In an ever-growing AI/ML-based society, this project will serve as replication of modern software engineering and AI practices in the real-world, including the Agile framework and the Software Development Lifecycle (SDLC). At the core of our approach is a large language model (LLM) that leverages a convolutional neural network (CNN) to process user requests; the application's cloud architecture is a scalable, event-driven system built on Amazon Web Services (AWS), where user requests are ingested via an API Gateway, placed into an SQS queue for asynchronous processing by a worker Lambda, with the final AI-generated playlists and user data stored in DynamoDB and S3. When a user enters a natural language prompt, our application identifies the core musical characteristics of the input and uses our database to find other songs of high similarity. We expect Music For You to deliver highly accurate songs and/or playlists that fit the user's intended desires. Ultimately, Music For You offers a user-friendly, accurate song recommendation engine for a user's listening needs through hyper-personalized songs.

Project Mentor: Shuai Xu, Case Western Reserve University

Page 189: Ultrafast Imaging Device For Hypersonic Experiments

Jaime Losada (Aerospace Engineering), Department of Mechanical and Aerospace Engineering

The study of hypersonic and hypervelocity phenomena requires imaging systems capable of capturing high-speed and spatially fine-scale events, with time scales on the order of microseconds and feature sizes of only hundreds of micrometres. Existing ultra-high-speed (UHS) camera technologies—such as gated intensified, rotating mirror, and advanced CMOS architectures—each meet certain requirements but fall short in simultaneously achieving the necessary frame rate (≥10 MHz), resolution (~20 MP), and image quality. To address these limitations, a novel optical approach is proposed, inspired by multispectral dichroic systems but uniquely applied to sequential ultra-high-speed imaging.

The goal of this project is to design and construct a device that optically couples two high-resolution cameras through a common light path, enabling 2-frame imaging at rates exceeding 50 million frames per second for advanced hypersonic research applications.

The project evolved through a series of design modifications aimed at resolving limitations identified during development. The initial concept was created in SolidWorks CAD, where individual components of the optical coupling system were modelled and virtually assembled. These designs were subsequently fabricated through 3D printing, yielding prototypes that provided critical insights into mechanical limitations and guided refinements to improve stability, alignment, and optical performance. To enhance precision and durability, key optical and mechanical components were sourced from Thorlabs, while the central mounting structure was professionally machined and anodized by an aluminum manufacturing specialist based on the final CAD design.

Project Mentor: Bryan Schmidt, Department of Mechanical and Aerospace Engineering, CWRU

Page 190: Improving Diagnostic Accuracy of DT-CMR with Vision Transformer Model

Belle Lu, Department of Biology; Zack Player, School of Medicine; Dr. Christopher Nguyen, Department of Biomedical Engineering, Cleveland Clinic

Cardiovascular disease is the number one cause of death in the United States, and the number of deaths is still increasing (AHA, 2025). We consider cardiac amyloidosis and hypertrophic cardiomyopathy, which are difficult to differentiate through existing noninvasive imaging techniques. Cardiac amyloidosis (CA) is a leading cause of restrictive cardiomyopathy with a prevalence of 8-17 per 100,000 person-years (Gilstrap, 2019). CA is caused by extracellular deposition of misfolded amyloid fibrils with insidious progression to heart failure. Symptoms often overlap with primary heart failure and other common cardiomyopathies. Diagnosis requires a costly and lengthy combination of imaging and confirmatory tissue biopsy, which, with the nonspecificity of symptoms, leads to frequent underdiagnosis (Shams, 2025). Hypertrophic cardiomyopathy (HCM) is an autosomal dominant disease of hypertrophy of cardiac myocytes, which is ultimately fatal without prompt intervention (Basit, 2024). HCM is the most common, recognizable cause of sudden cardiac death in individuals under 35 and has a worldwide prevalence of 0.2%. Up to 50% of patients may be asymptomatic or only mildly symptomatic, making early diagnosis crucial (Shams, 2025). Diffusion tensor cardiac MRI (DT-CMR) shows the diffusion of water in cardiac tissue and allows us to extract cardiac microstructural information such as cardiac myocyte bundles (Nguyen, 2013). The Vision Transformer (ViT) analyzes the global structure of images, extracting both microstructural and macrostructural features (He, 2023). We hypothesize that analysis of DT-CMR with a ViT model will produce novel diagnostic information. We aim to apply this model to the differential diagnosis of CA and HCM by analyzing research DT-CMRs from a cross-sectional cohort of patients with CA and HCM and controls consisting of healthy volunteers and patients with other cardiac pathologies. Future work will include identifying clinically relevant biomarkers from the AI model's analysis to provide greater insight into these pathologies.

Project Mentor: Dr. Christopher Nguyen, Department of Biomedical Engineering, Cleveland Clinic

Page 191: Integrating Ontology and Knowledge Graphs for Photovoltaic Degradation Analysis

Vinh-Khang Luu (Materials Science and Engineering)

Abstract The increasing reliance on data-driven methodologies in scientific research has led to an explosion of available data, particularly in photovoltaic (PV) degradation science studies which are critical for optimizing solar energy systems. Despite this wealth of information, extracting meaningful insights remains challenging due to issues such as inconsistent metadata, fragmented datasets, and the absence of advanced reasoning mechanisms. To address these challenges, this study introduces a semantic reasoning framework for PV degradation analysis by developing ontologies called PV-Onto and knowledge graphs that incorporate processed data. This framework aligns with the FAIR (Findable, Accessible, Interoperable, and Reusable) data principles to ensure that data is systematically structured and applicable for future studies. Utilizing Materials Data Science Ontology (MDS-Onto), FAIRlinked and FAIRmaterials, the resulting structured data and analytical framework will be integrated into GraphDB to facilitate automated reasoning and predictive analysis, ultimately improving PV degradation modeling and forecasting for more effective solar energy solutions.

Project Mentor: Roger French, Department of Materials Science and Engineering, CWRU

Page 192: Racial bias in forensic risk assessment tools

Ariana Elizabeth Lyngdoh, Psychology and Cognitive Science

Despite the United States criminal justice system being advertised as having improvements, common forensic assessment tools still actively contribute to systemic racial inequities. This narrative literature review examined whether racial bias in risk assessment tools classifies people of colour as higher risk, which may lead to discrimination in policy reforms, parole decisions and recidivism. It is important to expand on this topic because the existing validation studies are carried out on populations that are predominantly White or that do not break down racial/ethnic subgroups. Hence, the gap and need for further research is to ensure extensive, multi-ethnic validation studies that evaluate each racial/ethnic group's forecast accurately and independently. This narrative literature review used PsycInfo, PubMed and Google Scholar paired with key terms like racial bias, risk assessment, forensic psychology bias, algorithmic fairness, criminal justice. The preliminary findings of this study are in line with the hypothesis as they show how risk assessment instruments depict racial prejudice by classifying people of color as higher risk which leads to unequal parole choices, recidivism forecasts, and policy effects. The implications of this research are important as they can help to improve and alter forensic risk assessment tools to mitigate and diminish racial bias. The main weakness of the study being a lack of longitudinal existing literature which limits long-term findings of a phenomenon while it occurs in a natural setting.

Project Mentor: Joshua Wilt, Psychological sciences, CWRU

Page 193: Quick-Dry Hydrogel Wound Sensing Bandage for Real-Time Infection Monitoring

Keno Oki, Biomedical Engineering; **Ellie Schneider**, Biomedical Engineering; **Timothy Ma**, Biomedical Engineering; **Esther Gao**, Biomedical Engineering

Chronic wounds, such as diabetic foot ulcers, affect millions of people in the United States, often resulting in extended healing times, increased infection risk, and high healthcare costs. Current clinical practices typically involve packing wounds with cotton or gauze and visually inspecting them over regular time intervals. This approach provides limited feedback on wound status between clinical visits. Early identification of infection is crucial for preventing complications and reducing the likelihood of amputation. Our project aims to develop a quick-dry hydrogel wound sensing bandage that can provide real-time, non-invasive detection of wound infection by monitoring pH changes in the wound microenvironment. pH is a key biomarker: mild infections typically maintain a pH ~ 6.8, whereas more infected wounds shift to an alkaline range ~ 7.8. This prototype consists of a hydrogel embedded with colorimetric pH-sensitive dyes that change color based on the wound exudate's pH, which will be covered with Tegaderm. Similar to cotton packing, the hydrogel maintains close contact with the wound surface, allowing moisture uptake and enabling accurate pH detection. The prototype is designed for easy application and removal as a disposable, non-electronic indicator that is compatible with telehealth follow-up (visual checks without redressing). The hydrogel will be tested for its mechanical integrity, swelling behavior, dye responsiveness, and color visibility, as well as its ability to adhere comfortably to curved body surfaces such as the foot. By pairing an analytically grounded hydrogel design with a practical, clinic-adjacent simulator, we aim to demonstrate a low-cost, easy-to-read bandage that advances at-home monitoring of diabetic foot ulcers. This enables earlier intervention and potentially reduces progression to severe infection and amputation.

Project Mentors: Dr. Matthew Williams, Department of Biomedical Engineering; Dr. Colin Drummond, Department of Biomedical Engineering; Dr. Steven Eppell, Department of Biomedical Engineering

Page 194: Improved Lower Bounds for the Projective–Injective Tensor Norm Ratio

Lucas Maciel Bueno da Silva, Department of Mathematics, Applied Mathematics, and Statistics, Case Western Reserve University

Using tools from functional analysis and convex geometry, we investigate configurations yielding improved lower bounds for the projective–injective tensor norm ratio ρ(X,Y) for normed spaces X,Y of nontrivial dimension (i.e., at least 2). This ratio represents the universal gap between local and global strategies in the framework of general probabilistic theories, which encompass all physical models whose predictive power obeys minimal consistency requirements. Building on a modified version of Auerbach's Lemma introduced in Universal Gaps for XOR Games from Estimates on Tensor Norm Ratios (Communications in Mathematical Physics, 375, 2020), we provide a more detailed derivation of the bound 19/18 obtained in that paper and study configurations yielding a better 8/7 bound that was conjectured there. The configuration tested to yield the 8/7 bound was investigated using numerical methods and confirmed analytically, with the accompanying Mathematica code to be provided.

Project Mentor: Professor Stanisław Szarek, Department of Mathematics, Applied Mathematics, and Statistics, Case Western Reserve University

Page 195: Optimizing T-cell Activation Analysis Through Tissue-Specific Antibody Titration

Ria Makkar - Biochemistry B.S, Filip Goshevski, Amar B. Desai

T Lymphocytes are a type of white blood cell that play a crucial role in generating immune responses. T-cell activation is the process by which mature T-cells become responsive to antigens, leading to T-cell proliferation, cytokine production, and the initiation of immune responses. When activated, T-cells upregulate the expression of CD25, CD44, and CD69 surface antigens. CD69 is found on all activated T-cells within hours of initial stimulation, indicating recent activation. CD25 is found on activated regulatory and effector T-cells while CD44 is found on memory and effector T-cells. Together, the variety and specificity of these markers provide reliable indicators of the cell's functional state. However, the activation of T-cells and the expression of surface markers are variable throughout different tissues in the body. To optimize staining for flow cytometry and achieve reliable results on T-cell populations across different tissues, we optimized the detection of CD25, CD44, and CD69 in murine bone marrow, lymph nodes, and spleen by performing antibody titrations and maximizing the Staining Index (SI) for each marker.Using these optimized concentrations, antibody mixes were created for each tissue type, enabling consistent and efficient analysis of T-cell activation in future experiments. This work lays the foundation for the reliable assessment of T-cell activation across diverse immune environments and strengthens our ability to study immune dynamics in disease models frequently used in our lab such as graft-versus-host disease (GVHD), idiopathic pulmonary fibrosis, and chemotherapy-induced neutropenia. Importantly, this project supports our investigations into the immunological impact of XPO1 inhibitors which have shown efficacy in models of hematopoietic recovery, aging and GVHD. We aim to investigate if our XPO1 inhibitors decrease immune activation. Through optimizing our staining protocol for T-cell activation, we have laid the groundwork to do so, allowing us to better understand the therapeutic scope of PGDH inhibition.

Project Mentor: Amar Desai

Page 196: Synthesis and Evaluation of "Magic Methyl Effect" in Antidepressants and Antiparkinsonian Analogues

Athena Mandal (Biology), Department of Biology; Swagata Sil, Department of Chemistry, IISER Kolkata; Siuli Das, Department of Chemistry, IISER Kolkata

The “magic methyl effect” describes the enhancement of potency of biologically active compounds resulting from the introduction of a methyl group into the compound. Its role in optimizing biological compounds is broad, including the displacement of water molecules via hydrophobic interactions, participation in van der Waals interactions and modulation of physiological properties such as aqueous solubility of the biochemical drug in cellular environment. Despite its clinical relevance in increasing drug performance, site-selective methylation of bioactive molecules remains synthetically challenging without transition metal catalysis. This study aimed to synthesize methylated analogs of clinically relevant neuroactive compounds used in the treatment of major depressive disorder and Parkinson through a transition metal free cross-electrophilic approach. Aryl halide analogs of citalopram, piribedil and amoxapine were methylated using phenalenyl-based ligands to a methyl-substituted analog which were further characterized under in vivo hippocampal neuronal cell model studies to compare changes in drug potency. The transition metal-free cross-electrophilic coupling afforded moderate to high yields (81% citalopram, 69% piribedil and 67% amoxapine), showing robust selectivity for late-stage aryl halide methylation. In vivo biological assays compared methyl-substituted citalopram to an unsubstituted analog, revealing that post-synaptic activity in hippocampal neurons increased when treated with methyl-substituted antidepressant. By avoiding transition metal catalysis, this work avoids heavy-metal contamination in pharmaceutical industries and provides a sustainable framework for synthesis of methyl substituted bioactive compounds. Hence, this work highlights a clinically relevant methodology for evaluation of how methyl substitution influences drug-cell receptor interactions.

Project Mentor: Dr Siuli Das, IISER Kolkata and Dr. Jean Burns, CWRU Biology

Page 197: Dietary Fat Composition Shapes Metabolic Reprogramming and Therapeutic Vulnerabilities in Pancreatic Cancer Under a Ketogenic Diet

Nimat Manzoor, Department of Biology; Dr. Jordan Winter, Department of Surgery, Case Comprehensive Cancer Center, University Hospitals

Pancreatic ductal adenocarcinoma (PDAC) remains one of the most lethal malignancies as the third cause of cancer death in the U.S, defined by its metabolic adaptability and resistance to treatment. This research examines how the ketogenic diet (KD), characterized by high fat and low carbohydrate intake, reprograms PDAC metabolism and exposes therapeutic vulnerabilities. Our previous findings demonstrated that KD enhances tumour sensitivity to glutaminase inhibition, disrupting tricarboxylic acid (TCA) cycle fueling and redox homeostasis by impairing major reactive oxygen species (ROS)–neutralizing pathways. Using orthotopic KPC mouse models, distinct survival outcomes were observed among different fat-based KDs, with coconut oil KD producing the longest median survival (47 days) compared to 17 days under a standard Western diet, suggesting that medium-chain triglycerides enhance metabolic efficiency and tumour suppression. In vitro, PDAC cells cultured in ketogenic media exhibited increased oxygen consumption rates and decreased glycolytic activity, consistent with a shift toward mitochondrial oxidative phosphorylation (OXPHOS). These cells also showed greater sensitivity to fatty acid–induced lipotoxicity, revealing a PDAC-specific metabolic vulnerability. A panel of fatty acids were tested across a range of concentrations to assess their cytotoxic effects on tumour cells. Corresponding fatty acid formulations were incorporated into diets administered to C57BL/6 mice to assess tumour response and survival in vivo. Targeted and untargeted metabolomic analyses further characterized KD-induced alterations in tumour metabolism. Ongoing studies focus on quantifying cell viability across varying fatty acid concentrations and isolating RNA from PDAC cells cultured under ketogenic and control conditions to analyze transcriptomic and metabolomic changes. Further research aims to explore how KD influences immune responses and the tumour microenvironment using tamoxifen-induced models. These efforts seek to identify the metabolic and immunological mechanisms underlying KD's anti-tumour effects and determine how optimizing fat composition can improve both cancer outcomes and systemic health in PDAC therapy.

Project Mentor: Dr. Jordan Winter, Department of Surgery, Case Comprehensive Cancer Center, University Hospitals

Page 198: Examining the Influence of Obesity Assessment Techniques on Obesity Prevalence in Middle-Aged Women

Paris A. Martin[1], Nursing; Melissa T. Lodge[2], Natalie J. Sabik[3], Nicole E. Logan[2,4], Christie L. Ward-Ritacco, PhD, FACSM[2,4]

1 Frances Payne Bolton School of Nursing, Case Western Reserve University, Cleveland, OH
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Excess body fat increases the risk for serious health conditions, yet body mass index (BMI), the standard measure for classifying obesity, does not directly assess body composition. As a result, individuals with high body fat but a "normal" BMI may be misclassified, a condition known as normal weight obesity (NWO). NWO is defined as having a BMI between 18.5–24.9 kg/m² and body fat greater than 30%. Misclassification can lead to inadequate treatment and missed opportunities for early intervention. This data analysis aimed to examine the prevalence of NWO in a sample of middle-aged women. Participants included women aged 40–64 years who were weight stable for at least three months, had a BMI between 18.5–45.0 kg/m², were non-smokers, lived independently, and were able to safely undergo body composition and physical function assessments. Data were collected over two in-person visits and additional at-home tasks. At the first visit, anthropometric measures (height and weight), vital signs, questionnaires, and objective physical function assessments were completed. Body composition, including percent body fat, lean mass, and fat-free mass, was measured using dual-energy X-ray absorptiometry (DXA). Among 106 participants (mean age = 53.0 ± 6.2 years), 33 women were classified with NWO (BMI 18.5–24.9 kg/m² and body fat >30%). Fifteen women had a normal BMI and normal body fat percentage (<30%). Thirty-seven women were classified as overweight (BMI 25.0–29.9 kg/m²) and had elevated body fat, while 21 were obese (BMI ≥30.0 kg/m²) with high body fat. These results demonstrate that body composition varies widely across BMI categories and underscore the limitations of relying on BMI alone to assess obesity. Incorporating body composition assessments earlier in the lifespan may improve early detection of risk and support more individualized, effective health interventions.

Project Mentor: Christie L. Ward-Ritacco, PhD, FACSM, Department of Kinesiology, College of Health Sciences, University of Rhode Island, Kingston, RI

Page 199: Filtration and Raman Analysis of Microplastic Particles

Martin McIntosh, Engineering Physics

The presence of plastic waste in the environment and in nonhuman animals has long been a subject of research, but in recent years, attention has turned to the presence and health effects of microplastics in the human body. To detect microplastics in human tissue, tissue samples must be digested, solubilizing as much biological material as possible. Then, the insoluble microplastics are filtered and studied using various methods. The detection and chemical characterization of microplastics is labor intensive and time-consuming, potentially requiring painstaking visual microscopy to identify and count particles.

Raman spectroscopy systems have already been used in studies of microplastics for chemical characterization, but benchtop Raman systems may also be able to provide efficient detection and quantitative analysis for larger studies, taking the place of visual microscopy. Small, automated Raman systems have the potential to reduce the labor cost of studies of microplastics.

Although particles under 5mm in size are considered microplastics, the smallest particles under 100μm are most easily able to enter the human body and penetrate various tissues. In my project, I explored methods for generating microplastics under 100μm in size and modified a syringe-driven filtration system to filter these particles out of suspension in water using the minimum possible effective filter area. Filter area is constrained by the pressure limits of membrane filters and the need for high flow rates in high volume studies. The goal of the project is to concentrate particles on the filter, with the eventual aim of detecting the presence of microplastics using Raman alone, without visual microscopy.

Project Mentor: Ozan Akkus, Department of Mechanical and Aerospace Engineering

Page 200: Social Policies to Subdue Political Adversaries: The Case of COVID Mitigation

Eleanor "Lena" McMillin: Political Science

Social policies are often used as a covert form of social control. This is especially true in electoral democracies, which lack repression mechanisms and face some accountability measures from the population. The research team and I analyzed COVID-19 mitigation policies to see if there was a difference between the level of democracy and the measures chosen. Overall, electoral democracies were more likely to institute strict movement and assembly restrictions than other regime types, even as other types of restrictions were used roughly evenly across regime types.

Faculty Mentor: Dr. Kelly McMann, Department of Political Science

Page 201: A Systematic Review and Meta-Analysis to Treat Acute Ischemic Stroke Patients with Sovateltide, Alteplase and Tenecteplase

Preyan Mehta, Department of Mechanical Engineering, CWRU; Anil Gulati, Pharmazz; Amaresh Ranjan, Pharmazz

Sovateltide is a novel, first-in-class neural progenitor-based therapeutic under development for the treatment of acute cerebral ischemic stroke (ACIS). Sovateltide demonstrated high safety and efficacy in Phase II and III trials with an extended therapeutic window of up to 24 hours. This study aims to systematically review and meta-analyze the impacts of sovateltide and thrombolytic treatments—alteplase and tenecteplase. Methods: Clinical trial studies were retrieved from PubMed and Google Scholar up to June 2025. They were screened using the PICOT framework. A total of 29 high-quality studies comprising 15,589 ACIS patients were included: 10,595 treated with alteplase, 4,823 with tenecteplase, and 194 with sovateltide (36 in phase II, 158 in phase III). Primary outcomes were measured using the modified Rankin Scale (mRS) at 90 days. The risk of bias was assessed using the ROB-2 and the study was registered with OSF (Registration #……..). Results: Compared to alteplase (0.9 ± 0 mg/kg) and Tenecteplase (0.324 ± 0.025 mg/kg), patients treated with sovateltide (2.7 µg/kg) showed significantly superior outcomes at mRS 0–2 (OR 4.27 ± 0.97 vs 1.09 ± 0.11; 95% CI 2.29 to 4.08; p=0.0001) and mRS 0–3 (OR 5.20 ± 1.51 vs 1.02 ± 0.16; 95% CI 2.81 to 5.49; p=0.0001), and non-inferior at mRS 0 (OR 1.92 ± 0.29 vs 1.32 ± 0.20; 95% CI -0.48 to 1.66; p=0.25) and mRS 0–1 (OR 1.87 ± 0.41 vs 1.20 ± 0.11; 95% CI -0.04 to 1.43; p=0.06). Nonetheless, the subgroup treated with sovateltide in absence of thrombolytics had significantly better outcomes (OR 5.17 ± 1.51 vs 0.89 ± 0.13; 95% CI 2.46 to 6.10; p=0.001) even at mRS 0 compared to alteplase. Notably, sovateltide outperformed tenecteplase at mRS 0-1, 0-2 and 0-3, while at mRS 0 it was found non-inferior. Mortality and intracranial hemorrhage (ICH) analyses indicated no significant difference among these treatments. Heterogeneity level with mean Tau2= 0.0485 ± 0.059, I2 = 15.50% ± 8.38%, and mean H2 = 1.077 ± 0.250 for mRS 0, 0-1, 0-2 and 0-3 were observed. The Galbraith plot suggested an acceptable level of variability. The study utilized ROB-2 to evaluate bias, with Egger's test (p = 0.561) confirming no significant publication bias. The funnel plot indicated minimal bias in the included studies. Conclusions: Sovateltide demonstrates promising efficacy and a strong safety profile in treating ACIS; however, further larger scale, multicentric trials are needed to confirm its therapeutic potential.

Project Mentor: Amaresh Ranjan, Pharmazz Inc.

Page 202: The Investigation of Ethanol Exposure on RIG-I and IgA in the Small Intestine of Mice

Andreea Merzianu, Chemical Biology; Dr. Gail Cresci, Department of Inflammation and Immunity, Cleveland Clinic Lerner Research Institute

Chronic ethanol exposure has been shown to cause gut dysbiosis and intestinal barrier impairment. When the gut barrier is disrupted, bacteria from the intestinal lumen can enter the bloodstream and migrate to other organs, inducing inflammation and organ injury. Certain beneficial metabolites (butyrate and retinoic acid) derived by the gut microbiota may be affected by ethanol exposure, and supplementation of these metabolites can protect the intestinal environment. Foxp3DTR mice on a C57BL/6 background were fed the Lieber-DeCarli chronic-binge ethanol feeding protocol. Mice were randomized to either pair-fed (control) or ethanol-feeding model and ± supplemented with butyrate and retinoic acid. To understand intestinal immune function and the effect of ethanol on the gut microbiome, we focused specifically on the RIG-I gene and Secretory Immunoglobulin A (sIgA). We conducted qRT-PCR in the jejunum and ileum, assessing for RIG-I mRNA. Cecal contents were used to assess for sIGA protein via ELISA. RIG-I assists in activating the innate immune system and transporting sIgA into the gut lumen, which regulates bacteria in the gut and neutralizes pathogens. We hypothesize that disruption in the gut microbiome and barrier by ethanol exposure will impair RIG-I mRNA expression and sIgA levels. We find reduced RIG-I mRNA expression and sIgA levels compared to pair-fed control and ethanol-fed mice supplemented with butyrate and atRA. These results suggest that ethanol exposure dampens immune responses in the small intestine, suppressing the pathway of RIG-I, and that supplementation of butyrate and retinoic acid mitigates these responses. Understanding how ethanol contributes to intestinal immune and inflammatory processes can help us better link overall gut health to the immune system.

Project Mentor: Dr. Gail Cresci, Department of Inflammation and Immunity, Cleveland Clinic Lerner Research Institute

Page 203: Role of β-Estradiol in Genomic and Non-Genomic Mast Cell Responses Linked to Sex Bias in hEDS and MCAD

Chloe Meyer[1,2,4], Sydney Severance[1,3], Roman Fenner[1], Matthew Huff, PhD[1], Cortney Gensemer, PhD[1,5], Russell Norris, PhD[1,5]

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Hypermobile Ehlers-Danlos Syndrome (hEDS) disproportionately affects females, and emerging evidence supports underlying immune dysregulation that intersects with Mast Cell Activation Disorders (MCAD). Patients with hEDS and MCAD often report flares of symptoms during different phases of the menstrual cycle and improvement of symptoms during pregnancy. This suggests a potential role for sex hormones in regulating mast cell activity. Mast cells express hormone receptors that may respond and lead to changes in gene expression, mast cell activation, mediator release, survival, and proliferation.

To investigate how sex hormones might affect mast cell function, we assessed hormone receptor expression, mast cell degranulation, cytokine secretion, and transcriptional responses in LUVA cells. RT-PCR and western blotting confirmed expression of estrogen receptor beta (Erβ) in LUVA cells. Upon exposure to β-estradiol, Erβ translocated to the nucleus, seen by western blot of nuclear and cytoplasmic extracts from LUVA cells. Given the ability of LUVA cells to respond to β-estradiol, hormone dosing was optimized for RNA-sequencing of LUVA cells exposed to β-estradiol to identify mast cell specific transcriptional responses to estrogen. A bulk RNA sequencing pipeline was designed to identify differentially expressed genes and shared pathways.

In addition to transcriptional responses, we also examined the role of sex hormones in mast cell degranulation and cytokine secretion. Together, these data suggest that sex hormones may influence mast cell behavior and gene expression. Through these findings, we hope to elucidate potential pathways linking sex hormones with MCAD symptom fluctuations in hEDS, providing insight into sex bias and therapeutic targets.

Project Mentors: Matthew Huff, PhD, Department of Regenerative Medicine and Cell Biology, Medical University of South Carolina, Charleston, South Carolina and Cortney Gensemer, PhD, Department of Regenerative Medicine and Cell Biology; Department of Neurosurgery, Medical University of South Carolina, Charleston, South Carolina

Page 204: Design and Build Display Case for Order of the Engineer Ring

Garrett Miller, Mechanical and Aerospace Engineering

In Spring 2024, CWRU received its own link in the Order of the Engineer. Adapted from the Canadian Ritual of the Calling of an Engineer, the Order of the Engineer aims to foster pride, integrity, and responsibility within the profession. As a symbol of one's commitment to the Order's ideals each member receives a stainless steel ring during the induction ceremony. During the ceremony, members place their hand through a large representation of the ring they receive. This large ring is the centerpiece of this project, which serves to display the ring and information about the Order of the Engineer. The display case will have integrated lighting to improve the appearance of the ring. The case will also house several other items used during or after the ceremony in its base. The case will have wheels to easily move between display and ceremony locations, as well as some security to protect the items within. Upon completion of this project, the display case will be fully constructed and operational. A detailed CAD model of the case will also be provided to facilitate easy modifications or repairs as needed.

Project Mentors: Sunniva Collins, Department of Mechanical and Aerospace Engineering; Kathy Harper, Division of Engineering Leadership and Professional Practice; Michael Butler, Roger E. Susi First Year Engineering Experience Laboratory

Page 205: Exploring Tensile Effects in Liquid Water Under High-Speed Cavitation

Mitchell Milun, Department of Mechanical and Aerospace Engineering

Cavitation is a phenomenon in which a liquid undergoes a phase change to gaseous vapor when the pressure of the system falls below the vapor pressure of the fluid, creating cavities in the liquid. The Flow Physics and Imaging (FPI) Laboratory is investigating water entry experiments, where projectiles are shot into water at supersonic speeds. The dynamics of the water in the initial microseconds after projectile impact remain a point of interest, with researchers believing that cavitation is occurring. This project will analyze cavitation directly by creating a small structure which can be integrated into an existing drop tower. When fully integrated into the drop tower, experimentation will involve a ball being dropped onto the hanging structure containing water to allow for both optical and deformational data to be analyzed and characterize cavitation. During this initial phase of the project, which is the beginning of a master's thesis, the cavitation structure will be manufactured and tested.

Project Mentor: Dr. Bryan Schmidt, Department of Mechanical and Aerospace Engineering, CWRU

Page 206: Design and Evaluation of a Customizable Corset for Lower Limb Exoskeletons

Nikhil J. Misra, Department of Mechanical and Aerospace Engineering; Marshaun N. Fitzpatrick, Department of Mechanical and Aerospace Engineering; Sandra K. Hnat, Department of Mechanical and Aerospace Engineering; Roger D. Quinn, Department of Mechanical and Aerospace Engineering.

Lower extremity exoskeletons (LEE) enable walking for patients with spinal cord injuries (SCI). However, misalignments of the exoskeleton are a common and serious problem for users. A quickly adjustable corset would not only reduce donning and doffing times and ensure proper joint alignment, but could potentially enhance rehabilitative outcomes. This project focuses on redesigning aspects of our previous prototype corset to better integrate with our motor-assisted hybrid neuroprosthesis (MAHNP).The primary objectives of the redesign were to improve fitment, reduce weight, enhance the adjustment mechanisms, and increase user protection. Updated anthropometric data for hip breadth and buttock depth were integrated to ensure appropriate medial/lateral and anterior/posterior adjustments. To reduce the original weight, the material selection, overall geometry, and dimensions of each component were reevaluated. Once the model was finalized, we conducted dynamic movement simulations incorporating overground walking kinetics to replicate real-world conditions and identify any design limitations prior to human testing. Additional simulations evaluated corset behavior under varying phases of the gait cycle at both comfortable and fast walking speeds. Through the redesign process, the corset's sagittal plane adjustment and frontal plane adjustment accommodates the range set by 5th percentile female to 95th percentile male anthropometric data. Under the worst-case unilateral simulation, the minimum factor of safety was 1.034, and the maximum von Mises stress was 266.1 MPa (below the 6061-T6 aluminum yield strength), confirming the corset's structural integrity under extreme conditions. Once final prototyping and assembly are completed, future work will involve participant fitment testing and kinematic gait analysis. Comfort and fit will also be evaluated through participant surveys. Initial results suggest that this project will deliver a reliable, adjustable corset for the MAHNP exoskeleton that combines improved functionality, safety, and structural efficiency while accommodating diverse patient anthropometry.

Project Mentor: Dr. Sandra K. Hnat, Department of Mechanical and Aerospace Engineering, CWRU

Page 207: Reversal of Air Pollution Exposure Improves Vascular Function and Atherosclerosis

Kala Mitcham (Biology)

Cardiovascular disease (CVD) is the leading cause of mortality worldwide, yet the contribution of environmental exposures such as fine particulate matter (PM2.5) remains incompletely understood. To assess the effects of chronic pollution exposure and subsequent reversal to filtered air (FA), male ApoE$^{-/-}$ mice were exposed to FA, concentrated PM2.5 , or transitioned from PM2.5 to FA (REV) using the VACES system. Vascular reactivity was evaluated using pin myography, and atherosclerotic burden was assessed in brachiocephalic arteries (BCA) and aortic roots using hematoxylin and eosin (H&E) and Masson's Trichrome staining. PM2.5 exposure impaired endothelium-dependent relaxation to acetylcholine and increased contractile responses to phenylephrine, consistent with endothelial dysfunction and hypercontractility, while REV mice demonstrated partial recovery at levels similar to FA models. Endothelium-independent relaxation to sodium nitroprusside (SNP) was unaffected. Histologically, lesion area was significantly greater in BCAs of PM2.5-exposed mice compared to FA and REV, whereas collagen deposition and aortic root lesions showed no significant differences between groups. These findings indicate that chronic PM2.5 exposure disrupts vascular function and promotes site-influenced lesion development, while reversal to filtered air partially restores endothelial function and reduces plaque burden, highlighting both the vascular risks of pollution and the potential for recovery with exposure reduction.

Project Mentor: Sanjay Rajagopalan, M.D.

Page 208: Lifestyle vs. Genetic Risk: Identifying the Strongest Predictors of Diabetes in Pima Indian Women

Anika Mittal, Biomedical Engineering; **Michael Dumas**, Biomedical Engineering; **Charles Price**, Mathematics and Physics

Diabetes remains a major public health concern, influenced by both lifestyle and inherited factors. This study analyzes data from adult Pima Indian women to identify the strongest predictors of diabetes diagnosis and evaluate the relative influence of metabolic indicators versus genetic predisposition. Using variables such as body mass index (BMI), glucose concentration, insulin levels, and the Diabetes Pedigree Function, the analysis explores how obesity-related and physiological measures compare to family-history-based risk. The findings aim to highlight which factors most significantly contribute to diabetes likelihood, supporting early risk detection and informing preventive health strategies in high-risk populations.

Project Mentor: David Clingingsmith, CWRU

Page 209: Evaluating Pediatric Disaster Preparedness Resources for Pediatric Disaster Centers of Excellence Websites

Neel Agarwal, Carolyn E. Ievers-Landis, Justin Malave, Pat Frost, **Farhan Mohammad**, Psychology and Business Management, **Liam McKay**, Psychology and Cognitive Science, Nita Gupta, Hazel Jeong, Julie Bulson, Deanna Dahl-Grove

There exists a gap in information for families and caregivers on pediatric disaster preparedness in U.S children's hospitals. Children face unique vulnerabilities during disaster events, highlighting the need for such resources on hospital websites. This study aimed to identify the pediatric disaster preparedness resources offered by the Pediatric Disaster Centers of Excellence (PDCOEs). This study grouped hospitals with similar characteristics in clusters and aimed to examine clusters with a greater dissemination of preparedness materials. A structured search using both manmade and natural disaster terms of 31 children's hospitals was conducted using Google Gemini to identify disaster preparedness resources. Hospital characteristics researched included the number of staffed beds, hospital type, FEMA (Federal Emergency Management Agency) region, system affiliation, pediatric trauma center level, number of pediatric emergency medicine providers, and deprivation indices. The identified website content was categorized into 4 groups: dedicated sections, downloadable resources, multimedia content, and functioning links to external agencies. To explore relationships between hospital characteristics and content resource availability, descriptive statistics, principal component analysis, hierarchical clustering, and Kruskal-Wallis tests were conducted. On average, the total number of resources per hospital was 20.32 (SD = 5.25), with 38.7% of hospitals providing content in all 4 categories. The top 3 most frequently linked external agencies were the Centers for Disease Control (31), FEMA (23), and Ready.gov (19). Three hospital clusters emerged: Cluster 1 (n = 8) featured a higher than average resource score (24.25); Cluster 2 (n=15) had an average resource score (20.6); Cluster 3 (n=8) had a lower than average resource score (15.88). Cluster 1 was larger and more resource-driven, whereas Cluster 3 included smaller hospitals in areas of higher deprivation. Overall, these results highlight the disparity in dissemination of disaster preparedness materials across U.S. hospitals.

Project Mentor: Carolyn E. Ievers-Landis, University Hospitals

Page 210: Physician Position Monitoring during Surgery Training

Juri Moon 1 , Yeo Weon Seo 1,2 , Mohit Kosuru 1 , Adam Brooks 1 , Thanu Sree Mallela 1
1Department of Biomedical Engineering, 2Department of Electrical Engineering

Surgeons face a risk of musculoskeletal disorders (MSDs), particularly during minimally invasive surgeries that demand prolonged static posture and constrained arm positioning. Early correction of poor posture during surgical training may mitigate long-term ergonomic risks. This study presents a wearable system designed for periodic assessment of spinal alignment using dual inertial measurement unit (IMU) sensors positioned along the cervical and lumbar regions. The system passively tracks spinal alignment and classifies posture using β-angle thresholds but intentionally omits real-time or any active alerts to avoid distracting the surgical workflow. Instead, it delivers quarter-based ergonomic summaries, including posture duration, deviation, and suggestions for improvement in the future after the surgical activity passively. Other visual information including a 3D skeletal visualization, various graphs will further aid in user feedback and ergonomic awareness. Preliminary results demonstrate the system's ability to distinguish neutral and slouched postures, maintain comfort even during extended wear, and ensure stable data logging. This non-intrusive, training-oriented monitoring approach offers a practical framework for promoting ergonomic awareness and reducing the long-term incidence of MSDs among surgeons.

Project Mentors: Dr. Colin Drummond, Department of Biomedical Engineering; Dr. Matthew Williams, Department of Biomedical Engineering.

Page 211: Stroke Amplitude Control in Biomimicry of Manduca Sexta

Brandon Moore (Mechanical Engineering BS/MS)

Flapping wing micro aerial vehicles (FWMAVs) have become an increasingly popular field of exploration due to their robust benefits over typical micro aerial vehicles for applications of search and recovery, hazardous zone exploration, and monitoring. Their ability to minimize noise, fly with collision damage to the wings, and overall improvement in flight maneuverability in confined spaces set them apart.

This project builds off of previous research and development of a biological inspired FWMAV, modeled after Manduca Sexta. Specifically, the goal of this project is to develop an additional degree of freedom in a 3:1 scale flapping mechanism to allow for control over the flapping stroke amplitude, a characteristic found in M. Sexta flight data for turning and varying wind speed.

To create the amplitude control mechanism, a double slot mechanism is developed between the driving scotch-yoke mechanism and wing to vary the pin distance between the fixed rotation point of the wing and the flapping driver. A servo motor is used in conjunction with a rack and pin mechanism to move the location of the driving pin, allowing for precise, independent control of the wing amplitude. Amplitude extrema is modeled after flight data of M. Sexta in various wind speeds.

To prove the wing amplitude variations are in scale of the actual creature, the mechanism is tested at various pin distances to achieve the specified amplitudes found from empirical data of M. Sexta. Additionally, pin distances are varied asymmetrically for the left and right mechanism to show that disparity is possible. Future data will be implemented to show the scale of the disparity in relation to observations found from M. Sexta.

Project Mentor: Dr. Roger D. Quinn, Kenneth C. Moses

Page 212: Novel Device for IV Injection Infection Prevention

Yusang Bejarano, Biomedical Engineering; **Ipsa Bijumalla**, Biomedical Engineering; **Isabelle Deputy**, Biomedical Engineering; **Jesus Moreno**, Biomedical Engineering; **Aniruth Ramanathan**, Biomedical Engineering

Catheter-associated bloodstream infections (CABSIs) remain a major cause of hospital-acquired infections despite strict hygiene protocols. While infection control is generally well managed in hospitals, it becomes a significant challenge in at-home healthcare, where proper sterilization is harder to maintain. Over two billion peripheral intravenous catheters (PIVCs) are used annually worldwide, carrying infection risks mainly through skin migration and hub contamination. Even though the per-catheter infection rate is relatively low (~4.4 per 100,000 catheter-days), the widespread use of PIVCs leads to thousands of infections annually, often resulting in sepsis, prolonged hospital stays, and increased mortality. Current prevention strategies, such as disinfecting caps, barrier devices, and antimicrobial coatings, have reduced contamination but still heavily rely on user compliance and manual cleaning steps. This project aims to address the need for user independence, automated sterilization systems to reduce IV-connector-related infection risks, particularly in at-home care. The proposed solution is a handheld UV-C sterilization device that disinfects IV catheter connectors promptly before or after use. The design uses UV-C LEDs housed in a single-barrel enclosure with an internal reflective lining to accomplish uniform 360° sterilization. The device uses Velcro fasteners to close and secure the IV connector within the compartment during sterilization, allowing quick access while maintaining proper positioning. An analog timer ensures a sterilization cycle is completed every time, and the device is battery powered, reusable, and compact, minimizing human error and workflow interruptions in both clinical and home settings. Prototype testing will evaluate mechanical functionality and usability. Through this design, the expected outcome is a low-cost, automated accessory to existing infection control protocols that improves safety during IV access, minimizes human intervention, and lowers CABSI risk.

Project Mentors: Dr. Matthew Williams, Department of Biomedical Engineering; Dr. Colin Drummond, Department of Biomedical Engineering

Page 213: Volume Detection and Alert System for Catheter Bags

Carter Asbury (Biomedical Engineering)**, Tara Chatty** (Biomedical Engineering)**, Henry Cho** (Biomedical Engineering)**, Elinor Morrissey** (Biomedical Engineering)**, Ashley Novak** (Biomedical Engineering)

Catheter-associated urinary tract infections (CAUTIs) in the ICU remain one of the most common and preventable healthcare-associated infections. These infections frequently result from mechanical and maintenance failures in urinary catheter systems, including drainage bag overflow, which can cause backflow in the tubing. Current preventive strategies, such as antimicrobial coatings and catheter removal protocols, rely heavily on user compliance and fail to provide continuous, real-time monitoring. This project aims to design a smart catheter monitoring system that detects bag capacity status to reduce the risk of CAUTIs in the ICU by preventing the bag from overfilling. The proposed system alerts care providers with visual signals when the drainage bag reaches pre-determined levels, thereby reducing the propensity for infections from backflow. Specifications emphasize ease of use for nurses, patient comfort, compatibility with existing medical equipment, and detection sensitivity. This novel design, if implemented in ICU environments, will help reduce the frequency of CAUTIs, benefiting both nurses and patients by creating a visual cue for nurses to quickly assess whether the bag needs to be emptied and minimize patient infection rates.

Project Mentor: Matthew Williams, CWRU

Page 214: Mechanical and Electrical Characterization of Aerosol Jet Printed Strain Gauges

Dakin Muhlner, Mechanical and Aerospace Engineering; Aarush Agarwal, Materials Science and Engineering; **Tara Kodukula**, Biomedical Engineering; Anthony Decarlo, Biomedical Engineering; Aidan D. Selkirk, Mechanical and Aerospace Engineering; Caroline Kromalic, Materials Science and Engineering

Flexible circuits are a rapidly growing technological field thanks to their applications in aerospace, medicine, and energy. Aerosol jet printing (AJP) is a novel additive manufacturing process enabling the production of small-scale flexible electronics. A rigorous characterization process is required to maintain high print quality when utilizing AJP. This work details a process to evaluate the mechanical and electrical characteristics of an aerosol jet printed strain gauge. Following printing and sintering with optimized parameters, the circuits were imaged using digital optical microscopy under standardized lighting conditions. These images were analyzed using a custom MATLAB script which evaluated the conformity of the sample to the intended geometry, checking for overspray and imperfections. This process yielded an overall Visual Conformity Grade (VCG), a metric that combines this data in aggregate as a numeric score. Laser profilometry was used to determine the printed traces' step height. The circuits' electrical resistance was measured using a four-point probe method then converted to conductance. To evaluate the mechanical reliability of the circuits, custom fixtures were designed to hold the samples under variable angle bending fatigue, axial fatigue, and torsional fatigue. These characterization methods form a baseline methodology which can be applied to newly developed circuits in the future. Further research should rigorously apply this characterization process to a variety of circuit designs and explore its effectiveness across a wider range of techniques.

Project Mentor: Dr. Janet L. Gbur, Materials Science and Engineering

Page 215: CarpalVision: A Digital Rehabilitation Platform for Carpal Tunnel Syndrome Recovery and Prevention

Sohan Muppidi, Department of Computer Science, CWRU

Carpal Tunnel Syndrome is one of the most common peripheral neuropathies, affecting millions of individuals annually and resulting in pain, numbness, and reduced hand function. This project investigates whether a mobile health platform can enhance patient adherence and recovery following CTS treatment. Despite the prevalence of Carpal Tunnel Syndrome, patient compliance to treatment protocols and early intervention strategies can be inconsistent, often due to limited access to personalized guidance outside of clinical settings. To address this issue, we developed CarpalEase, a prototype mobile application designed to bridge the gap between clinical care and self-management, especially for individuals with limited access to both chronic and acute care. The study focuses on the design and implementation of CarpalEase's functionality and user experience. The application integrates four core modules: a recovery tracker for pain, numbness, wrist strength rebound, and brace use; a guided exercise suite with evidence-based therapy routines prescribed by clinicians; an educational hub providing accessible recovery information; and an optional clinician dashboard enabling AI-driven remote monitoring and trend analysis through computer vision. Initial development was completed using an iterative, user-integrated design process. By combining behavioural engagement features such as progress streaks and milestone tracking with clinically validated rehabilitation content, we aim to determine whether digital recovery support can improve adherence and early detection of symptom recurrence compared to traditional care approaches.

Project Mentor: Rajendra Muppidi, Sohan Software Technologies LLC

Page 216: Androgen Receptor Acetylation Modification with Chemical Inducers of Proximity

Abbey Murcek, Chemistry, Emily Novak, Department of Pharmacology

Prostate cancer is responsible for 11% of cancer mortality, making it the second largest contributor to cancer-related deaths. The androgen receptor (AR) is a major target of prostate cancer treatments, with high levels being associated with more aggressive cancers. In prostate cancer, overactivation of AR promotes proliferation and decreases apoptosis. One major factor of AR activity is post-translational modification. Specifically, acetylation of the hinge region of AR increases levels of activity. Post-translational modifications also become even more of an important factor in prostate cancers in which AR becomes active independently from androgen levels. One of the key enzymes responsible for acetylation of AR is the histone acetyltransferase p300. Our lab has developed a chemical inducer of proximity (CIP) which binds to the bromodomain of CBP/p300 and the ligand-binding domain of AR. This molecule, AR-CBP CIP, binds with both p300 and AR, bringing them in proximity to each other. This increases the rate that AR and p300 will interact with each other, increasing levels of acetylated AR. To examine the levels of acetylation, prostate cancer cells were treated with AR-CBP CIP or a control. Immunoprecipitation for acetylated lysines in these cell samples, followed by Western blotting for AR in cells treated with AR-CBP CIP showed that AR is acetylated in higher levels when in the presence of AR-CBP CIP. Further immunoprecipitation and Western blots show that acetylation is induced in a dose and time dependent manner. Utilizing this molecule could allow further investigation into the effects of AR acetylation and activity on prostate cancer.

Project Mentor: Berkley Gryder, Department of Genetic and Genome Sciences

Page 217: A Novel Prodrug Strategy for Liver-Selective HIF Stabilization to Treat Retinopathy of Prematurity

Mahiyah Muthukumaran, Department of Biology, Case Western Reserve University; Dr. George Hoppe, Department of Ophthalmology Research, Cleveland Clinic Cole Eye Institute; Demianna Hanna, Department of Ophthalmology Research, Cleveland Clinic Cole Eye Institute; Dr. Jonathan Sears, Department of Ophthalmology Research, Cleveland Clinic Cole Eye Institute

Retinopathy of prematurity (ROP), a leading cause of blindness in premature infants, is an adverse consequence of the high-concentration oxygen therapy required for the survival of premature infants. A promising therapeutic strategy involves stabilizing the hypoxia-inducible factor (HIF) to promote normal retinal vascular development. However, the use of systemic HIF stabilizers is limited by their potential to cause negative effects in the central nervous system (CNS), such as delayed myelination. To address this challenge, we developed a hepatotropic prodrug strategy to achieve liver-selective HIF induction, as the lab's prior work established that liver-specific action is helpful for retinal protection. We synthesized a series of novel ester prodrugs of the known HIF inhibitor, Roxadustat. The design rationale was that the high concentration of carboxylesterases in the liver would preferentially bioactivate these prodrugs, localizing the therapeutic effect and minimizing brain exposure. We first assessed their HIF-stabilizing potency in vitro using retinal glia and primary hepatocyte cultures. Successful candidates were then advanced to in vivo mouse studies to determine their liver-versus-brain selectivity and to test their therapeutic efficacy in the oxygen-induced retinopathy (OIR) model. Among the candidates, RE-07, an ester of Roxadustat, was identified as an efficient compound. It showed highly liver-selective HIF activation with minimal accumulation in the brain. Also, this targeted organ-specific activity provided significant protection of the retinal vasculature in the OIR model. These results establish RE-07 as a promising therapeutic candidate for the safe and effective prevention of ROP. Future work will involve identifying the specific pathways in the liver and retina that explain the pharmacological protection offered by RE-07.

Project Mentor: Dr. George Hoppe, Department of Ophthalmology Research, Cleveland Clinic Cole Eye Institute

Page 218: PAR4-Driven Calcium Signaling in Platelets Enhances CD8+ T Cell Activity in Glioblastoma

Tanvi Navadgi [1,2]; Anthony Sloan [2], George Bukenya [2], Gavin Tanish [2], Samrutha Kamatala [2], Justin Lathia [2]

[1]Department of Neurosciences, Case Western Reserve University

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Glioblastoma (GBM) is the most common primary malignant brain tumor, accounting for nearly 50% of all cancerous brain tumors in adults. Tumor progression in GBM is shaped by immunosuppressive interactions within the tumor microenvironment (TME), most notably between platelets and CD8+ T cells. These interactions exhibit sex-dependent differences, with males being 1.6 times more likely to develop GBM than females. However, the mechanisms governing platelet-T cell communication within the TME, especially the underlying sex differences, remain poorly understood.

Patients with GBM experience heightened platelet coagulation and a 30% increased risk of developing blood clotting events such as venous thromboembolism (VTE) or pulmonary embolism (PE). A critical contributor to this hypercoagulable state is protease-activated receptor 4 (PAR4), a membrane receptor known to drive platelet reactivity. Building on prior murine models demonstrating that PAR4 inhibition confers a survival advantage exclusively to females, we co-cultured platelets and T cells under controlled calcium conditions to examine the mechanisms underlying the sex-dependent response. Our findings indicate that this female-specific advantage is driven by enhanced CD8+ T cell infiltration, mediated by intracellular calcium signaling. Mechanistically, inhibition of PAR4 decreases downstream calcium signaling. However, in females, this effect is counteracted by the presence of estrogen, which helps to maintain elevated intracellular calcium levels, thereby promoting CD8+ T cell recruitment.

Collectively, these findings identify PAR4 as a key regulator of calcium signaling that modulates antitumor CD8+ T cell activity in GBM. This work reveals a hormonal basis for GBM progression and underscores the need for sex-specific therapeutic strategies to improve patient outcomes.

Faculty Project Mentor: Anthony Sloan, Department of Cardiovascular Medicine, Cleveland Clinic Lerner Research Institute

Page 219: Synthesis of Gene-Editing DNA Origami Nanoparticles

Anshul Nayak,[A] Kayla Neyra,[B] Divita Mathur[B]

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With the onset of modern medical advancements, scientists have made countless advancements in the field of genetic engineering in the hopes of preventing genetic diseases. Gene-editing platforms have become a cornerstone of this research, necessitating the creation of a unique gene delivery system that can safely deliver base-editing proteins to target mammalian cells. One key method that is being vigorously explored in the recent decade is leveraging DNA's physical shape to create functionalized DNA Origami nanoparticles. DNA "Origami" particles are 3D nanostructures consisting of a long gene-encoding ssDNA strand (scaffold) and various segments of ssDNA oligonucleotides (staples). Unique 3D constructs can be assembled by designing the staples to bind to specific regions of the scaffold; this is possible because of the hydrogen bonding between the complementary (G-C/A-T) strands. For my experiment, I will synthesize a nanostructure encoding for an adenine base editor. To achieve this, I have efficiently synthesized the gene-encoding scaffold for this project through Asymmetric Polymerase Chain Reaction (aPCR) and have assembled a 44 helix bundle DNA nanostructure that encodes for the target base editor protein. My next objective is to deliver this nanoparticle to mammalian cells and assess the sustainability and depth of the expression through fluorescence microscopy. Assembly of this nanoparticle was an integral first step for many more achievements to come, and through this study, I aim to advance the development of a new gene delivery system.

Project Mentor: Kayla Neyra; Principal Investigator: Dr. Divita Mathur, Department of Chemistry, CWRU,

Cleveland, Ohio

Page 220: Politicians' Business Interests and Civil War Cessation

Jared Neely, Political Science and Sociology

This research examines the relationship between regime type, elite economic motivations, and civil wars. Specifically, it aims to answer the question of: To what extent do politicians' personal economic interests hinder the resolution of pressing public problems? Prior research on the subject has examined corruption on a broader scale. It has also failed to explore how government elites' personal enrichment during periods of civil war can incentivize them to prolong violence and infighting. By addressing this gap in scholarship, this project helps develop a deeper understanding of how leadership and government regime type can influence conflict resolution. I completed multiple case studies on Nigeria, Sierra Leone, the Democratic Republic of the Congo, and Sri Lanka. Through these case studies, I examined the intersection between elite enrichment and civil war dynamics. These specific case studies were used as they are all examples of countries that have experienced varying degrees of unrest over precious resources. Through my research, I discovered how political elites were able to leverage their influence and power in order to enrich themselves while delaying peaceful resolutions. The early findings from my research suggest that less democratic regimes make government elites more prone to prioritize personal enrichment over peace. Democratic regimes are more successful at creating accountability mechanisms that prevent elites from engaging in corrupt practices and wealth building at the expense of peace and conflict resolution.

Faculty Mentor: Professor Kelly McMann, Department of Political Science, CWRU

Page 221: Verifying Targeted Chemogenetic Manipulation of Hypocretin Neurons in HCRT:Cre Rats through Immunohistochemistry

Kanishk Neerumalla, Case Western Reserve University Department of Biology; Shanna Samels, Drexel University College of Medicine Department of Neurobiology and Anatomy, Rodrigo España Drexel University College of Medicine Department of Neurobiology and Anatomy

Hypocretin/orexin (HCRT) is a neuropeptide produced primarily in the lateral hypothalamus and has been proven to be essential for regulating motivated behavior. Historically, efforts to examine the importance of HCRT has relied mainly on pharmacological approaches to block or activate HCRT receptors. Here we set out to establish methods to selectively activate or inhibit HCRT neurons themselves. We used HCRT:Cre transgenic rats that express the Cre recombinase enzyme only in HCRT neurons. We allowed selective targeting within HCRT neurons to express Cre-dependent DREADDs (Designer Receptors Exclusively Activated by Designer Drugs) for activation or inhibition of HCRT neurons. We injected HCRT:Cre- and HCRT:Cre+ rats with either a Gi or Gq DREADDs virus tagged with fluorescent mCherry. To assess specificity of our approach, we first quantified the co-expression of mCherry tag and HCRT peptide-1 via immunohistochemistry. As expected, we found co-expression of HCRT-1 peptide and mCherry only in HCRT:Cre+ rats, with HCRT:Cre- rats displaying none. Next, to determine the degree of HCRT neuron activation, we injected HCRT:Cre+ and HCRT:Cre- rats with a Gq DREADDs virus and treated with deschloroclozapine (DCZ) 3 weeks after virus injection. Brain slices containing the lateral hypothalamus were analyzed for co-expression of HCRT peptide 1 and the immediate early gene cFos—often used as an index for neuronal activation. Surprisingly, we determined that DCZ administration did not significantly increase cFos in HCRT neurons, with no differences in co-expression of cFos and HCRT-1 peptide between HCRT:Cre+ rats expressed Gq DREADDs and HCRT:Cre- rats. Together, our studies show DREADDs can target specific neurons, but reliable activation using this approach was not achieved. Future studies will be needed to assess other measures of neuronal activity and potentially other DREADDs ligands to determine if we can manipulate the activity of HCRT neurons.

Project Mentor: Professor Rodrigo España, Department of Neurobiology and Anatomy, DUCOM

Page 222: Enhancing Business Efficiency through Customer Retention, Marketing, and Funding Models for Lock-in Billiard Youth Camps

Kanishk S Neerumalla (Business Management), **Hyunjin Kim** (Accounting), **Tedros Hemberger (**Finance) ,

Isabelle Hufnagel (Finance) , Megan Buchter 1, Ayushee Agarwal 1

1 Case Western Reserve University Fowler Center Business for World Benefit

Lock-in Billiards' Youth Camp (LIB YC) is a Cleveland-based community initiative that utilizes both billiards and filmmaking as a platform to engage, mentor, and empower young individuals. LIB YC is an 8-week intensive, paid experience offering structured activities within a constructive environment (i.e., tournaments, life-skills workshops, etc.) designed to foster personal development. Lock-in Billiards operated as a community-centered social venture generating revenue through sponsorships, fundraisers, and grants. The program begins August 25th, 2025 and includes weekly pool instruction and hands-on video production, with $115 regular fees and $85 early registration. Our team conducted comprehensive assessments of LIB's operational and financial model with the goal of enhancing long-term stability. Through client interviews and business model analyses, we identified critical areas for funding diversification—particularly with grant allocations (transportation efficiency), marketing strategies, customer retention strategies, and brand visibility. These recommendations provide preliminary foundations for scalable growth, improved financial stability, and sustained social impact while retaining the camp's mission-driven focus. Grant analysis incorporated internal financial data and external funding sources, drawing on the organization's operational budget, the 2025 Cleveland-Cuyahoga Port Authority Community Investment Fund (CIF) grant, and microgrant applications from St. Luke's Foundation and MyCom, and projected costs related to programming, staffing, equipment, and logistics. Transportation analysis followed a two-phase methodology integrating demographic data for the Fairfax neighborhood (ZIP 44103)—including youth population, household income, transit accessibility, and poverty rate—with a customized transportation cost-benefit model evaluating ownership, leasing, and rental options for vans, supported by total-cost-of-ownership (TCO) and sensitivity assessments. Marketing and customer retention analyses were developed through client meetings, request forms, and youth retention strategies aligned to optimize turnout.

Project Mentor: Megan Buchter, CWRU

Page 223: Optimization of Bipolar Concentric Ring EEG Electrodes for Improved Spatial Resolution

Tiger Newman (Neuroscience, CWRU)

This project investigates design parameters for prototype concentric ring electroencephalography (EEG) electrodes to enhance recording resolution and reduce signal noise during recording. EEG systems often rely on traditional disc electrodes, which can be limited by volume conduction and reduced spatial specificity. Concentric ring electrodes (CREs) are a promising alternative that estimate the surface Laplacian directly, allowing for more accurate mapping of local cortical activity. However, a useful design and spacing parameters for optimized bipolar CRE configurations remain underexplored.

The goal of this study is to design and produce a range of low-cost prototype bipolar concentric ring electrodes with varying inner disc and outer ring dimensions, enabling future testing of Laplacian accuracy and impedance stability across different designs. Initial modeling is guided by prior mathematical studies, including Makeyev et al. (2018, 2021), which identified improved Laplacian accuracy when inner rings are compact and inter-ring spacing is progressively wider toward the periphery.

Prototypes are being developed using design software (Inkscape) and production with a Cricut Maker 3. The prototypes employ flexible, conductive materials to test scalability and adaptability. Current work involves comparing electrode geometries with varying total diameters and disc to ring ratios based on published optimization models.

The anticipated outcome is to identify geometric configurations that provide the strongest theoretical but also practical basis for high-resolution EEG recording. Findings from this phase will guide future bench testing of electrode performance and contribute to broader efforts to enhance EEG signal quality and inclusivity across applications in neuroscience and clinical diagnostics.

Project Mentors: Dr. Dawn Taylor, Cleveland Clinic Lerner Research Institute(PI); Dr. David Friel, Department of Neurosciences, Case Western Reserve University

Page 224: Transcriptional landscape of human iPSC-derived podocytes treated with the STING activator diABZ

Harry Nguyen[1], Najeong Kim[1], Uyen Wessely[2], Oliver Wessely[2] and Agustin Gonzalez-Vicente[1]

[1] Department of Physiology and Biophysics. Case Western Reserve University School of Medicine
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The stimulator of interferon genes (STING) pathway is an important innate immunity defense against DNA viruses. Activation of this pathway by the abnormal presence of self DNA in the cytoplasm, has been linked to chronic inflammation and kidney function decline. Podocyte loss is a hallmark of inflammatory proteinuric diseases, yet the transcriptional effects of STING activation in these cells remains poorly defined. To better understand this process we treated human iPSC-derived podocytes with either Vehicle (DMSO, n=3) or diABZI, a cell-permeant small molecule STING agonist, at 200μM (n=3) and 400 μM (n=3) concentrations. Bulk RNA sequencing of 26,853 genes identified 15,632 protein-coding genes, which were analyzed using Weighted Gene Co-expression Network Analysis (WGCNA). Module–trait correlation (MTC) analysis revealed 58 co-expression modules, among which Navajowhite, Darkolivegreen, and Red displayed significant associations with diABZI. Darkolivegreen (34 genes; r=0.89, p=0.002) presented enrichment terms associated with canonical STING signalling, such as interferon regulatory factor 3 (IRF3) and components of the NF-κB complex (RELA, RELB). Navajowhite (93 genes; r=–0.67, p=0.047) showed enrichment for p53 signaling, oxidative stress, and apoptotic pathways, likely representing secondary and higher order responses to STING activation. Red (62 genes; r=0.28, p=0.072) contained diffuse enrichments spanning Wnt/β-catenin (LRP6), platelet activation, and coagulation cascades; pathways commonly associated with inflammatory and fibrotic remodeling in the kidney. Interestingly, MTC analysis under different dose-response models revealed that the transcriptional response to diABZI likely plateaus below 400 μM, as evidenced by higher correlation coefficients and lower p values under a binary fit. These findings demonstrate that STING activation drives broad transcriptional reprogramming in human podocytes. Moving forward, these transcriptional signatures will be integrated into the molecular taxonomy of podocytes from patients in the Kidney Precision Medicine Project (KPMP), with the goal of a patient subpopulation that may benefit from targeted modulation of STING signaling.

Project Mentor: Agustin Gonzalez-Vicente, Department of Physiology and Biophysics, Case Western Reserve University School of Medicine.

Page 225: Analysis of Social Media Algorithms and Their Impact on Individual Online Engagement Time

Chase Kulsakdinun, Mechanical and Aerospace Engineering; **Robert Nichelson**, Economics; David Clingingsmith, Department of Economics, CWRU School of Management

People use the internet for many purposes. This research analyzes patterns of internet use across countries, emphasizing how individuals engage with different forms of online media. Using the UR-2 Global Internet Use Dataset, we examine various categories of digital activity, including social media use, online shopping, news consumption, music listening, reading, and television watching. These and others are different ways people use their phones and other devices to access the internet. We aim to identify relationships between demographic characteristics and preferred media consumption. The findings will enhance understanding of global differences in digital engagement, highlighting how factors such as age, gender, and other demographic characteristics shape patterns of online behavior across diverse populations.

Project Mentor: Professor Clingingsmith, Department of Economics, CWRU

Page 226 The Effect of Tetracycline Treatment on Microcystis aeruginosa growth and Microcystin-LR Production

Eva Nieman, Chemical Biology and Environmental Studies; **Dr. Matthew Bertin,** Department of Chemistry, CWRU

Cyanobacterial harmful algal blooms (cyanoHABs) and the toxins produced during these events are a major concern for water security in the U.S. There are key knowledge gaps in bloom mitigation strategies including improving the selectivity of chemical mitigation agents. In this environmental chemistry study, we aimed to find an antibiotic that will limit cyanobacterial growth and toxin production of microcystins, which is the group of molecules causing the major concern with respect to cyanobacterial harmful algal blooms (cyanoHABs) and their impact on drinking water resources. Multiple potential antibiotics were tested at varying concentrations and a suitable antibiotic and dosage was determined. This study lays the groundwork for a broader study aimed at addressing the growing issue of cyanoHABs and pathways toward mitigation.

Faculty Project Mentor: Dr. Matthew Bertin, Department of Chemistry, CWRU

Page 227: Investigating the Role of TDP-43 Mislocalization in ALS and SBMA Using Human iPSC-Derived Models

Chinecherem Nnoli, Neuroscience

This research paper examines the mislocalized TDP-43 involved in amyotrophic lateral sclerosis (ALS) and spinal and bulbar muscular atrophy (SBMA) in human induced pluripotent stem cell (iPSC)-derived motor neurons. AS and SBMA are both diseases that share the same pathogenic features, including TDP-43 aggregation and motor neuron degeneration associated with TDP-43 aggregation. Our data revealed increased mislocalized phosphorylated TDP-43 in C9orf72-mutant motor neurons relative to controls. Treatment of C9orf72-mutant motor neurons with Glial-derived neurotrophic factor (GDNF) resulted in some reduction in mislocalized phosphorylated TDP-43, which may provide a novel therapeutic pathway. This iPSC-based model of ALS and SBMA allows for better mechanistic understanding of the two diseases and additionally allows for screening and testing of therapeutic strategies for targeting protein aggregation in ALS and SBMA.

Project Mentor: Dr. Helen Miranda, Department of Neurology, School of Medicine
Faculty Sponsor: Dr. David Friel, Department of Neurosciences, School of Medicine

Page 228: Lightweight Tissue Tonometer Device for Detecting Pitting Edema

Lauren Hong, Electrical Engineering; **Jhosua Oajaca**, Electrical Engineering and Systems & Control Engineering; **Jago Dorn**, Electrical Engineering and Systems & Control Engineering; **Connor Kissack**, Electrical Engineering

Pitting edema is a symptom of the accumulation of intercellular fluid in tissue cells that results from an increase in interstitial fluid, characterized by swelling of tissues and formation of an indentation wherever pressure is applied to the skin. While early detection is critical because it indicates underlying heart, liver, or kidney issues, current diagnostic methods are subjective, relying solely on a clinician's visual assessment and grading of the skin indentation and rebound time. To address the lack of standardization, potential misclassification of severity, and delayed diagnosis, we designed a feedback-controlled tonometer capable of applying a known force and precisely measuring skin displacement and the normal force exerted by the skin on the device.

Our methodology integrates three primary subsystems: (1) a capacitive force sensor to measure the force applied to the skin, utilizing two isolated copper plates and a capacitance-to-digital converter (FDC1004) to quantify the normal force; (2) an infrared displacement sensor (TCND5000) to measure the depth of the pit formed; and (3) a feedback-controlled pneumatic actuator that uses a syringe pump, motor, and motor driver to regulate the pressure in a silicone bellow to apply constant indentation. All these components interface through a XIAO ESP32-S3 microcontroller.

We expect the device to apply a controlled force of approximately 10 N and measure skin indentation. We expect the prototype to deliver consistent, precise performance across its subsystems. The device is designed to measure internal actuation displacement over a range of 0–12 mm. Additionally, the device will record and process data sufficient to classify pitting edema into the four standard clinical categories, thereby laying the groundwork for objective, standardized diagnoses.

Project Mentor: Dr. Zonghe Chua, Department of Electrical, Computer, and Systems Engineering Capstone Instructor: Dr. Vira Chankong, Department of Electrical Engineering and Computer Science

Page 229: Physiological Stress and Obsessive-Compulsive Disorder Symptom Expression in Women

Presenter: **AliAnna Olivas,** Psychology Major
Faculty Project Mentor: **Rachel McClaine,** Department of Psychological Sciences

Women are disproportionately affected by obsessive-compulsive disorder (OCD), yet the mechanisms linking stress physiology to symptom onset and severity remain understudied. OCD can be profoundly debilitating and disrupts daily functioning, relationships, and the overall quality of life for many women. The purpose of this literature review is to examine acute and chronic stress in women with OCD within the context of psychological research and women's health outcomes. This review aims to elucidate how acute and chronic stress mechanisms influence the expression, recognition, and management of OCD symptoms in women across the lifespan. This project first defines how OCD manifests in women and considers its relevance to diagnostic challenges and gender bias within clinical assessment. It then analyzes how stigma and cultural norms contribute to the concealment or misinterpretation of women's stress related OCD symptoms, often delaying or leading to misdiagnosis and inadequate treatment. Finally, the review identifies research gaps in the intersection of stress physiology and OCD in women, emphasizing the need for more inclusive methodologies and advocacy for gender sensitive clinical practices. Through an integrative synthesis of psychological literature and literature from other disciplines, this project aims to clarify how acute and chronic stressors, such as pregnancy related complications, trauma exposure, and hormonal transitions, interact with OCD symptom expression and overall well being. The expected outcome is a conceptual framework that highlights the relationship between physiological stress and OCD severity in women, advancing the conversation around equitable, evidence-based care in mental health research.

Page 230: How Keyword Framing on "Protein Packed" vs Standard Food Product Labels Affects Customers' Perceived Attributes and Willingness to Buy

Ijeamaka Onuorah, Cognitive Science

This project looks at how the language used on food packaging, specifically the use of vocabulary emphasizing protein content versus standard product labeling highlighting taste, influences customers' perceptions and purchase habits. In recent years, protein intake is something that people are concerning themselves with. Because of this, "protein" has become a marketing buzzword. This study investigates whether the addition of protein related keywords can alter a customers' perceived healthiness, tastiness, and willingness to purchase food products across different categories like cereal, snacks, and ready made frozen meals.

The participants in this study will complete an online survey looking at pairs of food product images that were designed to have the keywords be the focus. There will be a standard version highlighting taste, while the other image will show a product highlighting the protein content. For each, they will have to rate their willingness to buy, perceived healthiness and tasties on a seven point likert scale, preceded by a forced choice task showing which version they would prefer to buy. The study uses a within subjects design with counterbalanced product order.

It is expected that keywords relating to protein will increase perceived healthiness but will decrease perceived tastiness. This could show a cognitive health-taste trade off. It is predicted that these effects will vary across the product categories, but there could be a strong positive impact in ready made frozen meals and cereal categories, and mixed for snacks. Findings from this project can contribute to understanding how linguistic choices can drive consumer decision making and how marketing focusing on health can influence perceived product value to customers.

Faculty Project Mentor:

Vera Tobin, Cognitive Science, Case Western Reserve University

Capstone Instructor:

Vera Tobin, Cognitive Science, Case Western Reserve University

Page 231: Measuring the Millimeter-Wave Absorption of Cryogenic Filter Materials Used for CMB Detector Characterization

Rafaella Ortiz Cardenas, Department of Physics; Dr. John Ruhl, Department of Physics

Understanding the absorption properties of cryogenic filters is essential for accurately testing Cosmic Microwave Background detectors in laboratory conditions. Such detectors are optimized for the very low in-band optical power they see when pointed at the sky from high-altitude observing sites. In laboratory conditions, the in-band loading from 300K blackbody emission will saturate those detectors. Therefore, to test those detectors in the laboratory, we need cryogenic filters that will absorb most of the in-band 300K blackbody emission and re-emit only at a much colder blackbody temperature, typically about 4K. In this project, we characterize the absorption properties of two absorbing filter materials, Eccosorb MF110 and MF112, at a temperature of 4K using a broadband bolometer detector cooled to 300mK.

Transmission data were collected from 70 to 250 GHz in 10 GHz steps using a Toptica TeraScan 1550 as a millimeter-wave source for three sample configurations: MF110, MF112, and "no sample". The broadband bolometer used for these tests has a gain that depends on optical loading, which was normalized using a constant-amplitude chopped reference signal from a 90 GHz Gunn oscillator. The MF110 and MF112 filters' transmission was calculated using gain-corrected ratios with the "no sample" configuration. These transmission data were fit to a model accounting for a frequency-independent reflection factor and a frequency-dependent absorption factor. These fits will be used to optimize filters made from these materials for laboratory tests of detectors currently being developed at Argonne National Laboratory for the next CMB camera on the South Pole Telescope.

Faculty Project Mentor: Professor John Ruhl, Department of Physics, CWRU

Page 232: Incorporating Sensors for Proprioception in a Tendon-Driven Robotic Hand

Amelia Oulvey, B.S. Candidate in Mechanical Engineering, Case Western Reserve University

This project enhances the proprioceptive sensing capabilities of the open-source ORCA Hand, a tendon-driven robotic hand, by integrating a magnetic rotary encoder system into a single finger joint as a proof of concept. The ORCA Hand—Open-Source, Reliable, Cost-Effective, and Anthropomorphic—currently lacks joint-angle feedback, limiting its motion precision and adaptability.

To address this, a custom 8 x 8 x 1.6mm printed circuit board (PCB) was designed to house the AS5048B magnetic angle sensor, a 14-bit I²C rotary encoder capable of non-contact position measurement. The board uses 0402-form-factor passive components and interfaces with a microcontroller through an Arduino-compatible library. The design pairs the sensor with a diametrically magnetized neodymium disc magnet mounted on the joint's rotation axis, maintaining a 0.5-2 mm air gap for optimal field alignment.

A Nitto NJ-1 Bend Sensor is also being evaluated as a potential comparative or hybrid feedback device to validate performance and expand proprioceptive sensing approaches. Testing will focus on angular accuracy, repeatability, and magnetic interference tolerance.

The successful demonstration of this system will provide a compact, scalable, and low-cost proprioceptive sensing solution for tendon-driven robotic hands, with applications in prosthetics, rehabilitation robotics, and human-robot interaction.

Faculty Project Mentor: Dr. Zachary Patterson, Department of Mechanical and Aerospace Engineering, Case Western Reserve University

Page 233: The Rise of Microplastics in Society and Their Impact to Humans

Julio Paez-Norena, Department of Biology, CWRU

The purpose of this capstone is to examine how microplastics enter and impact the human body, as well as evaluating their short-term and long-term health effects. The research compiled looks to show the impacts on the human mechanisms and propose changes to prevent microplastic rise. Microplastics, defined as plastic compounds less than 5 millimeters in diameter (Winiarska and Jutel, 2024), are becoming an environmental pollutant and public health concern due to their ease of indigestion, long biodegradation, and large spread throughout the environment. They are found everywhere from takeout containers to the water we drink and pose a threat to human health. Microplastics are contaminating the environment at a rapid rate and are now entering the human body more freely (Lee, et.al. 2023), causing harmful and sometimes irreversible effects to the human body. Their health problems continue to be poorly understood and not regulated. The importance of this capstone is to compile results from multiple studies about the understanding of microplastic toxicity as well as expressing the importance of creating health policies to decrease human exposure to these harmful compounds. This capstone research will look into an overview of what microplastics are, their effects and severity on each human body system, prevention strategies as well as current research to combat the rise of microplastics.

Project Mentor: Richard Drushel, Department of Biology, CWRU

Page 234: Effects of Temozolomide Treatment on Cell Cycle Dynamics in GBM

Gurnek Pahuja, Neuroscience; Dr. Andrew Dhawan, Department of Cancer Sciences, Cleveland Clinic Research

Glioblastoma (GBM) is the most aggressive and lethal primary brain tumor, with a median survival of only 12–15 months. Chemotherapy is a critical component of treatment, with temozolomide (TMZ) serving as the first-line chemotherapeutic used. TMZ alkylates tumor cell DNA, leading to cell cycle arrest and apoptosis. While TMZ is considered the standard of care for treating GBM, the temporal and dose-dependent effects of TMZ on GBM cell cycle progression remain poorly characterized.

This study aims to examine the dose-dependent cell cycle effects of TMZ treatment on patient-derived GBM models *in vitro*. We hypothesize that as TMZ dosage increases, cell cycle progression slows, and as time following treatment increases, more cells re-enter the cell cycle.

Two patient-derived GBM models were used in this study: HW1, a human-derived glioblastoma stem-like cell line modeling TMZ-sensitive tumors, and 3691, a patient-derived glioblastoma line representative of TMZ-resistant tumors. Both cell lines were plated in culture on Day 0 and treated with TMZ at varying concentrations (vehicle, E10, E25, E50, E75) on Day 1. Samples were collected on Days 3, 6, 8, 10, and 15, and cell cycle dynamics were assessed using flow cytometry.

We found that HW1 (intrinsically TMZ-sensitive) cells undergo senescence and apoptosis in a dose- and time-dependent manner during treatment, whereas 3691 (intrinsically TMZ-resistant) cells show a delayed response to TMZ, with only modest increases in senescence and apoptosis observed by Day 6 in a dose-dependent manner. These findings suggest that, as expected, pre-existing TMZ resistance is a strong determinant of the cell cycle response post-treatment. Further, our results demonstrate that the treatment of TMZ-sensitive cells may result in the generation of cellular senescence instead of cell death.

Page 235: A Controllable Perturbation System for Testing Dynamic Stability During Robotic Locomotion

Luke Palios, Computer Engineering, **Jinsol Kang**, Electrical Engineering, Amara Suehrstedt, Electrical Engineering

The nervous system responsible for animal locomotion is a complex system that is not yet entirely understood. Moreover, the inner workings of the nervous system vary greatly across the different body scales, further complicating the field. Fortunately, the CWRU Biologically Inspired Robotics Laboratory is currently investigating this exact topic, and for their research, they are developing a robot to replicate the muscular structure of a cat. In particular, they intend to study the mechanics behind keeping balanced during motion after being disturbed. One of the tests they intend to conduct to investigate this requires applying an abstract force on the robot while it walks along a treadmill, also known as a controllable perturbation. The goal of this study is to design and implement a system to facilitate this testing. Our design is based on Stanford's open-source Bump 'Em design, a controllable perturbation system designed to make arbitrary disruptions to a human walking along a treadmill. This design accomplishes this feat by mounting up to four brushless motors, each capable of applying up to 200N to the user, at waist height for the participant, with one to the participant's front, left, right, and rear. Using cables to transfer the force from each motor to the participant, any two perpendicular motors can be used to simulate an abstract force by combining the discrete forces from perpendicular axes. By scaling this system down using motors with a maximum of 20N, we can implement this design for the cat robot and allow testing to proceed.

Project Mentor: Dr. William Nourse, Biologically Inspired Robotics Laboratory, Case Western Reserve University

Capstone Instructor: Vira Chankong, Department of Electrical Engineering and Computer Science, Case Western Reserve University

Page 236: The Cognitive and Neural Effects of Psilocybin-Assisted Therapy: Implications for Memory Reconsolidation and Plasticity

Nithya Pandari, Department of Cognitive Science and Psychology

This project investigates how psilocybin-assisted therapy influences cognitive and neural processes related to memory reconsolidation and neuroplasticity. Recent research has shown that psychedelics such as psilocybin temporarily relax high-level predictive processing in the brain, creating a state of increased neural flexibility often described by the REBUS (Relaxed Beliefs Under Psychedelics) model. Within this framework, psilocybin may enable the modification of entrenched emotional memories by destabilizing and rewriting maladaptive associations during reconsolidation. This review synthesizes current empirical and theoretical work on the interaction between psilocybin, default mode network activity, and memory circuits involved in fear and trauma, including findings from Barrett et al. (2020), Carhart-Harris & Friston (2019), and related studies on fear memory erasure. Methodologically, the paper draws from a literature review of neuroimaging, behavioral, and clinical data to evaluate how psychedelic-assisted therapy could be used to enhance cognitive flexibility and therapeutic learning. The expected conclusion is that psilocybin facilitates a neurobiological environment conducive to emotional relearning by reopening critical periods of plasticity, which has implications for treating disorders such as PTSD and depression. By connecting cognitive science and neuroscience perspectives, this project aims to clarify how altered states of consciousness can influence learning and memory processes at both psychological and neural levels.

Project Mentor: Fey Parrill, Department of Cognitive Science, CWRU

Page 237: Placental and Fetal Monitoring System for Noninvasive Assessment of Maternal-Fetal Health

Ronit Pandey, Tosa Odiase, Meghna Mehta, Naomi Pagan Luna, and **Rafael Gonzalez**

Department of Biomedical Engineering, Case Western Reserve University

Conventional fetal monitoring systems, which primarily focus on measuring fetal heart rate (FHR) using bulky, wired equipment, are often inaccurate, invasive, or subjective, leading to high false-positive rates and unnecessary interventions. There is currently no established noninvasive way to obtain insights into fetal oxygenation levels in clinical settings. This project aims to design a noninvasive fetal monitoring system that integrates two key functions: FHR measurement using optical and electrical sensors, and placental oxygenation assessment using near-infrared spectroscopy (NIRS). The NIRS technique leverages the fundamental physiological principle of oxygen diffusion, where maternal arterial blood delivers oxygen across a gradient to the fetal circulation. By quantifying the oxygen supply immediately available for diffusion, the system gains insight into fetal hypoxia risk resulting from placental insufficiency, offering a more specific and earlier detection mechanism that complements FHR data and improves outcomes for both mother and fetus. To verify our design and system performance, we will run prototype testing, which will involve measuring the sensor accuracy using simulated tissue models in controlled settings.

Project Mentor: Professor Williams and Professor Drummond, Department of Biomedical Engineering, CWRU

Page 238: Long-Term Patient Outcome Following Adult Cardiopulmonary Bypass Surgery

Avisha Pandey, Department of Biology; **Dr. James Reynolds**, Department of Anesthesiology, Harrington Discovery Institute; **Dr. Boonphiphop Boonpheng**, Department of Nephrology-Transplant Nephrology, University Hospitals

Nitric oxide (NO) based oxygen delivery and microvascular functions are critically regulated by S-nitrosohemoglobin (SNO-Hb). Our previous prospective study following adult cardiopulmonary patients found that acute reductions in the levels of SNO-Hb in non-transfused patients were linked to adverse outcomes, notably declines in kidney function. We hypothesize that these acute changes are predictive of long-term prognosis, specifically the presence of chronic kidney disease. Through a retrospective chart review of this previously monitored cohort, we will connect these critical acute predictors to long-term clinical outcomes. After IRB approval and HIPAA authorization, we will review the medical records for 27 adult cardiac surgery subjects. Collected data will include kidney organ function testing, medication history, cognitive function data, and development of any new pathologies. We will then employ parametric and correlation statistical methods to analyze the differences in overall long-term health in comparison to their acute post-CPB biomarker status. The potential impact of this research is to establish SNO-Hb as predictors of long-term outcomes, providing a valuable risk management tool. This would lay the foundation for future studies and development of targeted interventions and strategies to maintain SNO-Hb levels in CPB patients.

Project Mentor: Dr. James Reynolds, Department of Anesthesiology, Harrington Discovery Institute Capstone Mentor: Dr. Susan Burden-Gulley, Department of Biology

Page 239: KLF6 Signaling in Macrophage Activation and Atherogenesis

Authors: Yashwant Pantra[1], Hang Pong Ng[1], Atif Zafar[1], Rachel Diamond-Zaluski[1], Gun-Dong Kim[1], Kartik Bhat[1], Owen Meadows[1], E. Ricky Chan[2], Jonathan D. Smith[3], and Ganapati H. Mahabeleshwar[1]

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A hallmark event in the development of atherosclerotic plaque is the accumulation of lipid-laden macrophages in the subendothelial layers of affected blood vessels. Macrophages are key players in all stages of atherogenesis, including plaque initiation, growth, and rupture, as well as healing of ruptured plaques. In this context, macrophages are the principal innate immune cells that modulate atherogenesis by engaging in various processes, such as inflammation, extracellular matrix degradation, phagocytosis, and efferocytosis. In the current study, Kruppel-like transcription factor 6 (KLF6) deficiency attenuated proinflammatory gene expression in macrophages and experimentally induced atherosclerotic plaque development. In vivo studies showed that myeloid-KLF6 deficiency on Apoe-null background significantly curtailed high-fat/high-cholesterol diet-induced atherosclerotic lesion formation and macrophage abundance in atherosclerotic plaques. Integrated transcriptomics and Gene Set Enrichment Analysis showed that KLF6 deficiency significantly curtailed a large number of tumor necrosis factor (TNF)-induced gene targets, TNF-induced interferon-γ response, interferon-α response, and inflammatory response signaling in macrophages. At the molecular level, KLF6 promoted interferon regulatory factor 1 (IRF1) signaling to enhance TNF-induced proinflammatory gene expression in macrophages. Collectively, study results show that KLF6 promoted proinflammatory gene expression in macrophages and enhanced experimentally induced atherosclerotic plaque formation in vivo.

Keywords: Atherosclerosis, Macrophages, KLF6, Proinflammatory gene expression, TNF-IRF1

Page 240: Evaluating the Fire Performance of Structures using Numerical Simulation

Sri Pariyangat, Mechanical and Aerospace Engineering, CWRU

Structural fire safety is a critical aspect of modern building design, as elevated temperatures during fire events can rapidly degrade the strength of materials. This project investigates the fire performance of reinforced concrete slabs using finite element analysis in ABAQUS. Heat transfer simulations were performed according to the ISO 834 standard fire curve to model temperature distribution across the slab over time. From these results, the slab's maximum moment capacity was calculated at various time intervals to determine the failure point at which the moment capacity dropped below the demand moment, indicating structural collapse. Two slab models were compared with different concrete cover depths (25 mm and 30 mm) to assess how concrete cover thickness influences time to failure. The 25 mm cover slab failed at approximately 137.9 minutes, while the 30 mm cover slab sustained loading for about 175.6 minutes, demonstrating that increased cover delays heat transfer to reinforcement and improves fire resistance. Temperature and stress distribution plots were used to visualize the heat propagation and internal stress states during exposure. These findings provide insight into how cover depth affects fire performance and can help guide safer and more efficient structural design practices.

Project Mentor: Professor Elias Ali, Department of Civil and Environmental Engineering, CWRU

Page 241: Effects of high-versus low-fat diet on a murine model of colitis-associated colon cancer

Hannah Park, Department of Chemistry, CWRU Background:

Obesity is a rapidly growing public health concern with many comorbidities, including colorectal cancer. Colorectal cancer is the most common obesity-related cancer, and the second most common cause of cancer deaths in the United States. Although the pathogenesis of obesity and colorectal cancer is multifactorial, higher fat consumption has been correlated with increased risk of obesity and colorectal cancer. We aim to test the hypothesis that a high-fat diet (HFD) will worsen disease severity and cancer risk in a murine model of colitis-associated colon cancer. Methods: To determine the effects of HFD on a murine model of colitis-associated colon cancer, mice were fed a HFD and a macronutrient-matched low-fat diet (LFD) for 8 weeks, beginning at 6 weeks of age. Body weight and food consumption were monitored for the 8-week treatment period, and the mice were then sacrificed. The following tissues were collected: colons for histology and gross microscopy, colonic mucosa for qPCR, livers for histology, spleens for weight, stool for fecal lipocalin, and serum for ELISA. Results: Tissue from the HFD exhibits a higher tumor burden on gross microscopy than the LFD, with many samples showing 0. All tissues were collected and then submitted for histology. The HFD samples have higher dysplasia and inflammatory scores than the LFD. The remaining analyses and assays will be performed in the upcoming weeks. Conclusions: This study demonstrates that an HFD can worsen colitis and colitis-associated colon cancer and that an LFD can be preventive in the development of colon cancer.

Project Mentor: Bianca Islam, MD, PHD, Department of Medicine, CWRU

Faculty Sponsor: Fabio Cominelli, MD, PHD, Department of Medicine, CWRU

Page 242: New Isoforms of the Stress Kinase DLK: Investigations of their Expression, Localization, and Function

Carly Parker, Neuroscience; Sophia Khan, Department of Neurosciences; **Dr. Harisankar Sheela**, Department of Molecular, Cellular and Developmental Biology, University of Michigan; and **Dr. Catherine Collins**, Department of Neurosciences CWRU;

Dual leucine zipper kinase (DLK) has been identified as an upstream regulator of MAP Kinase signaling in response to neuronal injury and stress. Activated DLK regulates signaling that has many downstream effects in neurons, such as initiating new axonal growth, regulating the expression of presynaptic proteins, and promoting axonal degeneration and neuronal death. Due to the variability in DLK-initiated responses, the underlying mechanisms that distinguish protective versus degenerative outcomes of DLK and signaling are currently being investigated. Unpublished data from the Collins lab suggests that a population of DLK protein localizes to the nucleus. We hypothesize that this nuclear-localized DLK may be expressed through alternative transcripts and/or alternative translation start sites. To test this, we are developing and implementing new tools to effectively knock down canonical DLK and any alternate transcripts. Our first strategy is a 'GeneTrap' approach to disrupt DLK expression in HT22 cells, which introduces mNeonGreen and a strong polyadenylation sequence into the first DLK coding exon. This approach should disrupt expression of all transcripts from the DLK locus. Our second strategy uses shRNAs that target canonical DLK and the proposed isoform separately. We have isolated stable HT22 cell lines that express 3 different shRNAs introduced by lentivirus. The shRNAs target canonical DLK, the proposed isoform, and a scramble sequence. We are currently evaluating the effectiveness of knockdown by quantitative RT-PCR. If knockdown is effective, then these lines can be used to evaluate DLK's function in cell growth and RNA splicing, following preliminary data in the Collins lab. We will also use the quantitative RT-PCR tests to measure the expression level of DLK isoforms in different conditions, including mouse models of Alzheimer's Disease and Amyotrophic Lateral Sclerosis.

Project Mentor: Dr. Catherine Collins, Department of Neurosciences.

Faculty Sponsor: Dr. Jon Niemi, Department of Neurosciences.

Page 243: The effect of targeting Mac-1: GPIba interaction in pancreatic cancer

Shubh Patel, B.S Biology; **Dr. Yunmei Wang**, Cardiovascular Research Institute, School of Medicine

Pancreatic cancer remains one of the most lethal malignancies,with a five-year survival rate below 10% and limited therapeutic options. Our laboratory has identified platelet–leukocyte interactions as critical mediators of tumor progression and metastasis. Specifically, the platelet receptor GPIbα interacts with the leukocyte integrin Mac-1 to drive tumor growth and dissemination. We initially aimed to evaluate a novel anti-GPIbα antibody as a therapeutic candidate in pancreatic cancer through two specific aims: (1) to assess whether the antibody inhibits platelet–leukocyte and platelet–tumor binding in vitro, and (2) to determine its efficacy in reducing tumor burden in a murine pancreatic cancer model. However, due to manufacturing delays and revised experimental priorities, antibody treatment studies have not yet commenced. In the interim, I contributed to a project investigating the mechanistic role of the Mac-1–GPIbα interaction in cancer progression using a genetic approach to examine how modulation of this binding influences tumor growth potential. During this period, I gained hands-on experience in murine tissue dissection and processing, histological staining (H&E, immunofluorescence, immunohistochemistry), cell culture of pancreatic tumor lines, tumor size measurement, microscopy, and quantitative image analysis. I also assisted with data collection and analysis, generating high-quality histological and imaging datasets that advanced understanding of GPIbα–Mac-1 interactions in inflammation and tumor progression. Building on these results, I initiated a mechanistic study in Foxp1 transgenic (TG) mice, as Foxp1 modulates Mac-1. This study provides a genetic framework to investigate leukocyte–platelet signaling in vivo and its role in immune response to tumor growth. These findings will integrate with upcoming antibody treatment studies to provide a comprehensive view of the Mac-1–GPIbα axis in pancreatic cancer, supporting the hypothesis that disrupting platelet–leukocyte interactions may limit tumor progression and metastasis.

Faculty Project Mentor: Dr. Yunmei Wang, Cardiovascular Research Institute, School of Medicine

Capstone Instructor: Christopher Cullis, Department of Biology, College of Arts and Sciences

Page 244: Generation and characterization of a novel Sting1 global knockout rat line

Diya T. Patel[1] , Thao Nhi Phan[1], Najeong Kim[1] and Agustin Gonzalez-Vicente[1]

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The stimulator of interferon genes (Gene: Sting1; Protein: STING) pathway is a central mediator of innate immunity, responsible for sensing cytoplasmic DNA and initiating type I interferon and related immune responses. Dysregulated STING signaling, triggered by aberrant cytoplasmic self-DNA, drives systemic, chronic sterile inflammation, leading to tissue degeneration and fibrosis. To study STING-associated pathobiology, we generated a novel global Sting1 knockout (Sting1) rat line. We targeted exon 1 in Sting1 with the CRISPR/Cas9 system, producing a two-base-pair deletion, and causing a frameshift that resulted in partially scrambled and truncated STING. Breeding of 4 heterozygous pairs produced 13 Sting1 $^{-/-}$, 28 Sting1 $^{+/-}$, and 7 Sting1 $^{+/+}$ offspring (n=48), trending to Mendelian inheritance distributions. Furthermore, 5 female Sting1 rats were crossed with heterozygous males, with all female breeders producing offspring (n=36). Growth curve analysis between weeks 6 and 15 of age, showed no significant differences in weight gain between wild-type and Sting1-$^{/-/-}$ littermates in either females (p=0.11, n=15) or males (p=0.46, n=9). Finally, complete loss of STING expression was confirmed in whole kidney homogenates by Western blotting and in glomeruli by Immunofluorescence. Together, these results indicate that our novel rat line is reproductively viable and present a normal phenotype up to week 15 of age. To our knowledge, this is the only global Sting1 $^{-/-}$ rat in existence, poised to support studies by our laboratory on the role of STING in proinflammatory signaling within the kidney glomerulus under chronic metabolic stress conditions. We also expect this model will enable collaborations with other investigators to study STING pathobiology in other organs.

Page 245: Crosstalk between MSCs and chondrocytes and its effects on chondrogenesis

Medha Patria, Chemistry; Dr. Rodrigo Somoza, Department of Biology; David Rodriguez, Department of Biology

Currently, no ideal solution to cartilage injuries or osteoarthritis exists, as cartilage does not regenerate in the body, and current therapies and surgical procedures do not result in sufficient mechanical characteristics of hyaline articular cartilage. Due to the limited availability of chondrocytes, research has turned towards the use of mesenchymal stem cells (MSCs) to produce cartilage. However, culturing MSCs alone poses challenges and typically results in hypertrophic of fibrous cartilage. Based on past studies of xenogeneic co-cultures using bovine or rabbit chondrocytes and human bone marrow MSCs that demonstrated enhanced levels of total collagen, increased extracellular matrix synthesis, and increased expression of GAG and COL2 in comparison to MSC monocultures, this study investigates how crosstalk between MSCs and chondrocytes affects chondrogenic differentiation. Crosstalk of MSCs and chondrocytes (CH) was initiated by 3 different methods. In the direct method, MSCS and chondrocytes were seeded in the same flask. There were four different groups: 1:1 ratio of MSC:CH, 2:1 ratio MSC:CH, MSC, and CH. The indirect method involved interaction through conditioned media. Four different groups were tested: MSCs with chondrocyte conditioned media, chondrocytes with MSC conditioned media, MSCs, and chondrocytes. The third method involved indirect crosstalk through trans wells. Two groups were tested: 1:1 ratio of MSC:CH and 2:1 ratio of MSC:CH. For each of the three methods, 7 days were given for crosstalk to occur before chondrogenesis induction. After 28 days of chondrogenesis, the chondrogenic pellets were tested through histology, PCR, and glycosaminoglycan (GAG) production to analyze how chondrogenic differentiation was affected. It is expected that co-culturing of MSCs and chondrocytes will demonstrate enhanced chondrogenic potential in comparison to monocultures.

Project Mentor: Dr. Rodrigo Somoza, Department of Biology; David Rodriguez, Department of Biology

Page 246: Graphical Relationships Between Time Spent Streaming and Sleep Statistics in Americans Using the ATUS

Owen Guffey, Department of Economics & Banking and Finance; **Tola Oshomoji**, Department of Computer and Data Sciences; **Penn Patten**, Department of English, CWRU

Streaming is a relatively new phenomenon that has undoubtedly affected human behavior, but it is still somewhat unknown in what ways and to what extent. This project aims to identify trends in usage of digital entertainment services and sleep statistics in Americans since 2020 by creating data visualizations from the American Time Use Survey (ATUS). This time period was selected because of newly created categories in the ATUS as well as because of the significant shift in time usage and streaming prevalence since the COVID-19 pandemic. We hope to determine whether there is a correlation between these two variables and to provide relevant insights by looking at this relationship through the lens of different variables that may have confounding effects such as age, sex, region, etc. Graphical techniques may expose how these time usages are complementary or antagonistic to each other, and this may vary widely between demographics and individuals' traits. Although we expect that people that spend more time streaming will have insufficiencies in their amount of sleep and overall restfulness, this relationship is not guaranteed, and we may discover unanticipated nuances in the process of visualizing the data.

Project Mentor: Professor David Clingingsmith, Department of Economics, CWRU

Page 247: Exploring the Association Between Perceived Stress and Food Security Status

Nandu Pentapati, Nutritional Biochemistry and Metabolism Sarah R. Morrison, M.A., Brenna Ellison, PhD, and Melissa Prescott, PhD, RDN

Food insecurity, defined by the limited or uncertain availability of nutritionally adequate and safe foods, or the inability to acquire such foods in socially acceptable ways, continues to pose a significant public health concern in the United States. According to the U.S. Department of Agriculture, 86.5% of U.S. households experienced food security throughout 2023, leaving approximately one in seven households experiencing some degree of food insecurity. Perceived stress, a key indicator of psychological well-being, reflects an individual's appraisal of life's demands and their ability to cope with them, making it an important factor to consider when examining the broader impacts of food security status. Prior literature has established that socioeconomic stressors are linked to dietary patterns, increasing rates of chronic diseases, and psychosocial well-being. This project aims to explore the association between perceived stress levels and food security status among adults in the Cleveland metropolitan area. Data was collected using responses from the baseline survey of a 9-week culinary nutrition intervention. Food Security was classified using the U.S. Adult Food Security Survey Module, and perceived stress was assessed using the Perceived Stress Scale (PSS). Responses will be statistically analyzed to assess the strength of the association between stress and food security categories. It is expected that higher perceived stress scores will correlate with lower food security status, suggesting that stress and food insecurity form a cyclical relationship in which each reinforces the other. Findings from this research will underscore the importance of integrating stress management and resource-access interventions to address both the psychological and material factors of food insecurity, contributing to a more holistic understanding of health and well-being, especially for marginalized communities.

Project Mentor: Melissa Prescott, PhD, Department of Nutrition, Case Western Reserve University

Page 248: Design and Build Liquid Nitrogen Loop for Performing Cryogenic Phase Change Experiments Supporting NASA's Long Duration Missions to Moon and Beyond

Manuel Jesús Petidier Oria, Department of Aerospace Engineering

Liquid propellant management for NASA's long-duration lunar and deep-space missions depends on lines that chill down rapidly and sustain stable two-phase transport. This senior project designs and constructs a liquid-nitrogen (LN_2) recirculation loop to reproduce and quantify line chilldown and flow boiling under controlled thermal–hydraulic conditions. The closed loop integrates a vacuum pump system, a modular test section, cryogenic-rated valves, vacuum-insulated transfer lines, and fast-response instrumentation for temperature, pressure, and mass flow. Experiments impose prescribed inlet subcooling, heat-flux, and mass-flux setpoints to record transient wall-temperature histories, pressure drops, and cool-down times from ambient to steady cryogenic operation. Data reduction yields (i) regime maps spanning film boiling, transition, nucleate boiling, and single-phase convection; (ii) chilldown correlation metrics, including heat-transfer coefficients as functions of wall superheat and Reynolds number; and (iii) validated pressure-loss characteristics for representative propellant-line geometries. The expected outcome is a reconfigurable, repeatable platform that reproduces rocket-relevant thermal transients and generates benchmark datasets for model validation, alongside preliminary guidance on operating windows and control strategies that shorten chilldown while limiting pressure excursions. By delivering an instrumented LN_2 loop and an initial performance baseline, the project supports data-driven design of efficient, reliable propellant storage and transfer systems for future NASA missions.

Project Mentor: Dr. Chirag Kharangate, Department of Mechanical and Aerospace Engineering; Dr. Ya-Ting Liao, Department of Mechanical and Aerospace Engineering

Page 249: Examining the Evolution of Audience and Critical Responses to the Marvel Cinematic Universe

Annette Pham, Finance; **Han Phan**, Data Science and Analytics; **Harvey Nghiem**, Computer Science

This study asks whether Marvel Cinematic Universe (MCU) films have lost appeal over time. We examine trends in audience and critic reception from 2008 to the present to test claims of declining quality or popularity. The project matters because the MCU shapes modern blockbuster economics, yet recent phases face criticism for repetition and oversaturation. Understanding these shifts reveals how economic constraints, production scale, and changing tastes affect entertainment markets.

We use film-level data (unit of observation: each MCU movie, Phases 1-5). Core variables include Rotten Tomatoes critic and audience scores, IMDb ratings, and box office revenue (domestic, international, worldwide). Control variables cover runtime, budget, release phase, and theater count. To isolate MCU-specific trends, we build a comparison set of non-MCU films matched by genre (superhero/action), budget range, and release year, drawn from Box Office Mojo and IMDb. Data come from the Kaggle "Marvel Movies Dataset" and Box Office Mojo franchise pages, merged on title and release date.

We apply descriptive visualization (time-series plots of ratings and revenue) and regression models with fixed effects for phase and year to measure change while controlling for scale. Difference-in-differences estimates compare MCU trends to the matched sample, testing whether declines reflect broader market forces or franchise-specific factors.

Expected results will show if MCU ratings and revenue fall relative to peers after adjusting for inflation and production cost. A steeper drop in MCU metrics would signal internal issues (e.g., creative fatigue); parallel declines would point to industry-wide shifts in viewer demand. These findings will clarify economic drivers of blockbuster success.

Project Mentor: David Clingingsmith, Associate Professor, Department of Economics, Weatherhead School of Management

Page 250: CAN-bus Splitter and Encoder Processor for Legged Robot Control

Minh Phan, Electrical & Computer Engineering, Home Institution: Department of Electrical, Computer, and Systems Engineering; **Anh Pham**, Electrical Engineering, Home Institution: Department of Electrical, Computer, and Systems Engineering; **Moses Muamba**, Electrical Engineering, Home Institution: Department of Electrical, Computer, and Systems Engineering.

The primary objective of this project is to design a hardware-software system in FPGA platform that can read from four motors on a quadruped robot with a delay of less than 1 millisecond. This project is funded by the CWRU Biologically Inspired Robotics Laboratory. The reason for this project is it previously took them 16 milliseconds to get sequential data readings from each motor and they want to have an alternative way to read data faster. We will create the hardware bitstream using Xilinx Vivado and develop standalone C programs for real-time control of the motors. The system architecture integrates several critical components: (1) the PMOD CAN IP blocks used for interfacing the motors with the FPGA board; (2) AXI DMA blocks for transferring data between the Programmable Logic (PL) region and the Processing System (PS) region; and (3) DDR memory used for command-line interface that displays the data readings. The PMOD CAN IPs will convert the data from CAN bus into SPI format. The AXI DMA block will fetch data from the FIFO memory blocks that are used to receive the CAN bus data memory and transfer them into the DDR memory on the PS region. On the user end, we develop a simple command line interface that displays the read data as string.

Project Mentor: Vira Chankong, Department of Electrical, Computer, and Systems Engineering. William Nourse, Department of Electrical, Computer, and Systems Engineering

Page 251: Development of a Smart Prosthetic Liner to Detect Residual Limb Pressure Patterns

Tayseera Pillane, Department of Mechanical and Aerospace Engineering; **Tharun Viswanathan**, Department of Electrical, Computer and Systems Engineering; **Ella Smith**, Department of Materials Science and Engineering; **Avary Peters**, Department of Biomedical Engineering; Zachary Halsey, Department of Biomedical Engineering; Alden Salmons, Department of Electrical, Computer and Systems Engineering; Lexi Miskey, Department of Biomedical Engineering

Pressure distribution within prosthetic sockets varies significantly from user to user due to factors such as residual limb anatomy, activity level, and socket fit. These variations can affect user comfort, mobility, and overall prosthetic performance with rising concerns around skin irritation and breakdown, which may go unnoticed due to neuropathy in the residual limb. To address this challenge, the current work focuses on developing an ultra-thin flexible sensor array fabricated using Aerosol Jet Printing (AJP) connected to a microprocessor. The system is designed to be embedded within a conventional socket liner to enable monitoring of pressure distribution. Currently, progress includes printing strain gauges using AJP and analyzing electrical interconnection methods. A four-point probe method was used to measure resistance of the printed strain gauges and determine conductance, indicating the viability of the strain gauges. To connect these strain gauges, four types of conductive threads were explored. To understand the conductive thread structure in cross-section, specimens were prepared using typical metallographic methods and imaged using optical microscopy. Each image was evaluated through the WEKA trainable segmentation plug-in of ImageJ. This separated the conductive thread fibers from the substrate and calculated the cross-sectional area to aid in determining mechanical properties of the threads. Additionally, mechanical and electrical testing of the thread connections was conducted by attaching the threads to either AJP strain gauges using epoxy or a lily pad printed circuit board (PCB) in which the threads are coiled around the PCB. As part of this effort, a testing procedure is also being developed to evaluate the strain gauges. By imaging and mapping strain data across the socket interface, the spatial distribution forces acting on the residual limb can be better understood. This information will enable prosthetists to further adapt and personalize sockets, ultimately improving comfort and mobility for prosthetic users.

Project mentor: Janet L. Gbur, Materials Science and Engineering and Douglas B. Shire, Advanced Platform Technology Center, VA Northeast Ohio Health Care System

Page 252: Foster Youth Exiting Care in Ohio Compared to the U.S.

Alexander Prospal, Economics, Mathematics, and Computer Science; **Styl Olea Peña**, Anthropology; **Andi Kellum**, Computer Science; **Naomi Moneme**, Political Science and Psychology

Our research question is how many youth exit the foster care system in Ohio in comparison to the rest of the U.S by age group. This will help to understand how many youth are exiting foster care and how much Ohio is contributing to the overall national rate. The age group that we intend to focus on is those who are 16-20, as it is expected of that age group to leave the foster care system at a decreased rate. We will be doing a comparison of those that have exited foster care of those that are in the system in Ohio and those that are in the care system all over the nation. By comparing the average and those that are in Ohio we will be able to compare if Ohio has a higher rate. We believe that Ohio's Foster Care rate will correlate with the national average.

Project Mentor: David Clingingsmith, Department of Economics

Page 253: Evaluation of Mechanical Pain Sensitivity in Mouse Models: Role of Asprosin

Andrew Qian, Department of Biology, Case Western Reserve University; **Alex Duval**, Department of Biology, Case Western Reserve University

This project investigates how the hormone asprosin influences mechanical pain sensitivity in mouse models. It builds on previous research that examined thermal pain responses and identified asprosin as a potential modulator of nociceptive signaling. Asprosin, a fasting-induced glucogenic hormone, has been shown to affect central nervous system processes related to metabolism and stress, but its role in pain modulation remains unclear.The present study expands upon these findings by testing whether asprosin's effects extend beyond thermal nociception to mechanical pain. Using von Frey assays and other established behavioral paradigms, we will measure mechanical pain thresholds in both wild-type mice and genetically modified models with altered asprosin signaling. Mice previously used in thermal pain studies will be re-evaluated to directly compare asprosin's impact across different nociceptive modalities. Data collected from these experiments will be analyzed to determine whether asprosin modulates peripheral or central pain pathways and whether its effects are modality-specific or generalized across pain types. This work will provide insight into the broader role of metabolic hormones in sensory processing. By identifying how asprosin interacts with mechanical pain mechanisms, the study aims to clarify whether this hormone functions as a cross-modal regulator of nociception or exhibits selective effects. Understanding these mechanisms could help establish new links between metabolic regulation and chronic pain disorders, offering a foundation for potential therapeutic approaches that target hormone-mediated modulation of pain.

Project Mentor: Dr. Atul Chopra, School of Medicine, Case Western Reserve University; Elliot Gardner, Biology

Page 254: Investigating Innexin Gap Junction Proteins and Calcium Signaling During Drosophila Embryonic Development

Auvai Ramalingam, Department of Biology

Morphogen gradients are critical for establishing proper cell fate specification and tissue patterning during embryonic development. The DPP/BMP morphogen subdivides the epidermis and neurectoderm by activating epidermal genes dorsally and repressing neural genes. We showed a new functional role of DPP/BMP in attracting cells towards the dorsal region by increasing cell adhesion. The resulting rise in local cell density is required for peak gradient levels. Here we investigate whether this novel cell-cell communication mechanism is mediated through gap junction proteins. Several lines of evidence suggest that the Drosophila Innexin gap junction proteins might be involved in this process. First, Innexins regulate intercellular Calcium flux forming a dorsal-to-ventral gradient in blastoderm embryos shown to pattern the embryo. Second, Innexins were shown to increase DPP activation in late development. Finally, Innexins physically interact with E-cad cell junction proteins, which we found to regulate cell movements induced by DPP. We hypothesize that Innexins facilitate intercellular calcium signaling that is essential for establishing and maintaining the DPP gradient. To test whether Innexins regulate the Calcium and DPP gradients, we used RNAi to knockdown the expression of three Innexins in the blastoderm: *ogre, inx2*, and *inx3*. To monitor the Calcium gradient, we utilized the GAL4/UAS system to ubiquitously express UAS-CaMPARI with a maternal-GAL4 driver. CaMPARI is a photoconvertible fluorescent protein that irreversibly converts from green to red in a calcium- and light-dependent manner. We confirmed the presence of high calcium levels dorsally through targeted photoconversion in control embryos. We will quantify the DPP gradient using phosphorylated Mad as a read-out for DPP activation. We expect that *ogre, inx2,* and *inx3* RNAi will lower the calcium and DPP gradients resulting in dorsal-ventral patterning defects. These results will provide definitive evidence linking gap junction communication to calcium gradient establishment and morphogen patterning.

Project Mentor: Dr. Claudia Mieko Mizutani, Department of Biology, CWRU

Page 255: Gasdermin A in Pyroptosis: Mitochondrial Localization and the Role of S-Acylation

Naomi Rawlins, Biology (B.S.)

Pyroptosis is a form of programmed cell death characterized by inflammatory signaling and plasma membrane rupture, playing a critical role in host defense and disease pathogenesis. Gasdermin proteins are central mediators of this process, with Gasdermin A (GSDMA) emerging as a key but less-studied member of the family. Upon cleavage by proteases, GSDMA releases its N-terminal domain, which oligomerizes to form pores in membranes. This pore formation drives cellular swelling, lysis, and release of pro-inflammatory cytokines.

In this project, we examined the role of GSDMA in pyroptosis, focusing on its subcellular localization compared to Gasdermin D (GSDMD), which was used as a control. Using cell fractionation and protein isolation, we determined that upon Nigericin treatment, GSDMA localized predominantly to the mitochondria, while GSDMD localized to the plasma membrane. We are further investigating whether S-acylation, a reversible lipid modification, influences this localization process. Preliminary results suggest that S-acylation may act as a signaling modification mechanism directing GSDMA insertion into mitochondrial membranes instead of the plasma membrane. These findings highlight GSDMA as a unique regulator of inflammatory cell death and suggest that post-translational modifications such as S-acylation may be critical determinants of gasdermin targeting. Understanding these mechanisms has important implications for therapeutic strategies aimed at autoinflammatory and infectious diseases.

Project Mentor: Katarzyna Bulek, Department of Pathology; Tsan Xiao, Department of Pathology; Sarah Bagby, Biology Department

Page 256: Predictors of Positive Stool-Based Colorectal Cancer Screening Tests in a Clinical Cohort

Ava Rezaee, Department of Biology; Dr. Kathryn Martinez, Cleveland Clinic Lerner Research Institute

Colorectal cancer (CRC) screening can be performed via colonoscopy or stool-based tests, including guaiac fecal occult blood test (FOBT), fecal immunochemical test (FIT), and multitarget stool DNA testing (mt-sDNA; Cologuard®). Stool tests differ in analytic sensitivity and positivity rates, and a positive result triggers diagnostic colonoscopy, which may not be covered like screening colonoscopy. Understanding predictors of stool-test positivity can guide first-line screening decisions and optimize colonoscopy capacity. In this study, we aimed to identify demographic, clinical, laboratory, and neighborhood-level factors associated with stool-test positivity among older adults using Cleveland Clinic electronic health record data. We conducted a retrospective, cross-sectional cohort study of patients aged 70 and older who completed FIT, FOBT, or Cologuard. Outcomes were based on coded stool-test positivity. Prespecified predictors included age, sex, race/ethnicity, smoking status, diabetes, anemia, serum albumin, creatinine, lipid measures, and the Area Deprivation Index (ADI). Cohort characteristics were summarized, positivity was compared across subgroups using χ^2 and ANOVA, and multivariable logistic regression models were fitted to estimate the association of each predictor with positivity, accounting for test modality. Preliminary analyses demonstrated significant differences in stool test selection by sex, race, and age (χ^2 94–1084, $p<0.001$). FIT positivity was 2.8%, whereas FOBT positivity was 28.0%, reflecting known analytic sensitivity differences. Early results suggest demographic and clinical characteristics influence both test choice and positivity. This work supports personalized CRC screening strategies by identifying subgroups with higher pre-test risk of a positive stool test. These findings may inform decisions regarding first-line colonoscopy versus non-invasive testing in older adults. Final multivariable model estimates and effect sizes will be reported in the full study.

Project Mentor: Dr. Kathryn Martinez, Cleveland Clinic Lerner Research Institute; Dr. Fritz Petersen, Department of Biology, Case Western Reserve University

Page 257: Achieving Nutritional Independence After Bariatric Surgery Complications: A 20-Year Experience with Supplemental Nutrition Support

Parsa Rezvani, Nutritional Biochemistry and Metabolism;

Bariatric surgery is the most effective treatment for patients with morbid obesity, achieving sustained weight loss and resolving comorbidities, including T2DM, HLD, and liver disease. However, malnutrition remains a potential complication. Certain patients become malnourished, requiring supplemental nutrition, including parenteral (PN) or enteral (EN) nutrition. This study characterizes the patient population developing nutritional complications following bariatric surgery. A retrospective review was conducted on patients between 2004-2023 requiring PN or EN following bariatric surgery at the Cleveland Clinic. Data collected included demographics, comorbidities, surgical characteristics, indications for supplementation, type/duration of support, complications, and outcomes. Descriptive statistics were performed to identify patterns of nutritional dependence.168 patients were included in the study, with most being female (85%). The median age and BMI [WMV1] at the time of index bariatric surgery were 41.2 years (32.9, 49.2) and 47.3 kg/m² (40.7, 55.4), respectively. The most common index procedures were Roux-en-Y Gastric Bypass (RYGB) (N=101, 53.2%) and sleeve gastrectomy (N=47, 22.1%). 67 patients were active smokers at the time of surgery (39.9%). Common comorbidities included HTN (51.8%), GERD (49.4%), and OSA (47.6%). Common complications included marginal ulcers (58.0% of RYGB), gastrojejunal (GJ) stenosis (32.2% RYGB, 23.8% conversion to RYGB), and sleeve leaks (36.2% in SG). 150 (89.3%) required EN, predominantly via Nasojejunal (46.3%) or gastrostomy tube (26.2%), with a median time on EN of 0.65 years (0.20, 1.6). 99 patients (58.9%) required PN, with a median time on PN of 0.17 years (0.07, 0.57). Among patients achieving nutritional independence (N=148, 88.1%), the most common final interventions were GJ anastomotic revision (N=13/126 RYGB, 10.3%), conversion to RYGB (N=14/44 non-primary RYGB, 31.8%), and endoscopic GJ dilation (N=13/126 RYGB, 10.3%).Patients requiring long-term nutritional supplementation following bariatric surgery represent a complex and high-risk population. The majority required EN and PN, with GJ anastomotic complications driving morbidity in RYGB patients.

Project Mentor: Mélissa V. Will and Jerry Dang; Cleveland Clinic Lerner College of Medicine of Case Western Reserve University, OH, Case Western Reserve University, OH

Page 258: Planorama: Data-Driven University Course Planning and Optimal Scheduling

Rose Bora, Computer Science; **Kennedy Jackson**, Computer Science; **Serena Lynas**, Computer Science; **Morgan Pascoe**, Computer Science; **Sofia Rivas Argueta**, Computer Science

Planorama is a web-based platform that gives students the data that they need to make informed course selection and the university the ability to derive an optimal course schedule. Recognizing the challenges of unclear expectations, inconsistent workloads, and limited peer feedback, the platform aggregates and analyzes course evaluation data to provide a comprehensive overview of each course and instructor. Through an intuitive user-friendly interface, students can explore detailed course profiles featuring metrics on difficulty, time commitment, grading trends, student satisfaction, and more. Planorama leverages sentiment analysis to extract meaningful insights from qualitative feedback, combining these findings with quantitative metrics to reduce academic uncertainty, enhance transparency, and help students align their course selections with their goals, strengths, and learning preferences.

For the university registrar, Planorama integrates an intelligent scheduling algorithm that generates optimized timetables based on student course preferences and class availability. By modeling class durations, time slots, and room capacities, the algorithm uses conflict detection and penalty minimization to create an optimized schedule and rosters that minimize time overlap of desired courses. By integrating human-centered design with data analytics, Planorama transforms the way students and educators interact with course information, shifting from intuition-based choices to evidence-based planning. The platform’s mission is to make the course selection process easier, better informed, and more optimal.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences

Page 259: Simulating Solid Material Burning in Partial Gravity Centrifuge

Christopher Riviears, Mechanical Engineering B.S., Aerospace Engineering B.S., Aerospace Engineering M.S., Department of Mechanical and Aerospace Engineering

In crewed spaceflight, it is extremely important to ensure that spacecraft interiors are constructed of materials that pose a low flammability risk, especially in the non-standard environments encountered beyond Earth Significant research has been done investigating material flammability in microgravity environments onboard platforms such as the International Space Station. These experiments have made it possible to mitigate fire risk in those specific environments. As NASA and other entities look forward to establishing human presence on other celestial bodies such as the Moon and Mars, research is needed to determine the behavior of fire within partial gravity environments. A series of experiments has been run at the NASA Glenn Research Center's Zero-Gravity Research Facility 5.2 second drop tower, which utilizes a spinning chamber in free fall to simulate a partial gravity environment by exploiting centrifugal force. While data from these experiments is useful, the nature of using rotationally simulated gravity may cause results to differ from a true partial gravity environment by an unknown amount. To quantify this difference, this project utilizes computational fluid dynamics to simulate the fire dynamics of a burning sample in both a rotational gravity and true gravity environment for direct comparison. This analysis is split into two main components, the first assumes the sample releases heat without fuel vapor, and the second includes a constant rate of fuel vapor release. This report covers the results of the first component. The key physical phenomena driving the behavioral differences in the fluid flow for rotational gravity are the gravitational acceleration changing in magnitude and direction throughout the simulated volume and the Coriolis force caused by the rotation of the volume. By studying these values, correlations to true gravity can be found, and corrective equations can be made to transform real life centrifuge experiment data into true gravity.

Project Mentor: Dr. Ya-Ting Liao, Department of Mechanical and Aerospace Engineering

Page 260: Histological Evaluation of Tissue Responses to Implanted Pressure-Injury Devices in a Rabbit Model

Diya Rohatgi, B.S. Biology; Dr. Kath M. Bogie, Department of Orthopaedics, School of Medicine, Case Western Reserve University; Case Western Reserve University; Bryan Hausman, Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center; Katie Schwartz, Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center

Pressure injuries remain a persistent healthcare challenge, particularly among immobile or neurologically impaired patients. Preventive strategies increasingly consider implantable or sensor-guided approaches, which require a clear understanding of long-term soft tissue responses to implanted materials. This project evaluates histological patterns of local tissue response surrounding a subdermal FlexStim implant in a preclinical rabbit model conceived for pressure injury prevention. The FlexStim device is engineered to provide automated weight shifting; in this study, it was implanted to assess biocompatibility and chronic peri-implant tissue response over a six-month period. Following surgical implantation, tissue blocks containing the device and adjacent skin, subcutaneous tissue, and muscle were excised at prespecified endpoints, fixed in neutral buffered formalin, and embedded in paraffin. Sections were stained with hematoxylin and eosin to assess cellular architecture and Masson's trichrome to evaluate collagen distribution and fibrous capsule development. Whole slide images were acquired for light microscopic review and digital analysis. Standardized regions of interest were defined around the implant interface for comparative assessment. Preliminary qualitative review indicates localized inflammatory infiltration and fibroblast proliferation near implant interfaces, with maturing collagen deposition consistent with an expected foreign body response and early fibrotic encapsulation. Adjacent tissue architecture remained largely preserved without gross necrosis or infection across interim time points. We are expanding image acquisition and will perform quantitative histology to validate and extend these observations, including capsule thickness, collagen proportionate area, and inflammatory cell density using automated segmentation with manual quality control. The six month dataset will benchmark local tissue response to the implanted weight shifting stimulator and identify metrics that correlate with favorable integration. These results will inform device design parameters, translational study planning, and modeling assumptions for pressure injury prevention. Findings will guide future preclinical and clinical evaluation.

Project Mentor: Dr. Kath M. Bogie, Department of Orthopaedics, School of Medicine, Case Western Reserve University; Dr. Fritz Petersen, Department of Biology, Case Western Reserve University

Page 261: Compact Orientation Sensing System for MRI Environments

Lucas Romero, Biomedical Engineering and Electrical Engineering; **Danil Mosley**, Electrical Engineering; **Savo Vidakovic**, Electrical Engineering

Magnetic resonance imaging (MRI) offers excellent soft-tissue contrast but provides limited real-time feedback during procedures. The inability to directly track tool orientation within the MRI environment restricts precision and efficiency in minimally invasive surgeries. This project aims to develop a compact, MRI-compatible orientation sensing system capable of determining the three-dimensional orientation of tools without interfering with any imaging processes. Accurate real-time tracking has the potential to enhance patient safety, reduce procedure time, and improve clinical outcomes by complementing existing MRI-based localization techniques. The proposed system utilizes three orthogonally arranged analog Hall-effect sensors to detect magnetic field components along each axis. Sensor outputs are amplified through low-noise instrumentation amplifiers and processed in order to compute real-time orientation data. All components are non-ferromagnetic and selected to comply with MRI safety and electromagnetic compatibility requirements. The final system will target a 3x3 cm PCB footprint, maintain continuous operation for at least four hours on a single charge, and achieve orientation accuracy within ±1 mm. Ongoing work focuses on PCB design, calibration under controlled magnetic conditions, and validation of the device's feasibility for reliable, low-cost orientation sensing in MRI-guided procedures.

Project Mentor: Dr. Cenk Cavusoglu, Department of Electrical, Computer, and Systems Engineering, Case Western Reserve University; Dr. Vira Chankong, Department of Electrical, Computer, and Systems Engineering, Case Western Reserve University

Page 262: SpartanSpend

Brianna Ross; Lalithya Gangula; Lakshmi Kunjan; Cormac Schliesmann, Computer Science

Due to per-semester costs, meal plans, and university-specific funds like CaseCash, college students are in a unique financial situation incompatible with many available budgeting tools. When combined with many students' inexperience with budgeting, this can make responsible spending difficult. Our project attempts to address this gap by creating an application that combines school and personal financial information with an AI helper to provide advice and helpful information. We created an application that would help students at CWRU budget better by integrating meal plan information, CaseCash, and personal funds into one financial tool with an AI helper. It will have a clear dashboard that displays important information and an AI prompt that is only accessible after a successful CWRU SSO login. Additionally, the software will be designed with security in mind so that students can use it without concern for their privacy.

Project Mentor: Dr. Shuai Xu, Department of Computer Science

Page 263: Hands Free Chess Board

Ryan Rovner, Mechanical Engineering

The purpose of this project is to create a physical game of chess that can be played without having the players have physical contact with pieces or the board itself. During COVID-19 one aspect of life was keeping separate due to health concerns, but having a physical game that can be played even with two players who are not together provides a unique experience compared to just focusing on a computer screen to play the game. The project is split into two main parts with a few sub sections in each main branch. The first section is the physical board, which includes the mechanisms used to move the pieces as well as alterations made to the game itself. The design aspect is further split into two main areas, the track system and piece grabber. The game alterations include increasing the size of the board to hold the mechanisms, electronics, and places for piece when not in play or when removed from the board and adding magnets to each piece. The second section is the computer elements of the project which include the electronics and coding of the board. These branches are less involved with subsections but cover the coding which will take a Matlab code and run inputs into motors that will actually control the mechanisms. The expected result by the end of this project is to have a fully functioning hands free chess board that can be played between two people. This project has a timeline of two semesters and is focused on the design aspects for this semester.

Project Mentor: Majid Rashidi, Department of Mechanical and Aerospace Engineering; Ya-Ting T. Liao, Department of Mechanical and Aerospace Engineering

Page 264: Design of a compliant robot arm

Adrián Ruiz Ibáñez, Mechanical Engineering

This project aims to design a compliant robot arm that departs from conventional multi-joint actuation by co-locating all motors at a single base position. The approach is motivated by human biomechanics: during arm movements, the shoulder and chest generate the dominant forces. Concentrating actuation at the base better reflects that mechanics, reduces the moving mass and inertia of the links, and lowers the likelihood of forced or constrained motions because most of the system's mass is not carried by the distal joints. The work is being developed for EMAE 398 and will continue in EMAE 399. We begin by selecting an appropriate motor arrangement and, for its worst-case loading scenario, computing the torque required to move the arm. These requirements inform the subsequent 3D CAD design of the upper arm and forearm. We then design and fabricate a compliant skin mold for the arm, integrating it with the structure to achieve the desired elasticity and safety in interaction. Finally, we conduct benchtop and functional tests to evaluate range of motion, backdrivability, and control responsiveness. By the end of this phase, we expect to deliver a functional compliant arm comprising the upper arm and forearm segments, establishing a foundation for continued development and refinement in EMAE 399.

Project Mentor: Zach Patterson, Department of Mechanical and Aerospace Engineering, Case Western Reserve University (CWRU); Ya-Ting Liao, Department of Mechanical and Aerospace Engineering, CWRU

Page 265: Dupilumab Non-Response Potentially Mediated by IL-4Rα Q576R Variant in Allergic Diseases: A Comprehensive Literature Review and Novel Therapeutic Proposal

Hana B. Ruran, Department of Chemistry

Over 20% of the U.S. suffers from type-2 allergic diseases, such as asthma and atopic dermatitis, occurring due to overproduction of cytokines interleukin-4 (IL-4) and interleukin-13 (IL-13). These cytokines bind to the receptor IL-4Rα, activating Janus kinase (JAK) enzymes, which activate transcription factor STAT6, causing inflammation from increased immunoglobin E and eosinophilic levels. Dupilumab is an antibody that binds extracellular IL-4Rα and blocks the STAT6 pathway, improving type-2 allergic conditions in many patients. However, some patients are non-responsive to dupilumab. The IL-4Rα-Q576R polymorphism activates the mitogenactivated protein kinase (MAPK), eliciting another inflammatory pathway, in addition to STAT6. This dual-pathway activation leads to more severe symptoms and potentially reduced response to dupilumab. This review explores the mechanism of how IL-4Rα-Q576R may lead to dupilumab non-response and proposes a novel therapeutic strategy based on a relevant medicinal chemistry. A literature review of PubMed (2000-2025) was conducted, focusing on 1) the structure and function of IL-4Rα, 2) the mechanism of dupilumab, 3) the IL-4Rα-Q576R polymorphism and disease severity, 4) dupilumab non-responsiveness mechanisms, and 5) medicinal chemistry strategies used to treat relevant cytokine receptor-related diseases. The literature shows that patients with the Q576R variant have an additional inflammatory pathway involving MAPK activation post IL-4/IL-13 receptor binding. Therefore, dupilumab's sole inhibition of STAT6 may not fully control symptoms. In cancer and immunology, small molecule inhibitors can be used to target intracellular proteins that are unable to be targeted by antibodies. In the STAT6 pathway, JAK inhibitors bind intracellularly to block all inflammatory cytokines, not just IL4/IL-13, which helps some dupilumab non-responsive patients. However, this does not address the MAPK pathway specific to Q567R patients. In cancer, MEK inhibitors stop the MAPK pathway to suppress tumor growth. MEK inhibitors paired with dupilumab may suppress both pathways and potentially improve outcomes in Q576R patients.

Project Mentor: Dr. Rekha Srinivasan, Department of Chemistry

Page 266: Subtype-Specific Axonal Regeneration in Dorsal Root Ganglion Sensory Neurons Following Conditioning Lesion

Dur-E-Nayab Sadruddin, BS Neuroscience

Peripheral nerve regeneration varies among dorsal root ganglion (DRG) sensory neuron subtypes. A recent study showed that while $TrkC^+$ and $MrgD^+$ neurons exhibit robust regeneration after a conditioning lesion (CL), $CGRP^+$ nociceptors do not. The mechanisms underlying this heterogeneity remain unclear. This project investigates regeneration within non-$CGRP^+$ populations, focusing on somatostatin-positive (SST^+) neurons, which are associated with itch sensation, and parvalbumin-positive (PV^+) neurons, which contribute to proprioception. Using dissociated cultures from lumbar DRGs collected seven days after a unilateral sciatic nerve transection, neurite outgrowth was quantified as a measure of regenerative capacity. Neurons were classified into four subtypes according to somatostatin and parvalbumin expression, as determined by immunocytochemistry: SST^+, PV^+, PV^+SST^+, and PV^-SST^-. To ensure that only axotomized neurons projecting into the sciatic nerve were evaluated, True Blue retrograde labeling was used to confirm their connection to the injured nerve. The length of the longest neurite for each neuron was quantified, and statistical analyses are underway to compare regenerative growth among the four subtypes. These analyses will clarify whether specific combinations of SST and PV expression correspond to distinct regenerative profiles following a conditioning lesion. By identifying subtype-specific differences in regenerative potential, this work enhances understanding of sensory neuron diversity and may inform strategies to improve functional recovery following peripheral nerve injury.

Project Mentor: Dr. Richard Zigmond, Department of Neurosciences, Case Western Reserve University; Dr. Jon Niemi, Department of Neurosciences, Case Western Reserve University

Page 267: A Safer and More Inclusive Phototherapy Device for Treatment of T-Cell Lymphoma

Irene Bhunia, Biomedical Engineering and Electrical Engineering; **Hannah Driscoll**, Biomedical Engineering and Electrical Engineering; **Lucas Romero**, Biomedical Engineering and Electrical Engineering; **Melis Sahin**, Biomedical Engineering and Electrical Engineering; **Jerry Yang**, Biomedical Engineering and Electrical Engineering

Cutaneous T-cell lymphoma (CTCL) is a slow-progressing skin cancer that presents with patches, plaques, and/or tumors in the mycosis fungoides CTCL subtype. CTCL significantly affects patients' quality of life due to discomfort from itchy lesions and undermined self-confidence from visible symptoms. Phototherapy with various wavelengths of light (e.g., narrow-band ultraviolet B (UVB)) is a common treatment for early stages of the disease, as exposure to UV light is shown to trigger apoptosis in cancerous cells. Current phototherapy solutions require frequent clinical visits; at-home alternatives have difficulties ensuring patient safety and treatment efficacy, often requiring extensive training due to risks of unintentional overexposure to UV light. This work aims to develop a wireless, hand-held phototherapy device for at-home use that limits UV exposure and accommodates patients of various skin colors. The device contains an LED array with comparable electrical characteristics (e.g., current draw, voltage drop) to a UVB LED. A microcontroller with a light intensity-adjusting algorithm varies light penetration depending on skin color. Skin color and ambient light conditions are determined using reflectance from a light sensor. The device has modular “cone” attachments that limit the area of exposure and shield the user’s eyes. Additionally, a liquid-crystal display, buttons, and haptic feedback allow for intuitive user control of treatment settings. These components will fit into a 3D-printed case resembling a barcode scanner. Individual functionality of these systems was validated through a multi-stage testing process, focusing on component integration, establishing power requirements, and safety. Early tests established the LED array functionality and individual electronic functions and requirements. Later validation focuses on the application and design of an Adjustable Cone, as well as the device housing. Future work will aim to integrate these components into a final prototype device and implement programmable light delivery features to incorporate clinician feedback.

Project Mentor: Dr. Matthew Williams, Department of Biomedical Engineering Capstone Instructor: Dr. Matthew Williams, Department of Biomedical Engineering

Page 268: NASA Propagation System Design

Melis Sahin, Electrical Engineering; **Grace Ansburg**, Electrical Engineering; **Hannah Driscoll**, Electrical Engineering

A unique piece of geography between NASA-Glenn and CWRU creates an atmospheric environment where the integrated air density across the river valley is approximately 80% of that typically expected in satellite communication conditions. This provides a rare opportunity to simulate satellite communication links terrestrially, using a radio system set up between the Glennan building rooftop and the Hopkins Airport control tower. Building on prior senior design project efforts, which developed methods for calculating bit error rates and a preliminary prototype of this system, the current project focuses on the transmit-receive protocol. Key objectives include enhancing the web-based interface for transmission control and data visualization, improving data collection and storage pipelines, refining the radio control and display systems, and implementing the real-time bitstream error analysis. To enable reliable operation outside of a controlled environment, the project will be upgrading the antenna hardware and computational resources on both the transmit and receive sides. Additionally, a customizable data encryption and modulation protocol is being developed to allow dynamic testing of parameters such as transmission power, frequency, and modulation schemes. The project culminates in a system capable of real-time comparison of the bitstreams, providing an advanced platform for the characterization of the communication performance.

Project Mentor: Vira Chankong, Electrical, Computer and Systems Engineering, Case School of Engineering; John Gibbons, Electrical, Computer and Systems Engineering

Page 269: SafeCath: An At-Home System for Bladder Pressure-Volume Monitoring

Melis Sahin, Department of Electrical, Computer, and Systems Engineering, Case Western Reserve University, Cleveland, OH, USA; Elias Hinson, Hui Zhu, Margot S. Damaser and Steve J.A. Majerus, Department of Biomedical Engineering, Case Western Reserve University, Louis Stokes Cleveland VA Medical Center, Lerner Research Institute, Cleveland Clinic, Cleveland, OH, USA

Neurogenic bladder, prevalent among spinal cord injury (SCI) patients, can lead to high bladder storage pressure, which increases the risk of severe complications. Risk management for these patients includes catheterization and annual Urodynamic Studies (UDS), which are invasive, costly, and logistically challenging, limiting the accessibility of routine monitoring. We are developing a simpler approach to this risk monitoring called SafeCath. The SafeCath system offers an at-home alternative that estimates bladder pressures by analyzing drainage dynamics during intermittent catheterization to screen for high bladder pressures. SafeCath consists of a high-flow pressure sensor, a solenoid locking valve to isolate bladder pressure, a strain gauge to monitor urine volume, and a microcontroller to automate data collection. A phantom bladder testing system was developed to evaluate the accuracy and clinical relevance of the system's performance in a benchtop setting. The setup simulates bladder dynamics through a controlled water chamber and abdominal pressure artifacts using a pressure generator. Controlled drainage tests were performed with and without artifact generation to determine whether both phases have comparable pressure-volume (PV) curves, and to verify SafeCath's functional capacity. Pressure and volume sensing accuracy were confirmed using a Bland-Altman analysis. Pressures were measured with a mean bias of -0.15 cmH2O +/- 0.65 cmH2O over a 0-100 cmH2O range. Volume was measured with a mean bias of 0.24 mL +/- 2.5 mL over a 0-500 mL range. Trials with abdominal artifacts confirmed SafeCath's reliability in maintaining consistent PV profiles, which support the system's potential as a simplified screening tool. SafeCath reliably estimates bladder pressure and volume while draining in the presence of generated abdominal artifacts. Ongoing clinical studies aim to validate drainage data against traditional filling UDS. Future work involves enhancing anatomical representation of the phantom bladder compliance and developing non-contact pressure sensing and locking mechanisms for at-home use.

Project Mentor: Steve Majerus, Electrical, Computer and Systems Engineering

Page 270: p300 Mutations in Colorectal Cancer

Jovanna Saimi, Zoe Lawler, Tohfa Kabir, Charlotte Connamacher, Leah Gates, Department of Biochemistry, Case Western Reserve University, Cleveland, OH, 44106

To efficiently store the massive amount of genetic material in a living organism, DNA is tightly packed into a dynamic structure called chromatin, where DNA wraps around histone proteins. Histone tails are decorated with post-translational modifications (PTMs), which are added by histone writers, such as acyltransferases like p300. These acyl group PTMs, such as acetylation, butyrylation, and crotonylation, affect the accessibility of chromatin and gene expression. Point mutations in the p300 acetyltransferase domain appear in many kinds of cancers, including colorectal cancer (CRC). In CRC, changes to histone PTMs and chromatin modifying enzymes are associated with tumorigenesis and cancer progression. It is not yet understood how these mutations in p300, such as I1395G and D1399N, alter p300 function in cancer. We hypothesize that the point mutations in p300 change its acyl-CoA substrate preference, which in turn alters the acylations deposited on histones and modifies chromatin accessibility. To study these mutations, we transiently transfected the different mutant acetyltransferase domains on top of wild type-expressing HEK293T cells and analyzed different histone PTMs. By immunoblot, the I1395G mutant simultaneously displays increased butyrylation and decreased acetylation on H3K27, as well as increased H3K18 crotonylation, when compared to wild type transfected cells. In contrast, the D1399N mutant showed no change in H3K27ac and H3K18cr, while H3K27bu was slightly decreased. Currently, we are developing cells with ablated p300 to repeat these experiments in both HEK293T and colon cancer cells such as HT29. We will additionally perform functional assays, such as colony formation, to observe phenotypic advantages conveyed by p300 mutants in the ablated p300 cells. Further research is necessary to continue to uncover the distinct roles of these point mutants on p300 activity and how these alterations to the chromatin landscape in the form of different PTMs contributes to colorectal cancer development and progression.

Project Mentor: Dr. Leah Gates, Department of Biochemistry, CWRU

Page 271: Hexacopter to X8 Drone Conversion

Danyal Sainz-Gootenberg, Mechanical Engineering

This project converts the existing VTOL CWRU firefighting hexacopter into an X8-configuration unmanned aerial vehicle (UAV) to enhance thrust, redundancy, and modularity while maintaining comparable flight endurance. Conventional six-motor hexacopters provide high payload capacity and stability but suffer from structural complexity and limited efficiency gains when scaled. The X8 layout with its coaxially mounting pairs of counter-rotating motors on four arms, offers improved yaw control and fault tolerance, a reduced arm span for payload mounting, and simplified maintenance and assembly. The research objective is to quantify the performance trade-offs between the legacy hexacopter and the new X8 system through controlled design, fabrication, and flight-test analysis. The design process included CAD modeling, finite-element and modal analyses to validate structural integrity and minimize vibration between coaxial propeller pairs. Components such as 7075-aluminum motor mounts were manufactured in the university's fabrication lab using waterjet cutting, milling, and 3-D printing. Electrical and control systems were re-integrated using the ArduPilot platform to enable autonomous flight data collection. The project also serves to document and streamline the manufacturing process with standard work for design, fabrication, inspection, assembly, and testing. Experimental testing compares endurance, maximum take-off weight, and stability under simulated mission profiles. The expected outcome is a validated modular X8 airframe and an updated standard-work document for future student teams to reproduce or modify the platform. Broader impacts include improved UAV resilience for emergency payload delivery and a foundation and physical platform for subsequent interdisciplinary research in autonomous aerial systems at CWRU.

Faculty Mentor: Prof. Sunniva Collins, Department of Mechanical and Aerospace Engineering, CWRU; Ya-Ting Liao, Mechanical and Aerospace Engineering, Case School of Engineering

Page 272: Data-Driven Kinematic Error Analysis Package in Advanced Manufacturing

Santiago Salazar Garza, Department of Chemical Engineering; Hein Htet Aung and Laura Bruckman, Department of Materials Science & Engineering Materials Data Science for Stockpile Stewardship: Center of Excellence, Case Western Reserve University

Direct Ink Writing (DIW) is an extrusion-based advanced manufacturing (AM) technique used to fabricate complex 3D structures. Its versatility and compatibility with a wide range of materials—including polymers, metals, and ceramics—make it suitable for numerous applications. However, like other AM methods, DIW has not yet achieved widespread industrial adoption due to persistent printing process errors that impact part quality and reproducibility. One key limitation is kinematic errors—deviations between intended and actual motion—that compromise the desired properties and the repeatability of the printing process. In this work, we analyze DIW kinematic error behavior and ultimately present a generalized error analysis package applicable to other AM kinematic technologies. Using DIW as a case study, we developed a kinematic error analysis package that integrates multiple data-driven techniques. We established correlations between data-centric observations and domain knowledge by integrating density-based spatial clustering (DBSCAN) with temporal (phase) clustering on the time series data. By applying dynamic time warping (DTW), we were able to quantify error variance across different print time series. We applied frequency-domain analysis using the Fourier Transform, which further revealed consistent error patterns in position, velocity, and acceleration. By generalizing this workflow into a reusable package, we aim to provide comprehensive kinematic error analysis across advanced manufacturing processes.

Project Mentor: Hein Htet Aung, Department of Materials Science and Engineering; Laura Bruckman, Department of Materials Science and Engineering

Page 273: Sleep Behaviors and Cognition: How does self-perception theory play a role in sleep deprivation?

Suman Sanghera, Cognitive Science

Sleep is an essential yet frequently neglected biological process necessary for cognitive, emotional, and physical health. Despite general awareness of the importance of sufficient sleep, chronic sleep deprivation remains prevalent, especially in undergraduate students. This capstone project explores the relationship between self-perception theory and sleep deprivation and attempts to provide insight on why undergraduate students engage in sleep deprivation behaviors in spite of knowing its detrimental effects. Self-perception theory refers to the idea that people infer their own internal states, beliefs, or attitudes by observing their own behaviors. This framework suggests that individuals may rationalize sleep deprivation through inferences drawn from their individual experiences around sleep, potentially reinforcing maladaptive patterns of sleep deprivation. To better understand this connection, two surveys were conducted in a population of undergraduate students in a COGS 101 course. The survey questions were identical but the order was different, with one survey presenting evidence-based sleep health information before asking for self-reported sleep behavioral questions while the other survey presented this evidence after asking the behavioral questions. Taking into account inoculation theory which refers to resistance to persuasion, we hypothesized that participants exposed to conflicting health information before self-assessment would demonstrate stronger defenses of their existing sleep behavior. Addressing self-perception theory, we also hypothesized that students self-reporting sleep deprivation behaviors would justify it by suggesting that they function normally on little sleep, attributing their own behavior to a belief they inferred about themself. Integrating both self-perception theory and inoculation theory, this capstone project provides insights on the persistence of sleep deprivation, potentially contributing to new methods for addressing and reducing the prevalence of sleep deprivation.

Project Mentor: Fey Parrill, Department of Cognitive Science

Page 274: The emergence of AI Psychosis in a World of Rapid Technological Progress

Gabrielle Santiago, Cognitive Science

The rapid progression of artificial intelligence (AI) has introduced major changes in human interaction with technology, more specifically through large language models (LLM). The transition from scripted dialogue systems based on pattern recognition to the ability to generate threads of text itself has shifted users' perception of the technology entirely. This paper aims to explore and consolidate the information that we have relating to this new phenomenon of "AI psychosis"-- a term used to describe the development of psychotic symptoms in adults after continuous interaction with chatbots. Regular psychosis is understood to be correlated with the misattribution of salience to neutral stimuli, due to abnormal dopamine regulation. AI amplifies this effect, as its responses to inputs are wildly sycophantic, thus reinforcing delusional ideas that its users share with it. Users assign human-like qualities to this AI chatbot due to the natural tendency towards anthropomorphism, making them even more inclined to believe the chatbot's responses. Their perception of the chatbot as a sentient and empathic being gives way for dangerous emotional reliance and makes it appear dangerously trustworthy. Even with the novelty of the program, there are many cases in which AI psychosis has been detrimental, and even lethal. This paper provides future steps to take to prevent further incidents– whether that be legally or psychologically. AI psychosis rests in the crux of cognitive science's overlap with technology, and these developments in artificial intelligence will only deepen the connection between the two.

Project Mentor: Vera Tobin, Department of Cognitive Science

Page 275: Mapping Immigration Patterns and Economic Outcomes in the United States

Gustavo Saraiva, Department of Computer Science/Data Science; **Jackson Dong**, Department of Computer Science/Data Science; **Harish Rajagopalan**, Department of Computer Science/Data Science; Case Western Reserve University

This project examines how immigration patterns in the United States have evolved over the past six decades and how demographic shifts intersect with key economic outcomes such as education and income. Using data from the Integrated Public Use Microdata Series (IPUMS), which compiles Census and American Community Survey microdata from 1960 to 2020, this study investigates the composition of foreign-born populations, their geographic distribution across states, and their socioeconomic integration over time. The analysis situates immigration within broader economic and policy contexts, exploring how structural changes in the U.S. economy have influenced the distribution and characteristics of immigrant populations. Methodologically, the project employs Exploratory Data Analysis (EDA) techniques using R, combining visualizations to uncover temporal and spatial trends. Preliminary findings reveal significant diversification of immigrant origins, rising educational attainment among foreign-born individuals, and persistent regional disparities in income and industry participation.

Project Mentor: Dr. David Clingingsmith, Department of Economics, Case Western Reserve University

Page 276: Anxious Learning: How State vs. Trait Anxiety Alters Matching vs. Maximizing Behavior

Anna Sarfalvi, Psychology & Economics B.A. ; Master of Supply Chain Management

Probability matching is the tendency to distribute choices in proportion to reward probabilities. This behavior often emerges in explore-exploit tasks despite its departure from immediate payoff maximization. This proposal is designed to synthesize prior literature to motivate an experimental design that tests whether experimentally induced state anxiety shifts people's preference away from probability matching towards economic utility maximization in a volatile, multi-trial setting. A moderation-mediation framework will be specified in which state intolerance to uncertainty (IU) will be evaluated as mediators of the shift from probability matching towards maximization. In addition, trait IU will be included as an exploratory moderator to disentangle dispositional sensitivity from induced changes. The plan design is structured to assess matching vs. maximization and learning dynamics across several intervals with changing reward contingencies. I predict that induced anxiety will increase exploitation and reduce proportional sampling, with indirect effects via elevated IU. Given that it has been proposed that exploration-explotation trade-offs have likely shaped human decision-making, clarifying when and how anxiety alters these trade-offs can shed light on the underlying mechanisms of choice under uncertainty, and thus inform targeted interventions to improve learning, and clinical or financial decision-making in volatile environments.

Project Mentor: Heath Demaree, Department of Psychological Sciences

Page 277: Molecular Analysis of 3’ Untranslated Region Isoforms in NF1 mRNA

Vedhan Sarvesh, Biology

Neurofibromatosis Type 1 (NF1) is a common autosomal dominant disorder characterized by neurofibromas, cognitive impairments, and skeletal abnormalities. NF1 patients inherit a mutant *NF1* allele, leading to haploinsufficiency: a condition where less than the normal amount of neurofibromin, a tumor suppressor protein, is produced due to the lost allele. Haploinsufficiency of *NF1* has been explored to a much lesser extent than the hallmark of the disease: neuronal tumorigenesis. Reduced expression of neurofibromin contributes to various non-tumor-related symptoms, which remain poorly addressed by current treatments. The Lou lab is taking an RNA-based approach to increasing neurofibromin expression. The 3’ untranslated region (UTR) of mRNA is often rich in regulatory elements, such as RNA-binding protein motifs and microRNA-interacting sites, that play key roles in mRNA stability and translational efficiency. One regulatory mechanism of interest in the 3’UTR is alternative polyadenylation site selection of either the proximal or distal polyA sites of the *NF1* mRNA, which give rise to isoforms of varying 3’ UTR length that have differential presence of regulatory motifs. I hypothesize that a shorter 3’UTR, as seen with the proximal poly-A isoform, will contain fewer destabilizing regulatory elements than the distal isoform and will thus be expressed at a higher rate. In the present project, I will clone the 3’ UTRs from both the distal and proximal isoforms behind a luciferase reporter to measure the effects on protein output as measured by luciferase activity in order to evaluate the effects of each isoform’s 3’ UTR on stability and translational efficiency.

Faculty Mentor: Dr. Hua Lou, Department of Genetics and Genome Sciences; Ronald Oldfield, Department of Biology, College of Arts and Sciences

Page 278: The role of hydrogen peroxide and L-lactate in streptococcal fitness in coculture with Aggregatibacter actinomycetemcomitans

Hana Sato, Biochemistry and Political Science; Grace Heine, Department of Molecular Biology and Microbiology; Dr. Gina Lewin, Center for Global Health and Diseases and Department of Pathology.

Bacterial interactions in the oral cavity impact gum disease onset and progression. Streptococcus, the most abundant and diverse genus in the oral cavity, engages in metabolite-mediated interactions with other microbes, such as Aggregatibacter actinomycetemcomitans (Aa), a pathogen responsible for periodontitis. We previously observed that streptococcal fitness generally increases when cocultured in biofilms with Aa, but the extent of this effect varies across diverse species, and the mechanisms driving these changes are unknown. We hypothesized that accumulation of streptococcal metabolites decreases its own fitness in monoculture—hydrogen peroxide (H2O2) through its antimicrobial properties and L-lactate via acidification of the environment—but that coculture with Aa mitigates these effects through production of catalase and consumption of lactic acid. To test this, we modified our culture environment to alter the impact of H2O2 and pH. First, to alter H2O2 levels, we supplemented the chemically defined media (CDM) with catalase, and we assessed the change in fitness by quantifying colony forming units after 23h growth. Of the six streptococci tested, we found that four strains exhibited increased fitness in catalase-supplemented CDM compared to standard CDM, whereas two strains that did not possess the gene for H2O2 production showed no change. Second, we investigated the role of L-lactate by removing the buffering agent from CDM. Three strains had an approximately one-fold increase in growth when cultured in buffered CDM compared to non-buffered CDM, supporting our hypothesis. Thus far, our results show that H2O2 and L-lactate impact streptococcal fitness but with varying degrees across strains, and other mechanisms are likely also at play. Next, we will quantify metabolite production across strains and test the fitness of metabolic mutants. This project is significant in uncovering the interaction mechanisms between diverse streptococci and Aa, which helps advance our knowledge of periodontitis.

Project Mentor: Dr. Gina Lewin, Center for Global Health and Diseases and Department of Pathology

Page 279: Photochemical Reactivity of DNA and RNA under Ultraviolet Irradiation

Arjun Saulnier, Chemistry; Tazrin Islam Tonny, Department of Chemistry; Dr. Carlos E. Crespo-Hernández, Department of Chemistry

Exposure to ultraviolet radiation (UVR) contributes to premature aging, oxidative cellular damage, and carcinogenesis through direct damage to DNA and RNA. While the products of these reactions have been characterized, the quantification of DNA and RNA damage from UVR remain poorly documented. This knowledge gap can be rectified by determining their photolysis quantum yield (QY), defined as the number of photodamage events per photon absorbed. This serves as a direct measure of reactivity and enables more accurate modeling of UVR-induced molecular damage. In this study, the canonical DNA and RNA nucleotides (AMP, CMP, GMP, TMP, UMP) were irradiated in phosphate buffer (pH 7.4) using a low intensity 267 nm laser. The flux of the laser was calibrated by actinometry using 1,3-dimethyluracil as a standard. QYs were calculated from the decrease in nucleotide concentration (measured using a spectrophotometer) with irradiation time. The measured quantum yields ranged on the orders of 10^{-2} to 10^{-3}. GMP has the highest photostability, with a quantum yield of $(1.2 \pm 0.1) \times 10^{-3}$ while UMP is the least photostable with a quantum yield more than ten times higher, at $(1.4 \pm 0.1) \times 10^{-2}$. Our results demonstrate that the purine nucleotides are less reactive to UVR than the pyrimidine nucleotides in DNA and RNA and provide key parameters in understanding photodamage from UVR in nucleic acids.

Faculty Mentor: Dr. Carlos E. Crespo-Hernández, Department of Chemistry

Page 280: Pathways to Products: Biosynthetic Gene Clusters and Analytical Methods to Isolate and Characterize New Cyanopeptides

Mary-Candler Schantz, Department of Chemistry; Aaditi Chopade, Department of Chemistry; and Dr. Matthew J. Bertin, Department of Chemistry, CWRU

Cyanobacteria have evolved over time to produce a multitude of specialized metabolites, many with intriguing applications to therapeutic development and biotechnology. These metabolites have been isolated from strains of cyanobacteria all over the world, and some of these novel molecules like Dolostatin 10 have been used in drug discovery (in the anti-body drug conjugate brentuximab vedotin) and other important applications. The Floridanema genus was recently discovered in the Florida Everglades, a place of interest for the discovery of novel cyanobacteria. The Floridanema species FLCC-F50 and FLCC-F46 were probed for certain biosynthetic gene clusters that represented the formation of cyanopeptides. These samples were then analyzed for potential unique molecules via LC-MS and isolated with HPLC-DAD. A cyanopeptide of interest was identified through analysis of the biosynthetic gene clusters and LC-MS data. Analysis of the loading domain of the biosynthetic gene cluster suggests that the starting unit for the macrocycle portion of the molecule was an unusual leucic acid derivative. The peptide was characterized using 1-D and 2-D NMR methods. The newly characterized tychonamide analogue will be tested for enzyme inhibition to probe for applications in medicinal chemistry. In addition, this particular tychonamide analogue was shown to be part of a larger group of cyclic cyanopeptides produced by a variety of cyanobacteria. The partial 16S rDNA gene sequences of the members of the Floridanema genus and other publicly available gene sequences have allowed for a re-analysis of potential peptide macrocycle producers to look for taxonomic harmony. It may be that previous producers of these molecules were misclassified due to limitations on the molecular biology tools at the time of discovery. The workflow used in the project suggests that a pathways to products approach holds utility for finding novel chemistry and new therapeutic leads.

Project Mentor: Dr. Matthew Bertin, Department of Chemistry

Page 281: Revealing Anatomical Variation in the Human Neck to Inform Neuromodulation

Sophie Scherer, [1] Noa B. Nuzov, [2] Brandon Brunsman, [1] Andrew J. Shoffstall, [2,3] Andrew R. Crofton [1,3]

1Department of Anatomy, Case Western Reserve University
2Department of Biomedical Engineering, Case Western Reserve University
3Department of Pathology and Cell Biology, University of South Florida

Vagus Nerve Stimulation (VNS) and Carotid Sinus Nerve Stimulation (CSNS) are therapeutic treatments for conditions such as epilepsy, depression, and cardiovascular disorders. However, both therapies suffer from side effects due to stimulation of adjacent off-target nerves, and routine surgeries in the neck area can cause tissue and nerve damage. The vagus nerve sits inside the carotid sheath, and the carotid sinus nerve targets the carotid sinus located at the bifurcation of the carotid arteries. Therefore, they are both in the area of the neck with a high density of other nerves and tissues. Understanding of the spatial relationships between these structures may provide insight into why certain adverse effects occur and how electrode placement could be altered to minimize them. Using an optical 3D tracing technique across 57 dissected human cadavers, we traced the pathways of the nerves in the neck and collected the coordinates of the carotid bifurcation and other landmarks. We will examine the 3D distances between the nerves and key landmarks to determine trends in their anatomical locations. The goal of this project is to analyze anatomical variation in the location of the carotid bifurcation within the neck, while accounting for neck length, to minimize damage during surgery to place CSNS devices. Additionally, the distances between key structures in the cervical region, including the carotid bifurcation, vagus, glossopharyngeal, hypoglossal, and spinal accessory nerves, will be used to inform ideal locations for stimulators that are far from off-target structures.

Project Mentor: Andrew Crofton, Department of Anatomy

Page 282: Quantifying Tissue Organization as a Biomechanical Marker of Atrial Fibrillation

Ellie Schneider, Department of Biomedical Engineering

Atrial fibrillation (AF) is a prevalent arrhythmia characterized by irregular electrical conduction within the atria, often linked to structural remodeling such as fibrosis. Areas of low electrical signal strength, known as low-voltage zones (LVZ), are associated with fibrotic remodeling and disrupted myocardial architecture. While fibrosis percentage and tissue thickness have been quantified in histological studies, tissue orientation remains a less explored metric that may provide new insights into atrial remodeling. Tissue orientation describes how fibers align or deviate within the myocardium. Fiber orientation affects tissue anisotropy, which influences how electrical and mechanical signals propagate through atrial walls. Disorganization of fiber alignment can therefore reflect underlying microstructural instability that contributes to a conduction block in AF. This project aims to investigate tissue organization in Masson's trichrome-stained atrial tissue. To address this, a computational image analysis pipeline is being developed to streamline orientation quantification. High-resolution TIFF images are processed in MATLAB, where grayscale conversion, Gaussian filtering, and Fourier transform-based analysis are applied to generate power spectra reflecting tissue alignment. Ellipse fitting around the FFT power distribution is used to calculate an orientation index (ratio of minor to major axis), serving as a quantitative measure of fiber organization. This approach enables a semi-automated extraction of structural features without extensive manual segmentation. We expect to observe more disorganized tissue orientation (lower orientation index) in AF and LVZ tissue compared to healthy tissue, reflecting microstructural disruption that parallels electrical remodeling. This pipeline seeks to bridge microstructural and functional remodeling in AF and has the potential to support future biomechanical modeling.

Project Mentors: Dr. Andrew Rollins, PhD, Michael Douglass PhD candidate, Department of Biomedical Engineering

Page 283: Sports Analytics Software

William Schneider, Computer Science; **Anna Harris,** Computer Science; **Quan Le,** Computer Science; **Long Nguyen,** Computer Science; **Lan Khanh Khuat,** Computer Science; **Jessie Tran,** Computer Science

Over the past few decades, the sports industry has begun to heavily rely on data analytics to enhance player performance and design competitive strategies. Following this trend, several sports analytics platforms like Catapult and Hudl have been created to satisfy the industry's needs. However, these enterprise companies present significant monetary barriers that block many users from accessing their product. Our Sports Analytics Software addresses these users' concerns by providing an accessible, AI-powered platform that delivers sports analytics for teams, ranging from the collegiate level to professional NBA courts. Our application features three core functionalities. First, users can query our platform using natural language, asking questions like "How is Lebron doing this season?" This allows users to find analytical trends without requiring technical expertise. Second, the platform provides flexible data management. This functionality ensures that users can create and manage player profiles, maintain relational information, and compute performance statistics without negatively impacting statistical trends. Third, we have designed an integrated analytics dashboard that visualizes statistical trends. Through these capabilities, we have designed software that allows coaches, analysts, and team management to focus on strategic insights without worrying about technical overhead. Our application provides an intuitive, cost-effective alternative to sports analysis while maintaining the analytical depth required for competitive sports environments.

Project Mentor: Shuai Xu, Computer and Data Sciences

Page 284: The Interaction of Adoptive Environment and Genetic Vulnerability: Understanding Substance Use Risk in Adoptees

Jillian Seaman, Major: Psychology, Department of Psychological Sciences

Substance use disorders (SUDs) represent a major public health concern in the United States, affecting millions of individuals and their families each year. Adoptees are at heightened risk for a range of psychopathologies and adjustment difficulties compared with their nonadopted peers, making them an important population for understanding substance use vulnerability. They also provide a unique opportunity for examining the etiology of SUDs, as they experience both inherited genetic risks and distinct postnatal rearing environments. Adoption studies are therefore well suited to disentangle genetic and environmental influences and explore how these factors shape substance use outcomes. Guided by theoretical models of gene-environment interplay, individual sensitivity, and parenting dimensions, this review synthesizes empirical findings examining how adoptive parenting and family environments interact with genetic predispositions to influence substance use risk. Examination of the literature suggests that both genetic and environmental factors contribute to substance use risk among adoptees, with genetic liability often serving as a primary pathway. High-quality adoptive parenting, particularly warmth and relational closeness, can buffer against this risk, although environmental effects are context-dependent and may interact with genetic predispositions in complex ways. Findings highlight the importance of considering gene-environment interplay, showing that the expression of inherited vulnerabilities is shaped by the quality of the rearing environment.

Project Mentor: Heath Demaree, Psychological Sciences

Page 285: Climate change and agricultural productivity

Ismail Seddon, Economics; **Nikhil Jindal,** Computer Science; **Cooper Zeh,** Mathematics

This study investigates the impact of climate change, specifically climate volatility, on agricultural productivity and farmer adaptation strategies across various regions. The primary research question is whether climate volatility diminishes crop yields and whether farmers in certain regions adapt more effectively. This research is significant for global food security planning, as understanding these dynamics can inform strategies to mitigate the adverse effects of climate change on agriculture. The scholarly context for this research includes the growing body of literature examining the interactions between climate change and agriculture, with a focus on the variability of climate conditions and their impact on crop yields. Methodologically, the study utilizes a multi-modal dataset that spans over 30 years (1990-2024) to capture long-term climate trends and their effects on agricultural productivity. The data, sourced from repositories such as "CropNet" and "The global dataset of historical yields for major crops 1981–2016," includes county or regionallevel agricultural data. The expected results suggest that climate volatility does indeed reduce agricultural productivity, but the extent of this impact varies by region. The findings will provide valuable insights for policymakers and stakeholders involved in global food security planning, highlighting the need for targeted support to enhance adaptive capacities in vulnerable regions

Project mentor: Dr Clingingsmith, Economics

Page 286: Designs of Experiment for Optimizing Aerosol Jet Printing

Aidan D. Selkirk, Mechanical and Aerospace Engineering; Aarush Agarwal, Materials Science and Engineering; Tara Kodukula, Biomedical Engineering; Caroline Kromalic, Materials Science and Engineering; Daniel Rakowsky, Biomedical Engineering; Sylvie Crowell, Materials Science and Engineering; Janet L. Gbur, Materials Science and Engineering

Bayesian optimization and Taguchi methods are designs of experiment for optimizing process parameters. Taguchi methods test multiple levels of process parameters in one batch. Bayesian optimization is an iterative process in which outputs of each iteration are analyzed by a surrogate model to determine new test points. Aerosol jet printing (AJP) is an additive manufacturing process used to fabricate flexible electronics. Both designs of experiments can be used to optimize AJP, but there is a lack of published data determining which design of experiment is more appropriate for AJP. In this study, Bayesian optimization was used to optimize the process parameters of AJP. Those parameters include gas flows, atomizer voltage, stage speed, and platen temperature. Prints were compared based on conductance and conformity to design, which indicates print functionality. The Bayesian approach utilized one input parameter set to create three iterations with five parameter sets each. Prints were fabricated on polyimide film using a diluted silver nanoparticle ink then thermally cured. Prints were imaged using an optical microscope under identical lighting conditions. Each image was analyzed using a custom MATLAB script which applied a color mask to separate the print from the substrate, and calculated values of rectangularity, line edge roughness, average trace width, overspray density, and average overspray distance. These measurements were standardized and weighted to calculate a value of Visual Conformity Grade (VCG) indicating print conformity to design. Electrical resistance was measured using a four-point probe method to calculate the conductance across the prints. The VCG, conductance, and trace width were compared across all parameters sets to determine the optimal process parameters. The aforementioned characterization results were combined with time and material considerations to compare the Bayesian optimization study to a previously conducted Taguchi orthogonal array to determine the optimal design of experiment for aerosol jet printing.

Project Mentor: Dr. Janet L. Gbur, Materials Science and Engineering

Page 287: What Works Best? Identifying Key Components of a Culinary Medicine Intervention for 8-14 Year Old Youth with Type 1 Diabetes

Juliet Seng, Biology Major

Culinary medicine is a growing field that combines nutrition science, cooking skill, and behavioral health to improve diet quality and disease management. While this model has been successful in adults with T2DM, its application to youth with T1DM is very limited. The Diabetes Inspired Culinary Education (DICE) program uses the culinary medicine model to address the unique needs of families managing Type 1 diabetes. DICE combines hands-on cooking sessions, family-based nutrition education, group discussions, and meal-planning activities to promote healthier food choices and strengthen diabetes self-management skills among children and caregivers. The DICE intervention was evaluated in a 2 year wait list randomized control trial. This sub-study presents qualitative data from caregiver and child focus groups conducted with cohort 2 intervention families. Thematic analysis of focus group transcripts were used to identify core themes related to program impact and family experience. 5 common themes emerged- 4 highlighting positive aspects of programming (increased confidence and skill in cooking, family connection, health behavior change with nutritional awareness, and emotional support from peer connections), and 1 highlighting a challenging aspect of the programming (accessibility with time constraints). These themes show the positive impact the DICE program had on both child and caregiver participants while simultaneously giving insight on logistical modifications that could further enhance its benefits.

Project Mentors: Dr. Catherine McManus, Department of Nutrition, PI Dr. Stephen Haynesworth, Department of Biology

Page 288: A Narrative Approach to Establishing Methods of Engaging the Next Generation of Correctional Physicians

Gigi Sengupta, Department of Philosophy and Department of Bioethics (CWRU Arts & Sciences).

This study considered ways to engage future healthcare providers in correctional medicine by analyzing semi-structured narrative interviews with 15 pre-medical and medical students in Ohio. Incarcerated populations demonstrate a significantly higher burden of chronic medical conditions than the general population, even after adjustment for sociodemographic factors. Despite clear need, a 2023 scoping review of U.S. academic health professions education (n=27 studies) found limited structured training in correctional health, with learner outcomes primarily documented at knowledge and attitude levels rather than behavioral change or case-specific approach. Correctional health also faces higher attrition than most other health specialties. Understanding future physician narratives is essential for developing recruitment and retention strategies. Semi-structured interviews were conducted with pre-medical students (n=8) and medical students (n=7) across Ohio institutions. Participants' correctional exposure was categorized as: no prior contact (n=7), minimal exposure through coursework/media (n=5), or corrections experience in non-healthcare capacities (n=3). Narrative accounts underwent thematic analysis to identify interests, concerns, and misconceptions. Nine students (60%) expressed career interest in correctional medicine. Key misconceptions included: correctional medicine primarily treats violence-related injuries, offers limited clinical variety, and requires minimal physician-patient relationships due to security constraints. Safety concerns dominated hesitations among 6 students (40%). Interested participants were motivated by serving marginalized populations (n=6), addressing health disparities (n=5), and managing complex comorbidities in resource-limited environments (n=4). One student specifically sought to provide healthcare for ICE detainees. Students with prior correctional exposure demonstrated greater interest and more realistic field expectations. Findings reveal significant knowledge gaps requiring targeted educational interventions. With the aim of better understanding student perspectives in mind, our study indicated that correctional medicine curricula addressing safety concerns and field misconceptions may improve physician recruitment to address documented workforce shortages in correctional healthcare settings.

Project Mentor: Monica Gerrek, PhD, Department of Bioethics, CWRU School of Medicine

Page 289: Location Independent GNSS Synchronized Environmental Data Collection Sensor Array

Brian Collins [1], **Dylan Pines** [1], **Yeo Weon (Mindy) Seo** [1,2]

1 Department of Electrical Engineering,

2 Department of Biomedical Engineering

Synchronized data collection is typically a complex and costly process. It requires access to expensive atomic clocks or complicated physically connected systems. Our project was inspired by limitations in tracking songbird migration, which requires tightly synchronized audio data collection over a large geographic area. There is no existing solution to this problem; atomic clocks are too expensive for researchers and the large search area prevents physical connection of sensors. The purpose of this project is to solve this problem with a cost-effective, fully disconnected sensor synchronization system using the Global Navigation Satellite System (GNSS). The project will utilize various analog sensors for data collection and a GNSS receiver to synchronize the data. From the GNSS receiver, an NIST traceable pulse-per-second can accurately trigger an interrupt at the top of each UTC second. This will prompt the microcontroller to sample data from the sensor. This process will synchronize all microcontrollers in an array at the top of each UTC second, preventing clock drift from desynchronizing the microcontrollers. Four GNSS synchronized boards fitted with audio were constructed and tested for synchrony. The test results showed that the GNSS receiver was synchronized.

Project Mentor: Dr. David Kazdan, Department of Electrical, Systems, and Computer Engineering

Capstone Instructor: Dr. Vira Chankong, Department of Electrical, Systems, and Computer Engineering

Page 290: Labor market churn and hiring tightness

Keyyshav Seth, Finance Major; **Yennie Seong,** Computer Science Major; **Eleanor McMillin,** Political Science Major

Analyze how job openings, hires, and separations co-move over the business cycle and in the post-pandemic adjustment, testing whether openings decouple from hires in tight markets. The unit of observation is industry by month (or national aggregates) using the BLS JOLTS dataset, 2000–2025. Main variables: job openings level/rate, hires, quits, layoffs, separations; contrasts by industry and census region. Time variation is monthly; methods can leverage the BLS benchmarking and rate definitions. Data and methodology documentation are available from BLS, with current levels via monthly news releases and FRED series for quick pulls.

Project Mentor: David Clingingsmith, Department of Economics

Page 291: Improving Tau Detection for Alzheimer's Disease Using Protein Amplification

Michaella Sevalie, Systems Biology

Alzheimer's disease involves the buildup and spread of misfolded tau proteins in the brain. While current lab tests can measure total or phosphorylated tau, they do not reliably detect the disease-causing "seeded" forms. This project, therefore, explored whether protein misfolding cyclic amplification (PMCA) could be used to selectively amplify Alzheimer's-specific tau seeds. This would provide a more sensitive, disease-focused detection method. The assay was developed using Alzheimer's brain tissue as the seed source and two recombinant tau substrates, 3-repeat (K19) and 4-repeat (K18). Both substrates formed detectable aggregates during PMCA, but the 3-repeat substrate showed a more precise separation between Alzheimer's samples and non-disease controls, which indicates greater diagnostic specificity. Next, proteinase K digestion and guanidine hydrochloride denaturation were used to assess the samples' resistance to enzymatic and chemical breakdown. Proteinase K did not clearly distinguish between groups, but Alzheimer's samples were resistant to guanidine hydrochloride at higher concentrations. Overall, these findings show that PMCA can amplify Alzheimer's-specific tau seeds when the proper substrate is used and support further development of this assay as a sensitive tool for detecting Alzheimer's and other tau-related diseases.

Project Mentor: Dr. Hillel Chiel, Department of Biology

Page 292: Paleoenvironmental reconstruction of the Turkana Basin Region: Preparing for Carbon and Oxygen Stable Isotope Analysis of Fossil Teeth

Ariyana Shafizadeh, Department of Anthropology

The Turkana Basin region of northern Kenya is often described as the cradle of humanity and the birthplace of human evolution due to its rich fossil record of early hominins dating from about 4.2 to 1.0 million years ago. Several notable paleoanthropological discoveries, such as "Turkana Boy", have shaped our understanding of the development of bipedal locomotion, brain size, growth rates, and behavior in early hominins. Turkana Basin fossils and strata are keys to understanding the extent to which changes in climate and landscape ecology (e.g., flora, fauna, and biome) may have been linked to evolutionary pressures and progressions.

The initial goal of our research is to identify a set of fossil remains for stable isotope analysis to constrain landscape ecology and paleoseasonality in the Turkana basin. Tooth enamel from the molars of large herbivores provides an excellent material to preserve time-resolved isotopic compositions that reflect diet and link to vegetation and rainfall patterns during the period of tooth mineralization. In the summer of 2025, I helped catalog and characterize recently collected vertebrate fossils at the Turkana Basin Institute.

The next steps in this research will include improving assays for detecting alteration vs. preservation of primary carbon and oxygen isotope compositions both in the specimens that I helped characterize as well as in previously characterized fossil teeth. Then we will proceed to measure the carbon isotope composition ($\delta^{13}C$ values) of structural carbonate ions in tooth enamel apatite and the oxygen isotope composition ($\delta^{18}O$ values) in carbonate and phosphate ions in enamel apatite. Our research efforts will inform the evolutionary biology and paleoclimate communities by helping reconstruct patterns in seasonality of rainfall and links to relative importance of grassland and forest ecosystems in the Turkana Basin during this evolutionarily important time period.

Project Mentor: Dr. Albert Colman, Department of Earth, Environmental, and Planetary Studies

Page 293: Continuity of Weighting and Applications of Magnitude in Metric Spaces

Shuai Shao, Applied Mathematics, Department of Mathematics, Applied Mathematics, and Statistics, CWRU

The central goal of this project is to study abstract theoretical concepts of metric geometry and relate them to practical statistical models, while demonstrating magnitude-based invariants as useful tools for data representation and inference. This project focuses research on the stability and continuity of two associated invariants, magnitude and maximum diversity, along with their corresponding indicators, weighting and the diversifier. The magnitude of a finite metric space quantifies a certain sense of size of the space, while maximum diversity represents its maximum effective diversity derived through a non-negative constraint, also known as the diversifier. The results presented and applied in this study are based on the theoretical work by Byungchang So, which extends magnitude from a theoretical quantity to an applicable framework where the weighting varies smoothly under certain conditions, while the diversifier remains uniformly continuous. Based on these results, new measures for finite point clouds and periodic time series can be established by integrating test functions against the weighting and the diversifier. These outcomes are useful in addressing sampling noise, phase shifts, and moderate variations in certain length ranges. The practical relationship between these features will be revealed through an application to a real-world dataset.

Project Mentor: Prof. Mark W. Meckes, Department of Mathematics, Applied Mathematics, and Statistics

Page 294: A Modular Finger Prosthetic for Traumatic Digit Amputees

Matt Davis, Maddy Dietrich, Tyler Garcia, Zachary Halsey, Ananya Shashi, All students' expected major is Biomedical Engineering.

Traumatic digit amputation is the clinical condition addressed by our device, which is the partial or complete loss of a finger after an injury such as being crushed, lacerated, or injured in industrial settings. This condition is common, and can result in functional impairment and pain, among other secondary complications. Due to the difficulty of engineering a mechanical system capable of restoring functionality of the finger, the current standard of care is to provide patients with simple silicon prosthetics. These one-degree-of-freedom devices dominate the market of current finger prosthetics, with their share consisting of over 51%. These prosthetics help restore the appearance of the hand, but lack much mechanical functionality.

Unlike such aesthetic solutions, our device restores the amputee's ability to perform daily tasks and complete fine motor activities. In addition, our medical device addresses finger amputations of various lengths in amputees to simultaneously restore function and appearance of the lost limb.

In the interest of reducing complexity, our prosthetic finger's flexion is controlled solely with wrist flexion. The mechanically driven system utilizes a three-segment system controlled by a wrist-driven chain, using a gear ratio to enable full finger flexion with only partial wrist flexion. Springs along the superior edge of each interphalangeal joint pull the device back into an extended position when the wrist is relaxed. We conducted range-of-motion and force tests to iterate and develop the optimal wrist to finger movement ratio for the user.

The device has a shape-adaptive grasp pattern that aims to restore at least 50% of grip strength lost. It is comfortably mounted on the residual limb, while protecting the hypersensitive scar tissue of the remaining distal tip. Lastly, the finger mount is adjustable in size to accommodate different residual limb lengths.

Project Mentor: Matthew Williams, Department of Biomedical Engineering, Case School of Engineering

Page 295: Showing You the World: How Parents of Special Needs Children Can Shape Their Child's Experience of the Environment

Elio Sherrill, Cognitive Science

As resources for disabled youth continue to expand every year, parents of these children are bombarded with different therapies and treatments that claim to give their child a better quality of life. Among these options is eco-therapy, which emphasizes the importance of connection with the environment to improve skills such as emotional regulation, language, and motor function. While the benefits of environment-centered therapy programs have been studied extensively, there remain a few key barriers to entry for parents of disabled children, including accessibility, accommodations, financial issues, and a lack of time. The proposed study aims to integrate principles of eco-therapy into these families' everyday lives with a less structured approach than many past studies/programs. Parents will be provided with detailed guides to use when encouraging their children to engage with their environment, offering alternatives for different accessibility needs and available resources. Parents will then be asked to provide feedback on their experience using these guides, providing data on their personal feelings about its effectiveness as well as recorded observations of their child's behavior and engagement with the material. These guides aim to meet parents at whatever engagement level they have the resources to achieve, whether that be a one time exercise on a vacation or a regularly implemented strategy when exploring the environment with their child. This flexibility is one of the most unique things about eco-therapy, and should be further explored to make it more accessible to the general public.

Project Mentor: Fey Parrill, Department of Cognitive Science

Page 296: Obstructive Sleep Apnea and Panic Disorder: A Critical Review of the Bidirectional Comorbidity

Katherine Shiells, Psychology and Cognitive Science

Obstructive Sleep Apnea (OSA), has a population prevalence of 2-4%, and is a sleep disorder that includes repetitive interruptions in breathing during sleep. Symptoms include sudden awakening, increased sympathetic arousal, sleep fragmentation, daytime sleepiness, and is connected to future development of significant health disorders. Panic Disorder (PD) is an anxiety disorder that includes symptoms of intense fear, increased heart rate, elevated blood pressure, and decreased quality of life. 18% of panic attacks occur from a sleeping state, and so, the comorbidity of obstructive sleep apnea and panic disorder is extremely significant in effective clinical treatment in patients. This paper aims to examine the bidirectional relationship between obstructive sleep apnea and panic disorder in the population, and analyze the current, yet limited, literature on the subject. Twelve empirical studies were selected for this review, using the keywords: Sleep apnea or obstructive sleep apnea or apnea; panic disorder or panic or nocturnal anxiety. The studies determined that individuals with both obstructive sleep apnea and panic disorder presented with increased respiratory irregularities which worsened individuals' sleep quality, arousal levels, somatic symptoms, and anxiety. CPAP therapy was shown to significantly reduce these symptoms, especially nocturnal panic, increasing sleep quality and daytime functioning. Future studies should aim to increase sample sizes, as diagnostic and treatment technology is now allowing a deeper analysis of the comorbidity that these two conditions are associated.

Project Mentor: Dr. Amy Przeworski (PhD), Department of Psychological Sciences

Page 297: Designing a Device for the Treatment of Pediatric Dysphonia

Alexey Shorin, Teagan Smith, Helina Wilson, Shahib Uddin Prokhor, and Vinesh Pendurthi, Department of Biomedical Engineering

Dysphonia is a condition characterized by impaired voice quality, pitch, or volume. It can result from improper or excessive voice use, known as phonotrauma, that can lead to the development of vocal fold nodules, reduced vocal range, and negative emotional, social, and academic impacts. Vocal abuse is a major cause of pediatric dysphonia, often the result of repeated yelling and screaming. Due to the behavioral nature of this condition, it is difficult to manage pediatric dysphonia without regular visits to a clinician, limiting the accessibility and adherence to treatment. The purpose of this project is to develop an accessible, engaging, and easy-to-use therapeutic device designed to help children aged 6 to 12 improve vocal control and reduce strain on the vocal folds via semi-occluded voice therapy (SOVT). The device aims to provide consistent, daily voice training outside of a therapy setting by developing a portable therapy tool designed for easy operation and progress tracking. This project seeks to promote healthy vocal habits and enhance the communication abilities of children affected by dysphonia. We intend to combine mechanical aspects of SOVT—such as a straw/pipe that changes size as the patient advances in therapy—with electrical components that provide real-time feedback on the patient's performance. We aim to test our device’s efficacy through usability tests for airflow sensor functionality and base therapy adherence while ensuring user safety.

Project Mentor: Matthew Williams

Page 298: Applied Medical Anthropology in Action: Evaluating Community Outreach & Engagement Initiatives for Prostate Cancer Prevention Among Black Men under an Anthropological Lens

Harshini Somisetty, Anthropology and Business Management (CWRU)

This medical anthropological capstone analyzes three community-based interventions for prostate cancer prevention among Black men, examining how these Community Outreach and Engagement (COE) efforts utilize anthropological methodologies in their design and implementation. Prostate cancer incidence and mortality rates among Black men remain significantly higher than any other demographic group in the United States, creating an urgent need for culturally-appropriate prevention strategies. The research evaluates a barbershop peer education model in Indianapolis, Indiana, a family health advocate intervention in rural Alabama's Black Belt counties, and cultural barriers research in Southern California to understand how anthropologically-informed approaches address structural and cultural obstacles to screening participation. Drawing from geographically diverse contexts across urban Midwest, rural South, and urban West regions, the analysis examines how these interventions use cultural spaces (barbershops as "third places"), kinship networks (female family advocates), and community knowledge systems to overcome barriers including medical mistrust rooted in historical trauma, masculinity norms around healthcare avoidance, and concerns about sexuality and the digital rectal examination. The family health advocate model achieved 83% screening uptake while the barbershop peer education approach generated 77% intention to screen—both significantly outperforming traditional clinical approaches that often fail to engage Black men. Following extensive review of public health literature, intervention studies, and medical anthropological theory, this paper demonstrates how working within existing cultural frameworks effectively increases prevention resource utilization and addresses health disparities. The paper critically assesses the COE efforts' effectiveness in addressing both cultural barriers (stigma, masculinity concerns) and structural barriers (medical mistrust, provider bias), pointing out remaining gaps and offering recommendations for future community-based health initiatives. This leads to the research question this paper focuses on: "How do these COE efforts utilize anthropological methodologies in their intervention design, and were they effective in addressing barriers to prostate cancer prevention among Black men?"

Project Mentors: Dr. Katia Almeida, Department of Anthropology; Kristina Austin, Case Comprehensive Cancer Center

Page 299: Long-Term Academic and Social Outcomes of Children with Learning Disabilities

Hannah Song, Psychology, Department of Psychology, CWRU

Children diagnosed with learning disabilities (LDs) often experience challenges extending beyond the classroom and into adolescence and adulthood, affecting their long-term academic achievement, social development, and overall quality of life. Research shows that while LDs can persist over a lifetime, outcomes vary widely based on the presence or absence of early and continuous intervention. This literature review examines how learning disabilities influence developmental trajectories over time and identifies the factors that shape long-term outcomes. This project synthesizes empirical findings from psychology, education, and sociology to explore how family involvement, school resources, teacher ability, and intervention timing contribute to academic resilience, emotional well-being, and adjustment to adulthood. Across studies, students who received individualized support, early intervention, and consistent academic accommodations demonstrate more positive educational outcomes, stronger peer relationships, and greater self-efficacy compared to those with limited access to these resources. On the other hand, stigma, socioeconomic barriers, and inadequate school services are linked to lower academic achievement and social isolation. By highlighting patterns in existing research, this review emphasizes that long-term outcomes are not determined solely by the initial diagnosis, but by the environment surrounding the child. Understanding these influences can inform future policy, guide intervention practices, and promote supports that improve lifelong trajectories for individuals with learning disabilities.

Project Mentor: Rachel McClaine, Department of Psychological Studies

Page 300: Evaluating the Role of NEK2 Overexpression in Regulating Growth in Luminal ER-Positive Breast Cancer Cells

Hannah Song, Psychology, Department of Psychology, CWRU

Breast cancer is the most common cancer among women and is commonly classified into subtypes based on hormone receptor expression. Estrogen receptor (ER) positive luminal breast cancer accounts for the majority of cases and is generally responsive to endocrine therapy. The mitotic kinase NEK2 is frequently overexpressed in a variety of cancers and has been associated with chromosomal instability, therapy resistance, and poor clinical outcomes in breast cancer. As a key regulator of centrosome separation and spindle formation, NEK2 activity must be precisely controlled; both insufficient and excessive NEK2 expression can disrupt mitotic progression and impair normal cell growth. NEK2's role in cell cycle regulation led me to hypothesize that NEK2 overexpression would enhance growth in luminal ER-positive breast cancer cells. To test this hypothesis, ZR-75 cells were genetically modified to overexpress NEK2 and compared with empty vector control cells. Cell number was measured over time using crystal violet staining, and growth kinetics were quantified in GraphPad Prism. Western blot analysis verified elevated NEK2 protein expression in the overexpressing cell line. NEK2-overexpressing ZR-75 cells displayed a reduced growth rate compared to control cells, suggesting that excessive NEK2 expression may impair proliferative capacity in luminal breast cancer. These findings suggest that NEK2 may influence cell growth through its role in mitotic and centrosomal processes. Future research will examine the consequences of both NEK2 overexpression and depletion on mitotic fidelity and growth control in hormone-dependent breast cancer.

Project Mentor: Dr. Ruth Keri, Department of Molecular Medicine, Cleveland Clinic Lerner Research Institute

Page 301: Navigating the Interview: Overcoming Methodological Challenges in Community-Based Harm Reduction Research

Katharina Staehr, Department of Anthropology; Dr. Lee Hoffer, Department of Anthropology; and Dr. Lihong Shi, Department of Anthropology, CWRU

Harm Reduction (HR) is an important strategy to reduce harms associated with drug use. Therefore, research is critical to understand how existing HR programs, such as Syringe Service Programs (SSPs), can be improved from the perspective of people who use drugs (PWUDs). However, conducting qualitative research with PWUDs is often characterized by the risk of social desirability bias (SDB), in which participants give socially acceptable responses, rather than their true opinions or behaviors. This can compromise data quality and impact the reliability of conclusions. This project aims to assess the presence of and mitigate SDB in a qualitative needs assessment study of a Cleveland SSP, The Centers. The study is conducting in-person, semi-structured interviews with SSP clients. Interviews explore clients' drug and SSP service use, their positive experiences with the SSP and suggestions for improvement. The interviews are transcribed and analyzed thematically through extensive notetaking. Techniques to mitigate SDB include: (1) clear communication to participants of confidentiality (2) structuring interview questions conducive to building rapport and (3) interview probes that elicit narrative-based responses. The success of these strategies will be assessed by analyzing transcripts and field notes for cues of SDB. The critical reflection of the study's methodological approach serves as a practical guide for future qualitative research to evaluate for SDB. Furthermore, the study design techniques, interview strategies and proposed refinements can inform the conduct of future qualitative HR studies to mitigate SDB.

Project Mentor: Dr. Lee Hoffer, Department of Anthropology, CWRU

Capstone Instructor: Dr. Lihong Shi, Department of Anthropology, CWRU

Page 302: Deletion of estrogen receptor alpha promotes regulatory T cell suppressive function in vivo.

Sarah M. Stark[1], Alyssia V. Broncano[1], Wendy A. Goodman[1]
[1]Department of Pathology, Case Western Reserve University School of Medicine, Cleveland, OH

Women are more likely to suffer from chronic autoimmune conditions, yet the underlying causes are poorly understood. Evidence suggests that steroid hormone signaling pathways, such as that downstream of 17□-estradiol (E2, estrogen), are significant contributors to sex differences in immunity. Signaling through the nuclear estrogen receptors alpha and beta (ERα, ER□) have clear immunomodulatory effects, with ERα generally promoting and ER□ generally restraining inflammation. The aim of this study is to determine the effects of ERα and ER□ on the suppressive capacity of regulatory T cells (Tregs). To do this, we utilized a murine model of T cell-dependent colitis by injecting wild-type (WT) CD4+CD25- T cells into sex-matched immunodeficient recipients, along with CD4+CD25+ Tregs from WT, ERα-KO, or ER□-KO donors. The ability of transferred Tregs to prevent colitis was determined via standard measurements of experimental colitis, including weight loss and histological inflammation. Our data shows that transfer of ERα-KO Tregs resulted in enhanced colitis protection compared to WT Tregs, suggesting that ER□-specific signaling enhances Treg function. Future studies will elucidate mechanisms contributing to this immunoprotective effect.

Project Mentor: Valerie Haywood, Department of Biology

Page 303: Evolution under vancomycin selection drives divergent collateral sensitivity patterns in Staphylococcus aureus

Amira Stocks, Biology; Kyle Card, Department of Genomic Medicine, Cleveland Clinic Lerner Research Institute; Jacob Scott, Department of Genomic Medicine, Cleveland Clinic Lerner Research Institute

Staphylococcus aureus bacteremia is typically treated empirically with vancomycin, with therapy later tailored based on susceptibility results. However, these tests occur before vancomycin exposure and do not account for adaptation during empiric treatment that can alter S. aureus' susceptibility to first-line drugs. To investigate these collateral drug responses, we experimentally evolved 18 methicillin-susceptible S. aureus (MSSA) populations under increasing vancomycin concentrations until they achieved intermediate resistance. Genomic sequencing revealed two distinct adaptive pathways characterized by mutations in the WalKR regulon, affecting cell wall metabolism, or rpsU, impacting translational stress responses. These pathways correlated with divergent collateral sensitivity profiles to first-line antibiotics. By developing a Collateral Response Score (CRS), we quantified the probability and magnitude of these responses, demonstrating that evolutionary dynamics critically influence resistance outcomes. Our findings suggest a probabilistic approach to antimicrobial therapy, advocating for rapid genomic diagnostics alongside susceptibility testing to better anticipate and respond to evolutionary changes.

Project Mentor: Dr. Kyle Card, Department of Genomic Medicine, Cleveland Clinic Lerner Research Institute

Page 304: Developing a Wound Sensing Bandage for Detecting Early Signs of Infection in Chronic Wounds

Adesh Balasubramanian, Department of Biomedical Engineering; **Olivia Bonnette,** Department of Biomedical Engineering; **Taylor Green,** Department of Biomedical Engineering; **Emma Struck,** Department of Biomedical Engineering; **Sneha Suresh,** Department of Biomedical Engineering, CWRU

Chronic wounds are those that fail to heal within the normal timeframe of four to twelve weeks, affecting nearly 2.5% of the U.S. population and significantly diminishing patient quality of life. These wounds can arise from a variety of underlying conditions, including diabetes, poor circulation, infection, or immune dysfunction, and are often accompanied by pain, swelling, and discomfort that may lead to amputation or death if untreated. Although numerous advanced therapies exist, there remains a lack of continuous, non-invasive monitoring solutions that can help patients and clinicians track wound healing in real time. This project aims to develop a wound sensing bandage capable of sensing key biomarkers associated with wound infection and healing progression, specifically temperature and pH. The design integrates low-cost sensors within a hydrogel interface to promote healing while maintaining flexibility and comfort for daily wear. Sensor readings are translated into LED indicators that alert patients when abnormal values are detected, providing an immediate and accessible feedback system. The methodology involves selecting and testing biocompatible hydrogel materials, calibrating sensors for accuracy in wound-like conditions, and evaluating system responsiveness through testing. The anticipated outcome is a functional prototype that demonstrates reliable sensing performance and user-friendly feedback, ultimately contributing to improved patient self-monitoring and earlier clinical intervention for chronic wounds. The purpose of this bandage is to continuously monitor wound conditions by measuring pH and temperature at the wound site. By detecting abnormal changes that may indicate infection or delayed healing, the bandage provides timely alerts to the patient, helping them stay informed about their healing progress and seek care when necessary.

Project Mentor: Dr. Steven Eppell, Department of Biomedical Engineering, CWRU

Capstone Mentors: Dr. Colin Drummond, Department of Biomedical Engineering; Dr. Matthew Williams, Department of Biomedical Engineering, CWRU

Page 305: Modulating Human Retinal Endothelial Cell Barrier Function with High- and Low-Molecular Weight Hyaluronic Acid

Ethan Su, Department of Biology; Jessica Altemus, Department of Ophthalmic Research, Cleveland Clinic Research; Bela Anand-Apte, Department of Ophthalmic Research, Cleveland Clinic Research

Diabetic macular edema is a leading cause of blindness in patients with diabetes and breakdown of the inner blood retinal barrier (retinal vascular barrier) contributes substantially to the pathogenesis. While endothelial tight junction proteins have long been considered to be an essential component for the integrity of the inner blood retinal barrier, the endothelial glycocalyx has more recently been hypothesized to also be involved. The retinal endothelial glycocalyx is a protective layer on the lumenal surface of the retinal vascular endothelium. Hyaluronan (HA) is a key component of the retinal endothelial glycocalyx. Previous studies have demonstrated that breakdown of hyaluronan by hyaluronidase disrupts the inner blood retinal barrier. Hyaluronidase is an enzyme that breaks down hyaluronan into low molecular weight forms.

We investigated the effect of LMW and HMW HA on human retinal microvascular endothelial cells (HRMVECs). Electric cell-substrate impedance sensing (ECIS) was used to directly measure barrier function of HRMVECs treated with 100ug/ml LMW or HMW HA. Immunofluorescent staining was also conducted with these treatments to identify if increased exogenous HA results in differential uptake.

Project Mentors: Jessica Altemus, Department of Ophthalmic Research, Cleveland Clinic Research; Bela Anand-Apte, Department of Ophthalmic Research, Cleveland Clinic Research

Page 306: Wrist-worn Electrical Stimulation (TAPS) Device to Suppress Parkinson's Tremor

Sweta Chivukula, Biomedical Engineering; **Danielle Sun,** Biomedical Engineering; **Maxine Meng,** Biomedical and Electrical Engineering; **Wenfei Zhao,** Biomedical Engineering, **Ajyad Al Khasawneh,** Biomedical Engineering

Parkinsonian tremors are involuntary rhythmic movements that affect over 70% of PD patients. They interfere with daily activities, reduce independence, and significantly impact quality of life. These tremors result from disruption in the neurological signaling pathways controlling muscle activation. White pharmacological interventions targeting dopamine precursors can reduce symptoms, their efficacy often diminishes over time, motivating the need for effective non-pharmacological alternatives. This project aims to develop a wearable tremor control system that mitigates tremors in real-time through targeted electrical stimulation. The proposed forearm-worn device detects tremor frequency using an integrated IMU sensor system (accelerometer and gyroscope) and classifies tremor origin based on muscle activity. Upon detection, the device delivers calibrated electrical pulses to agonist and antagonist muscles, stiffening the joining and thereby resisting tremor oscillations. The system continuously monitors motion data and dynamically adjusts stimulation intensity within safe limits, incorporating safety features such as skin temperature monitoring and an emergency stop function. The expected outcome is a lightweight, comfortable, and cost-effective wearable that neutralizes tremors as they occur, allowing users to regain motor control and perform daily activities more effectively. By integrating adaptive feedback control and user safety mechanisms, this device has the potential to improve quality of life, independence, and confidence for individuals with Parkinson's disease.

Project Mentor: Dr. Matthew Williams, Department of Biomedical Engineering

Page 307: Waves Around Black Holes: Electromagnetic Wave Optics and a Scalar Model of Gravitational Waves

Wanrou Sun, Mathematics and Physics; Harsh Mathur, Department of Physics

According to Einstein's theory of gravity, the presence of matter causes the surrounding spacetime to be curved. Black holes, some of the densest objects in the universe, induce curved spacetime, which affects the propagation of waves around these black holes. In this project, we study two types of waves that can be used to observe black holes: electromagnetic and gravitational. These waves are detectable by observatories on Earth, such as the Event Horizon Telescope (EHT) Collaboration and the Laser Interferometer Gravitational-Wave Observatory (LIGO). First, we consider electromagnetic waves. EHT analysis of light scattered by black holes does not encompass the full wave nature of light. This framework, known as ray optics, provides a functioning understanding of light, but fails to account for interference and diffraction, which require the more sophisticated treatment of light as a wave. Using quantum scattering theory, this project investigates whether such wave optics effects might be observable in future high-resolution images of backlit black holes. Second, we consider gravitational waves, which are ripples in spacetime emitted during black hole collisions. First detected in 2015 by LIGO, gravitational waves occur in three stages. We wish to develop a simplified model of the final stage of a gravitational wave, known as ringdown. During ringdown, the newly merged black hole settles and stabilizes, analogous to a bell that has been struck and continues to ring for a while afterwards. The propagation of the emitted gravitational waves is governed by solutions to the wave equation. By solving the scalar wave equation around a non-rotating black hole, we find that this simplified scalar model shares some key characteristics of the full tensor model of gravitational waves.

Project Mentor: Prof. Harsh Mathur, Department of Physics

Page 308: RoamIO - A Travel Companion Application

Ananya Kotian, Computer and Data Sciences; **Shreyhan Lakhina,** Computer and Data Sciences; **Nachikethan Srinivasan,** Computer and Data Sciences; **Ananya Sundararajan,** Computer and Data Sciences; Shravani Suram, Computer and Data Sciences

Planning travel requires coordinating numerous components, including selecting destinations, booking flights and accommodations, preparing packing lists, and organizing itineraries, which can be time-consuming and fragmented across multiple platforms. RoamIO is an integrated iOS application designed to streamline this process by centralizing travel planning tools into a single, user-focused interface. The application aggregates and processes data from multiple travel APIs to support personalized destination recommendations and automated outfit planning based on anticipated weather conditions. Authenticated users can securely create and manage accounts, with the ability to update credentials as needed. RoamIO enables users to review detailed flight itineraries, fees, and travel options, as well as access hotel information, including location, room availability, and pricing, facilitating informed travel decisions. Additional features include real-time language translation via text or image input, integrated mapping for navigation support, and the ability to save itineraries and document trips with photos. RoamIO aims to provide a unified and efficient travel-planning experience by consolidating key planning functionalities into a single platform, ultimately improving convenience, organization, and user satisfaction throughout the travel process.

Project Mentor: Dr. Shuai Xu, Computer and Data Sciences Capstone Advisor: Dr. Shuai Xu, Computer and Data Sciences

Page 309: 3-Dimensional Modeling of Fluid-Cilia Interactions Using Machine Learning Reconstruction

Kunal Sunil, Department of Applied Mathematics

This project uses a Long Short-Term Memory (LSTM) machine learning model to reconstruct the full 3D motion of a cilium that is interacting with a surrounding fluid. Cilia are microscopic, hair-like structures that can be found on the surface of many cells. Their motion plays a crucial role in transporting particles and fluids around the body, making this analysis necessary. To predict the motion of the cilium, an LSTM network was trained on data tracked on the cilium images from two camera views, a side view and a top view. Two separate models were created, one for each perspective, each of which learned the motion of the cilia in order to predict future movements. This reconstruction produces a 3D curve that captures the movement of the cilia, allowing for more in-depth analysis compared to separate 2D projections. Then we employ the method of regularized Stokeslet to model and predict fluid dynamics induced by the cilium movement. This research aims to capture the experimentally observed 3D cilium beating and investigate the full fluid-cilium interactions

Project Mentor: Longhua Zhao, Mathematics, Applied Mathematics, and Statistics

Page 310: Field-Ready Velocimeter with Adjustable Imaging Trigger

Joseph Swarm, Computer Engineering; **Robert Verba**, Electrical Engineering; **Thomas Yoder**, Electrical Engineering

Advanced flight vehicles and high-velocity projectiles currently lack a portable and accurate measurement tool to use in field experiments. Because these experiments are increasingly expensive for aerospace and defense researchers, they seek a solution that can provide precise imaging while remaining cost-efficient. To create a solution, our project takes inspiration from an existing dual light-gate system utilizing photodiodes and infrared LEDs with nanosecond response times. After pairing these components with a high-frequency microcontroller and custom PCB, our system only requires a simple program to send a signal to a digital camera and project the calculated velocity onto an LCD display. Our final design condenses our components into a weatherproof enclosure that can measure projectiles through a one meter window of aperture. These measurements are expected to improve in accuracy from competitors and our inspired design, while maximizing versatility for the user. We plan for researchers to use our system's calculations to make improvements to future technologies and observe possible in-flight errors or damages.

Project Mentor: Dr. Steve Majerus, Department of Electrical, Computer, and Systems Engineering, Case School of Engineering

Capstone Instructor: Dr. Vira Chankong, Department of Electrical, Computer, and Systems Engineering, Case School of Engineering

Page 311: Osmotic Stress Response in a Novel Thawing Permafrost Peatland Microbial Isolate

Madison Talley, Department of Biology, Department of Chemistry, CWRU

Rising global temperatures affect biogeochemical cycles in local and global ecosystems. Temperatures are rising disproportionately faster in arctic latitudes, threatening to thaw stored soil carbon. The Stordalen Mire in Sweden serves as a model ecosystem for studying permafrost peatlands along a thaw gradient, with habitats ranging from intact palsa to partially thawed bog to fully thawed fen. As permafrost thaws, previously frozen carbon sources become bioavailable for microorganisms' metabolic processes while simultaneously altering soil osmolarity. The occurrence of freeze-thaw cycles imposes osmotic stress on the soil ecosystems, such as soil degradation through both concentrating salt through freezing and soil saturation through thaw. Microorganisms can produce osmoprotectants to acclimate and tolerate both hypertonic and hypotonic environments, as osmoprotectants restore ion gradients internally and externally, protect cellular proteins, and regulate water balance. Here, we aim to characterize the osmotic stress response of a Caballeronia strain, one of the first microbes isolated from Stordalen Mire. This isolate was obtained from a 9–19 cm depth interval in the sphagnum-dominated bog habitat. Long-read genomic sequencing and assembly of this isolate yielded a near-complete genome, which was annotated to identify osmoprotectant biosynthetic pathways predicted to support acclimation to changes in external osmolarity. If these candidate pathways are functional, we reasoned that the isolate will produce osmoprotectants to counteract an increase in solute concentrations; then a return to a lower osmolarity medium will cause the cell to swell or even lyse. Laboratory experiments will manipulate the osmolarity of an enriched arctic media to examine Caballeronia growth responses through colony-forming unit (CFU) counts, optical density readings, and changes in size via microscopic imaging. Studying stress patterns of isolates in these ecosystems will improve understanding of tolerances and adaptations in the Stordalen Mire soil and the broader impacts of climate change on arctic soil functions and ecosystems.

Project Mentor: Dr. Sarah Bagby, Department of Biology; Dr. Derek Smith, Department of Biology, CWRU

Page 312: Parental Stress in Relation to Social and Behavioral Characteristics of Children with Prader–Willi Syndrome

Ayten B. Tamahkar, Department of Psychological Sciences, CWRU

Parental stress is markedly elevated in families of children with Prader–Willi syndrome (PWS), yet clinicians lack syndrome-specific behavioral thresholds to identify high-risk caregivers early. This project asks how children's maladaptive behaviors and social skills relate to caregivers' Parenting Stress Index (PSI) scores, and whether these associations differ by child age. The work is significant because PWS combines increased risk of externalizing behaviors, anxiety/rigidity, and lifelong care demands. Establishing actionable links between behavior profiles and parental stress can guide earlier, better-targeted supports and policy coverage for family services. This study is a secondary analysis of baseline data pooled across two age-banded cohorts of children with PWS (preschool 3–5; school-age 6–12) recruited through national PWS networks. Caregivers completed the PSI-4, Vineland-II (adaptive and maladaptive indices), and the Social Skills Improvement System (SSIS). Analyses will treat PSI Total Stress both continuously (correlations with Vineland internalizing/externalizing and SSIS subscales) and categorically (clinical cut-off defined high- vs. low-stress groups), followed by age-stratified tests and group comparisons. We expect higher stress measured by Parent Stress Index to be associated with more severe maladaptive behavior, especially externalizing (e.g., impulsivity, aggression), and with lower social skills (e.g., cooperation, self-control). We further expect stronger behavior–stress relationship in school-age than preschool children, reflecting escalation of daily hassles and behavioral complexity with age. Findings will delineate domain-specific stress profiles and candidate behavioral thresholds that can be translated into screening flags for clinicians and used by payers to justify family-centered intervention resources in PWS.

Project Mentor: Anastasia Dimitropoulos, Department of Psychological Sciences

Page 313: Autonomous Altitude Control of an RC Plane

Nate Cressman, Mechanical Engineering

A drone is “a remote-controlled, pilotless aircraft or small flying device” (Oxford Dictionary). The versatility of modern drones has enormous potential and has transformed many fields, including warfare, photography, firefighting, and pharmaceutical delivery. Current applications of small and large unmanned aerial vehicles remain largely underdeveloped. Why has drone technology not been applied more widely? Two major hindrances to the widespread use and development of drones are the high sticker price and a general belief that only rocket scientists can understand flight mechanics. The student will build a twin-propeller RC plane and its remote control from individual components (not prefabricated kits). The remote will be designed to set a target altitude for the drone, which will then autonomously maintain that altitude. Altitude control will be toggleable from the remote. The purpose of this research is largely educational. This project aims to demonstrate the simplicity of aerodynamic principles, often perceived to be too complex, and to develop a relatively low-cost drone with limited autonomy for altitude control. It is a fusion of three major fields: aerospace engineering, mechanical engineering, and education. This project is expected to yield a custom-built, flyable RC airplane with toggleable altitude control, CAD models of the plane, and altimeter data with graphical analyses demonstrating altitude autonomy. A final report will detail the design and manufacturing process and explain the underlying flight mechanics.

Project Mentor: Dr. Majid Rashidi, Department of Mechanical and Aerospace Engineering, Case School of Engineering

Page 314: Examining the Nutritional Stages of Hyperphagia in Prader-Willi Syndrome

Ky Tan, Department of Psychological Sciences; Anastasia Dimitropoulos, Department of Psychological Sciences, CWRU

Prader-Willi Syndrome (PWS) is a rare genetic disorder characterized by hypotonia, hypogonadism, intellectual disability, and hyperphagia—an insatiable drive to eat that emerges in early childhood and often leads to obesity and severe health complications. Although hyperphagia is one of the most life-threatening features of PWS, the relationship between its behavioral onset and age remains insufficiently understood. This study builds on Miller et al.'s (2011) seven-stage nutritional model to examine whether maladaptive food-related behaviors correspond to these developmental stages. Using caregiver reports from 84 children with PWS (ages 3–12) drawn from the Play-based Remote Enrichment to Enhance Development (PRETEND) and Hyperphagia (HYP) studies, this research investigates the presence and severity of hyperphagic behaviors across three age groups corresponding to Stages 2a, 2b, and 3 of Miller's model. The goal of this project is to clarify the developmental trajectory of hyperphagia and provide empirical support for stage-specific behavioral and clinical interventions for individuals with PWS.

Project Mentor: Professor Anastasia Dimitropoulos, Department of Psychological Sciences, CWRU

Page 315: Glucose-Dependent Regulation of Gelatinase Activity in Retinal Pigmented Epithelial Cells: Implications for Diabetic Retinopathy

Darwin Tan, Department of Neurosciences, CWRU; Jessica Altemus, Department of Ophthalmic Research, Cleveland Clinic Lerner Research Institute; Dr. Bela Anand Apte, Department of Ophthalmic Research, Cleveland Clinic Lerner Research Institute

Diabetic retinopathy (DR) is the leading cause of preventable blindness in the United States. Diabetic macular edema is a significant cause of vision loss in DR. While the regulation of the inner blood-retinal barrier has been extensively studied in diabetes, the outer blood-retinal barrier, formed by the retinal pigmented epithelium (RPE) has been mostly ignored. Recent evidence suggests that dysregulation in this outer barrier plays a critical role in the development of macular edema. We hypothesize that changes in the secretion of matrix metalloproteinases (MMPs) within RPE cells in response to hyperglycemia may contribute to the disruption of the outer blood retinal barrier. This study examined how D-glucose concentration influences MMP activity in RPE cells to better understand the molecular mechanisms driving DR. Primary RPE cells were isolated from whole porcine eyes and cultured in media containing 5, 10, or 25 mM D-glucose, with osmolarity normalized using L-glucose. The activities of gelatinases MMP-2 and MMP-9 in conditioned media were assessed using gelatin zymography. Elevated glucose concentrations were associated with increased total MMP-2 levels. MMP-9 activity exhibited variable responses, showing both increases and decreases under hyperglycemic conditions across replicates. These findings suggest that hyperglycemia has the potential to modulate MMP activity and activation in RPE cells, providing insight into the molecular mechanisms of diabetic retinal pathology.

Project Mentor: Bela Anand-Apte, Ophthalmology

Page 316: Development of a Senolytic CAR T-Cell System: Cloning and Transformation Workflow Targeting uPAR

Clara Tang, Neuroscience and Psychology; Dr. Fu Sen Liang, Department of Chemistry; Dr. Praveen Bellam, Department of Chemistry, CWRU

Cellular senescence contributes to aging and neurodegenerative diseases such as Alzheimer's disease (AD) by promoting chronic inflammation and tissue dysfunction through the senescence-associated secretory phenotype (SASP). Senescent cells express distinct surface markers, including the urokinase-type plasminogen activator receptor (uPAR), which can be leveraged for targeted elimination. Previous studies demonstrated that uPAR-directed chimeric antigen receptor (CAR) T cells effectively cleared senescent cells and alleviated age-related pathologies in other models, highlighting the therapeutic potential of senolytic immunotherapy. Building upon this foundation, this project aims to develop a chemically inducible, human uPAR-targeted CAR T-cell system designed to selectively eliminate senescent cells in human models. The experimental phase involves cloning and validating the human uPAR cDNA for incorporation into an inducible CAR construct, which enables temporal control of T-cell activation through a small-molecule switch, minimizing off-target cytotoxicity while maintaining potent senolytic activity. By enabling precise, controllable targeting of senescent cells, this platform establishes the groundwork for translational senolytic CAR T-cell therapies that could mitigate neuroinflammation and cellular aging processes underlying Alzheimer's disease.

Project mentor: Dr. Fu Sen Liang, Department of Chemistry, CWRU

Capstone Instructor: Dr. Jon Niemi, Department of Neuroscience

Page 317: RNAi Screen of Candidate Proteins Related to Meiotic DSB Protein, Vilya, In D. Melanogaster

Zion Tasew, Biology, Oscar Bautista, Department of Biology

Meiosis is a vital cellular division process, occurring in sexually reproducing organisms where diploid cells undergo two rounds of division, generating haploid gametes, while also facilitating genetic diversity. This is done through recombination and chromosomal segregation; however, errors in either will cause chromosomal missegregation, resulting in aneuploidy, a major contributor to miscarriages and infertility(Ohkura, 2015). At meiotic recombination's core is the reciprocal exchange of genetic information between homologous chromosomes, known as crossovers (COs). Programmed DNA double-stranded breaks (DSBs) are necessary for COs as these breaks are repaired by protein machinery into COs. Little is known about the totality of protein interactions and molecular machinery driving the meiotic recombination process and more knowledge would give insight into where chromosome segregation failures arise. This project's goal is to discover more proteins possibly interacting with Vilya, a meiotic DSB protein discovered to be required for the formation of DSBs that will mature into COs(Hawley, et. al, 2015). The objective is to use RNAi to analyze phenotypes indicative of a failure in the meiotic DSB and CO formation program, as this would indicate the possible importance of a protein to the meiotic program. We will screen nine genes shown to have possible interactions with Vilya. Six interactions were discovered through a proximity labeling experiment preceding mass spectrometry(MS), while three were found using the Molecular Interaction Search Tool(MIST). Results indicate that four of the genes screened are crucial to the developmental program of Drosophila ovaries, as their knockdowns resulted in agametic phenotypes and sterility in the F1 progeny.

Project Mentor: Nicole Crown, Department of Biology

Page 318: MapsModes - Research into Modes of Transportation - Cleveland

Daniel Tayman, Department of Computer and Data Sciences; **Oreofe Solarin,** Department of Computer and Data Sciences; **Chelsea Zebaze,** Department of Mathematics, applied Mathematics, and Statistics; **Isaac Gunaseelan,** Department of Computer and Data Sciences, **Tasfiqur Rob,** Department of Computer Science

We are making MapsModes, an interactive web platform that explores alternative transportation modes across Cleveland. The project focuses on the accessibility and efficiency of walking, biking, and public transportation within the city. By analyzing data on travel times, route density and infrastructure availability we aim to better understand how people move through urban spaces and how these patterns reflect local community dynamics. We have collected data relating to the ease of travel in various methods and will work with the data to gain insights into how people are getting around, how else they could be getting around, and what those facts can tell us about their local communities. Then we will be making an interactive map software to show all of the data in a comprehensible way. We are expecting to see areas where public transportation is common be similar to the areas where most shops and places of work are within walking or biking distance. Then in those areas, we are expecting to see more people who use those alternative methods of transportation to get around daily. Our goal is to use this data to identify areas where transportation options are limited, inform potential funding priorities, and explore strategies for reducing emission through increased use of sustainable travel methods. The interactive map interface will visualize these findings, allowing users to explore mobility trends and community impacts in a clear and engaging way.

Project mentor: Professor Shuai Xu, Department of Computer and Data Sciences, CWRU

Page 319: Role of Primary Cilia Deterioration in Alzheimer's Disease

Phoebe Templin, B.A. in Biology, Case Western Reserve University

Alzheimer's Disease (AD), the leading cause of dementia, is a progressive neurodegenerative disease that affects 6.9 million Americans. My research explores a novel pathophysiological process in AD: the role of primary cilia deterioration in AD. Primary cilia are sensory, microtubule based organelles that act as signaling hubs and sensors to receive and integrate extracellular signals. Defects in the structure and function of primary cilia can lead to cognitive and reduced brain mass, which are both common symptoms observed in AD. Primary cilia function depends on Adenylyl Cyclase (AC3), a key enzyme that regulates cyclic AMP levels and downstream signaling, making it a prominent marker of primary cilia in the brain. My project will investigate the deterioration of primary cilia using AC3 in AD mouse models. Establishing the link between primary cilia deterioration in early AD progression could reveal a novel locus of injury. My initial findings from immunohistochemical analysis have revealed sex- and region specific cilia deterioration. In the CA1 region, deterioration was specific to female 5xFAD, a trend consistent at 3 and 12 months. In the Dentate Gyrus (DG), cilia deterioration progressed with age, but was not gender specific. Ongoing analysis of additional regions (subiculum and cortex) is under way and will provide further insight into what changes are seen over time and between genders. The 5xFAD mouse model my lab uses harbors five different mutations, which all affect how amyloid precursor protein (APP) is processed. I hypothesize that CDK-5 mediated phosphorylation of APP at Threonine 668 drives cilia deterioration. To test this, I am generating an antibiotic resistant cell line where Cyclin-dependent Kinase 5 (CDK5) is overexpressed to see if altered APP can change cilia length. Collecting and western blot analysis will help determine if CDK5 phosphorylates APP on threonine 688.

Project Mentor: Dr. Andrew Pieper, MD, PhD and Emiko Miller, BS Case Western Reserve University School of Medicine, Harrington Discovery Institute, University Hospitals, Louis Stokes Veteran Affairs Hospitals

Page 320: Market Competition and Generic Drug Adoption: Exploring the Relationship Between Health Insurance Concentration and Generic Uptake in the United States

Laura Harris, Economics; **Ishaan Solanki,** Economics; **Liem Tesler,** Economics

This study examines the relationship between health insurance market competition and the adoption of generic drugs in the United States. Generic medications offer a cost-effective alternative to brand-name drugs, yet their uptake varies widely across states and over time. We aim to explore whether markets with more competitive health insurance structures, characterized by lower insurer concentration, tend to experience higher or faster uptake of generics after they enter the market. Our analysis will focus on describing correlations between insurance market structure and patterns of generic use. By highlighting how variation in insurer competition correlates with the diffusion of lower-cost alternatives, this study seeks to provide empirical insight into the incentives and constraints that shape pharmaceutical spending behavior. The findings may help policymakers, insurers, and researchers better understand how market dynamics interact with drug adoption and health care affordability.

Project Mentor: David Clingingsmith, Economics

Page 321: Role of SIRT3 in Maintaining Cancer Stem Cell Plasticity in Castrate Resistance Prostate Cancer

Leah Tharian, Department of Biology, Case Western Reserve University\

Prostate cancer remains one of the most prevalent malignancies among men in the United States, with over 313,000 new diagnoses and more than 35,000 deaths projected in 2025. Despite therapeutic advances, many patients exhibit limited responses, and metastatic disease remains a major cause of mortality. Approximately 10–20% of patients progress following androgen deprivation therapy (ADT) to develop castration-resistant prostate cancer (CRPC), an aggressive and treatment-refractory stage. Emerging evidence implicates cancer stem cells (CSCs)—a subpopulation of tumor cells with self-renewal capacity, therapeutic resistance, and tumorigenic potential—in driving CRPC progression, metastasis, and treatment failure. To identify transcriptomic signatures associated with CSC differentiation, we profiled gene expression in androgen-repressed human prostate cancer C4-2B cells using magnetic bead separation with a CD133 antibody. RNA sequencing revealed 33,676 differentially expressed genes, with 615 meeting the criteria of $p < 0.05$ and 56 remaining significant after FDR correction ($q < 0.5$). Pathway analysis using QIAGEN Ingenuity Pathway Analysis indicated enrichment of sirtuin signaling, oxidative phosphorylation, mitochondrial dysfunction, CXCR4 signaling, IL17A signaling, and TNFR2 signaling in the $CD133^{+}$/ALDH1^high population. Transcript profiling of the sirtuin gene family (SIRT1–SIRT7) demonstrated upregulation of mitochondrial sirtuins—SIRT3, SIRT4, and SIRT5—in $CD133^{+}$/ALDH1^high cells compared to the $CD133^{-}$/ALDH1^low fraction, correlating with enhanced oxidative phosphorylation (OXPHOS) activity. The SIRT3-centered protein–protein interaction (PPI) network highlights its central role in coordinating mitochondrial metabolism, NAD^{+} homeostasis, and chromatin regulation. SIRT3 interacts with NAMPT, NMNAT1/2, and NDUFA9 to sustain NAD^{+} levels and OXPHOS under androgen-deprived conditions. Through interactions with PGC-1α and FOXO3, SIRT3 promotes mitochondrial biogenesis and antioxidant defense, reducing ROS to maintain a CSC-like, therapy-resistant phenotype. This study aims to elucidate how SIRT3-driven mitochondrial reprogramming sustains CSC maintenance to identify SIRT3 as a potential therapeutic target for preventing CRPC progression and recurrence.

Project Mentor: Sanjay Gupta, Cancer Biology

Page 322: Investigating the effects of LPS in PRB Knockout compared to Wild-Type Mouse Models

Ghazal Thiruvengadam, Department of Biology CWRU; Jacqueline Shauh, Department of Reproductive Biology CWRU; Dr. Deirdre Scully, Department of Reproductive Biology, CWRU

Preterm birth continues to be a major global health issue and is a leading cause of neonatal morbidity and mortality. Previous research links inflammation to the initiation of premature labor, but the hormonal mechanisms associated with this remain unclear. Progesterone (P4) is a steroid hormone that maintains gestation and its functional withdrawal leads to parturition. Additionally, historical data shows that P4 has an anti-inflammatory effect. This study investigates how lipopolysaccharide (LPS), derived from Escherichia coli, affects pregnancy outcomes in mice through a dose-response experiment in a genetically modified model. LPS is a bacterial endotoxin known to induce inflammation that is used to model preterm labour (PTL) in pregnant mice. The experiment included a genetically modified mouse model, the Progesterone Receptor B Knockout (PRBKO) mice, and utilized a wild-type CD-1 strain as the control. We hypothesize that PRBKO mice, compared to wild-type, will require a lower LPS dose to induce preterm labor. The pregnant mice were injected intraperitoneally with LPS on day 14.5 of pregnancy. Prior established EC50 data indicated wild-type CD-1 controls received a dose-response range between 0.25-0.375 μg/g. Comparable doses were administered to the PRBKO mice to evaluate relative sensitivity to inflammation-induced PTL. The readout was the presence of pinkies in the cage at the 24 hour mark following LPS injection. Additionally, tissues from the ovary, oviduct, and uterine horn were harvested to assess inflammatory cytokine mRNA abundance via qPCR.

Project Mentor: Dr. Sam Mesiano, Department of Reproductive Biology, CWRU Capstone Instructor: Dr. Sarah Bagby, Department of Biology, CWRU

Page 323: Influence of Hydrogen Bonding on CO2 Capture in Choline and Ethylene Glycol Mixtures

Amelia Tomak, Chemical Engineering

Due to the increase in global temperatures, carbon capture interest has surged. One of the commonly used absorbers is aqueous amine solution because of its high affinity and selectivity for CO2 even under low concentrations. However, aqueous amine requires high temperatures for regeneration, while also being highly volatile and corrosive. Therefore, alternative sorbents with low volatility and tunable binding enthalpy, such as eutectic solvents, are being studied for carbon capture. Eutectic solvents relevant to CO2 capture are often composed of hydrogen bond acceptors (HBAs) and hydrogen bond donors (HBDs) with the ability to chemisorb CO2. Given that the HBA and HBD compositions affect key solvent properties, such as volatility and CO2 capacity, this study focuses on creating a better understanding of the impact of the HBD concentration on the CO2 separation process, in particular the capacity and regeneration. To achieve this objective, mixtures of ethylene glycol (EG) HBD and choline 2-cyanopyrrolide ([Ch]+ [CNpyr]-) HBA were examined as a function of HBA:HBD molar composition (1:3, 1:4, and 1:5). The samples were evaluated by performing absorption experiments at 25 °C and 1 bar of CO2 followed by desorption at 50 °C. Products and the various CO2 binding sites contributing to the overall capacity were identified and quantified by 13C nuclear magnetic resonance (NMR) spectroscopy. A general decrease of the gravimetric capacity was observed with increasing HBD concentration. Overall, while the concentration of HBDs did not directly impact the regenerability of the solvent, the increased HBD-HBD and HBA-HBD interactions at higher HBD concentrations resulted in a decrease in both the HBD-CO2 and HBA-CO2 adduct formation. This study showcases the properties of eutectic solvents, and primarily the compositional effects, in controlling the CO2 absorption-desorption capability as relevant to CO2 capture for emission mitigation and direct air capture efforts.

Project Mentor: Ruth Dikki, Department of Chemical and Biomolecular Engineering; Burcu Gurkan, Department of Chemical and Biomolecular Engineering

Page 324: Exploring the Dynamic Relationship Between Circadian Rhythm and Oligodendrocyte Cell Fate

Martina Torello-Viera, Neuroscience; Dr. Jesse Zhan, Institute for Glial Sciences, Department of Genetics and Genome Sciences; Dr. Paul Tesar, Institute for Glial Sciences, Department of Genetics and Genome Science, CWRU School of Medicine

Circadian rhythms regulate physiological and behavioral patterns in alignment with the routine 24-hour cycle. Oligodendrocytes, a type of glial cell, are responsible for forming myelin sheaths around axons, enabling fast and efficient neural signal transmission while providing structural stability and metabolic support to neurons. While most commonly associated with the sleep-wake cycle, in the central nervous system (CNS), we found that the circadian clock plays a crucial role in oligodendrocyte differentiation, a process vital for myelination and neural function. The objective of this study is to investigate the role of the circadian clock in oligodendrocyte lineage progression by focusing on the transcription factor BMAL1 and its role in regulating the key processes of the oligodendrocyte lineage: including proliferation, differentiation, and myelination. The downstream targets of BMAL1 remain relatively unknown, leading us to investigate BMAL1-regulated genes that are critical for oligodendrocyte differentiation. This study will utilize in vitro mouse models to investigate the role of BMAL1 in oligodendrocyte development and use techniques such as CRISPR knockout, RNA extraction, qPCR, and Western blot analysis, allowing us to study how BMAL1 disruption affects gene expression, myelination mechanisms, and oligodendrocyte differentiation. We expect that modulation of BMAL1 expression alters oligodendrocyte differentiation. By defining the transcriptional and functional output of the oligodendrocyte circadian clock, we aim to understand how disruptions in these rhythms may impair myelination, potentially leading to detrimental effects on neural function and contributing to neurodegenerative conditions. With a translational approach, our research aims to apply its findings to clinical settings, particularly in the context of multiple sclerosis, where promising new treatments are emerging. By understanding how the circadian clock regulates oligodendrocyte lineage processes, our findings will provide information on mechanisms that can be leveraged to develop more effective therapeutic approaches to help improve patient outcomes.

Project Mentor: Dr. Paul Tesar, Department of Genetics and Genome Sciences, Institute for Glial Sciences, CWRU School of Medicine

Capstone Instructor: Dr. Jon Niemi, Department of Neurosciences, CWRU School of Medicine

Page 325: LGBT Center Library Catalog

Boris Brondz, Computer Science; **Daniel Burwell,** Computer Science; **Hannah Hejazi,** Computer Science; **Deborah Park,** Computer Science; **Natalie Qiu,** Computer Science; **Fei Triolo,** Computer Science.

The CWRU Lesbian Gay Bisexual and Transgender Center, under the Division of Student Affairs' Student and Family Connections Hub, serves dozens of students, faculty, and community members daily. Among the services and resources provided is a small, single-shelf lending library that offers LGBT-themed books, DVD's, and other borrowable documents. According to the 2023 Student Engagement Survey, roughly 30% of the campus population identifies as LGBT. Despite serving such a significant campus population, the digital infrastructure for the LGBT Center library is severely lacking. Patrons looking to browse the collection are presented with a QR code to a disorganized Google Sheet and all loans are processed through a Google Form. The current system is not only cumbersome for patrons to navigate, it is also a source of overhead work for LGBT Center staff to track loans, maintain, and update library information in real time. The goal of this project is to create a custom web application that streamlines browsing, lending, and curation to fulfill the LGBT Center's organizational needs with a presentable, user-friendly interface for both patrons and staff. We expect the application to be used into the foreseeable future as a semi-automated library management system, as well as a fully browsable and searchable catalog for all lending materials in the LGBT Center library.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences.

Administrative Sponsors/Supervisors: Mailey Lorio, Division of Student Affairs: LGBT Center; Avery Ware, Division of Student Affairs: LGBT Center.

Page 326: IL-1β Mediated Regulation of Oxytocin Receptor at the Human Maternal-Fetal Interface

Emory Trout, Neuroscience [1] ; Deirdre Scully, PhD [2] ; Sam Mesiano, PhD [2,3]
1 Case Western Department of Neurosciences, School of Medicine
2 Case Western Department of Reproductive Biology, School of Medicine 3 Department of Obstetrics and Gynecology University Hospitals

Effective labor induction is essential for preventing adverse outcomes due to complications and reducing reliance on emergency Caesarean delivery. Pitocin, a synthetic derivative of oxytocin, is the standard for labor induction, but its limited efficacy can lead to failed inductions and higher rates of emergency Caesarean sections. Oxytocin has been shown to upregulate prostaglandin (PGE2) signaling and induce myometrial contractions in the natural process of labor. Additionally, labor can be initiated pre-term in response to immune system activation. The intermediary between the fetal and maternal immune systems consists of the amnion, chorion, and decidua, and in whole is referred to as the maternal-fetal interface (MFI). Thus, the MFI is involved in triggering pre-term labor. Despite both the MFI's role in pre-term labor induction and the induction of labor via Pitocin, the interaction between oxytocin and the MFI have yet to be fully elucidated. This study tested the hypothesis that oxytocin receptor (OXTR) is localized in the MFI and that OXTR expression is modulated by an inflammatory state. Human fetal membranes were collected and processed for immunohistochemistry (IHC) and immunofluorescence (IF) staining. Additionally, human decidual-stromal cell line was cultured and treated with IL-1β, an inflammatory cytokine, then processed for IHC and RT-qPCR. The human MFI samples expressed OXTR in each membrane layer of the MFI – indicating responsiveness to oxytocin release and involvement in parturition. The decidual-stromal cells demonstrated a decrease in OXTR expression in response to increasing levels of IL-1β. The lack of knowledge regarding the mechanism of oxytocin at the MFI necessitates further research. The exploration of OXTR localization and dynamics in both human tissues and induced cell lines allows for increased understanding of oxytocin signaling leading to labor, ultimately providing insight to increase the success of labor induction through the administration of Pitocin.

Project Mentor: Sam Mesiano PhD, Reproductive Biology Deirdre Scully PhD, Reproductive Biology

Capstone Instructor: David Friel, Neurosciences

Page 327: Characterizing Fungal Communities to Investigate Environmental Exposures in Hypersensitivity Pneumonitis

Shruti Vasagiri, Systems Biology; Dr. Bridget Hegarty, Department of Civil and Environmental Engineering; Dr. Maeve MacMurdo, Pulmonology, Cleveland Clinic

Hypersensitivity pneumonitis (HP) is an interstitial lung disease triggered by immune reactions to inhaled environmental antigens, most commonly from residential mold exposure. However, identifying fungal exposures that contribute to HP is challenging, as current inspection and testing methods are expensive, inconsistent, and don't account for the diversity of fungi in environments. This project investigates how fungal community composition and diversity within residential dust samples may relate to HP, with the goal of developing a reliable framework for identifying potential environmental triggers of disease. Dust samples were collected from patient homes, from which fungal DNA was extracted and sent for sequencing. The sequencing data were then processed to form ASVs (amplicon sequencing variants) with the DADA2 pipeline and analyzed using RStudio. Preliminary findings reveal variation in fungal diversity and structure between samples, suggesting that environmental and biological factors strongly influence fungal communities. Additional analysis will be done to consider additional diversity metrics and environmental metadata. Ultimately, this project aims to establish a computational pipeline capable of characterizing fungal exposure in residential settings, to improve the ability to identify and assess environmental risk factors contributing to hypersensitivity pneumonitis.

Project Mentor: Dr. Karen Abbott, Department of Biology, CWRU

Page 328: Data Analysis and Visualization of Changes in Approval Rating of Institutions in Ukraine

Umair Vaseemuddin, International Studies and Economics; **Max Goldenson,** Political Science and Economics; **Santiago Castro-Lopez,** Computer Science; **Quan-Le,** Computer Science

Given the ongoing war in Ukraine and Russia, Ukrainian institutions have been evaluated in their effectiveness of supporting citizenry and protecting territorial integrity. This project will examine the changes of trust in the office of the president, the Verkhovna Rada, and the military from the beginning of Volodymyr Zelensky's presidency, which started in 2019. Russia invaded the mainland of Ukraine in 2022, so this timeframe allows examination before the invasion, during the invasion, and a few years later with the war still being fought. The scholarly research of this project will be based on the Kiev international institute of sociology and their omnibus data. The compliant datasets are publicly available on their discussed data platform. The legitimacy of these offices has been called into question frequently by notable members of the international community, especially given the wartime context. This project aims to evaluate how approval ratings of government institutions within the Oblasts during the war in Ukraine have varied depending on proximity to the Russian-Ukraine front.

Project Mentor: David Clingingsmith, Economics

Page 329: How does the presence of artificial light and predators affect gray tree frog reproductive behavior?

Isabel Vasquez, Biology; Haley Altadonna, Biology; Michael Benard, Biology

Due to urbanization, the amount of light pollution has increased. Sources of light pollution, such as streetlights, create artificial light at night (ALAN) that can alter wildlife's reproductive behavior and interactions with predators. Gray tree frogs have been shown to prefer areas where ALAN is minor or absent. One explanation for this preference is that ALAN increases their risk of detection by predators and may also affect a male's willingness to call, which is done to attract mates. However, it remains unclear how the combined presence of light and a predator influences gray tree frog reproductive and exploratory behavior and whether they prioritize avoiding one threat over the other. The experiment used artificial pools with either ALAN, a predator call, both or neither. During the breeding season, frogs and eggs in each pool were counted, and some frogs were selected for a behavioral arena study immediately after capture. Although data analyses are ongoing, we expect gray tree frogs to prefer pools without ALAN or predators and to avoid those containing both, with frogs in the preferred conditions exhibiting greater exploratory and reproductive behavior. Previous studies have found mixed results. Some show that males continue to call with ALAN. Others suggest that females reduce movement when ALAN is present or may ignore predator calls to reach a calling male. Exposure to both ALAN and a predator could either increase exploratory behavior during trials due to threat removal or decrease it if frogs become more cautious afterward. Understanding these changes in behavior can reflect how frogs choose and weigh their options when threats are present and they are looking for a mate. Examining how frogs respond to human-caused environmental changes alongside natural threats can provide insight into the effects of urbanization on wildlife reproduction and behavior.

Project Mentor: Mike Benard, Biology

Page 330: In vitro Evaluation of Hemostatic Impairments Due to Platelets Number or Coagulation Inhibition

Isabel Vazquez, Biomedical Engineering; Dr. Sen Gupta, Department of Biomedical Engineering

Hemostasis is the physiological process that prevents uncontrolled bleeding by forming a stable thrombus at the site of vascular injury. It relies on the precise coordination between platelet activation and coagulation factor pathways, whose interplay ensures effective clot formation and stabilization. Changes in platelet count or inhibition of coagulation factor pathways disrupt this balance and increases bleeding risk. This study seeks to identify how quantitative platelet dysfunctions and coagulation factor inhibition through direct oral anticoagulants (DOACs) affects thrombus formation. While conventional coagulation assays such as Prothrombin Time (PT) and activated partial thromboplastin time (aPTT) provide information about specific stages of the coagulation cascade, they are both static assays and thrombus formation occurs under flow conditions. Whole blood samples were analyzed in the microfluidic platform TTAS-01 which quantifies thrombus formation kinetics through pressure changes over time. The effect of platelet number was evaluated with conditions ranging from 200k platelets/μL (healthy) to 20k platelets/μL (severe dysfunction), while coagulation factor inhibition was assessed with DOACs apixaban (eliquis) and dabigatran (pradaxa), with concentrations ranging from 100 nM to 1000 nM. Thrombus formation kinetics were quantified using T-TAS parameters: occlusion start time (OST) for thrombus initiation, occlusion time (OT) for overall thrombus development, and area under the pressure–time curve (AUC) for clot stability. Our results show that a decrease in platelet number caused a prolongation in OST and OT as well as a lower AUC, indicating delayed clot initiation and reduced stability. Treatment of blood samples with DOACs also showed a prolongation of OST and OT and a reduction in AUC due to hindered thrombin generation. These results reveal how quantitative platelet dysfunctions and inhibition of coagulation factors translate into functional bleeding phenotypes, enhancing our understanding of how DOACs affect different stages of hemostasis.

Project Mentor: Dr. Sen Gupta, Wallace R. Persons Professor, Department of Biomedical Engineering

Page 331: Stereo Electronic Stethoscope for Improved Clinical Auscultation

Ananya Veerubhotla, Department of Biomedical Engineering; **Nicholas Leonard,** Department of Biomedical Engineering; **Quan Tran,** Department of Biomedical Engineering; **Mackenzie Mueller,** Department of Biomedical Engineering; **Zachariah Jones,** Engineering Physics

Conventional stethoscopes demand high cognitive loads and require short term memorization to compare sounds from varying regions. Stereo stethoscopes enable real-time comparison of differing regions, increasing audio discrimination and decreasing mental effort. In addition, electronic stethoscopes in general have much greater amplification and selective filtration capabilities when compared to their traditional counterparts. Our team aims to design and manufacture an innovative stereo electronic stethoscope capable of achieving these design goals. This will be accomplished by building and testing three main subsystems: the bell, control box and computer interface. The bell will consist of two off-the-shelf stethoscope heads, each with their own hermetically-sealed microphones and preamplifier circuits. Wires will then connect both bells to a central control box capable of performing stereo analog filtration, amplification and headphone driving powered by an on-board battery system. Optionally, a user can also connect an auxiliary cable to the output of the amplifier, enabling higher-level processing on a laptop interface. This may include real-time visualization and sound recording capabilities. By combining these systems, we expect to have a fully functional stereo electronic stethoscope capable of amplifying, filtering and recording clinically relevant sounds in environmental conditions with a wide range of background noise characteristics. Our device holds significant potential to improve diagnostic accuracy, enhance clinician workflow, and provide patients with timelier access to treatment.

Project Mentor: Matthew Williams, Department of Biomedical Engineering

Page 332: Adjunct Probiotic and Psychobiotic Therapies in Depression: A Review of Randomized Controlled Trials

Nina Venigalla, Department of Biology, Case Western Reserve University

Depression is a complex disorder traditionally explained by disruptions in brain chemistry, particularly involving neurotransmitters like serotonin and dopamine. However, emerging research points to a broader physiological perspective involving the gut microbiome, centered on the gut–brain axis. The gut-brain axis is a bidirectional pathway that links the gastrointestinal tract and central nervous system through neural, hormonal, and immune pathways. Gut microbes actively participate in this system by producing neuroactive compounds, regulating inflammatory responses, and influencing host signaling mechanisms. When gut microbiota composition is disturbed, these functions can become dysregulated, leading to immune activation and altered neurotransmitter levels, both of which have been linked to the development and persistence of depressive symptoms. This literature review examines whether microbiome-based interventions, specifically probiotics, prebiotics, and psychobiotics, can improve outcomes when used as an adjunctive therapy alongside antidepressant treatments. To investigate this, randomized controlled trials (RCTs) published between 2000 and 2025 were reviewed. Studies were included if they involved adult participants (18+), administered microbiome-targeted supplements in combination with conventional depression treatments, and assessed symptom severity using validated clinical scales such as the HAMD, MADRS, or BDI. Trials incorporating microbiome analysis were also considered to better understand how changes in gut microbial composition may relate to treatment response. Several studies reported that multi-strain probiotic formulations, especially those containing Lactobacillus and Bifidobacterium species, were associated with greater improvements in depressive symptoms compared to placebo. Some also showed beneficial shifts in microbial diversity, metabolite profiles, and neuroinflammatory markers. However, findings across studies were inconsistent, and differences in study design, microbial strains, duration, and outcome measures limit broader conclusions. Taken together, current evidence suggests that microbiome-targeted therapies may offer a biologically plausible and low-risk complement to conventional depression treatments. Standardized research is needed to determine clinical relevance and clarify how gut microbiota influences mechanisms underlying mood regulation.

Project Mentor: Claudia Mizutani, Department of Biology

Page 333: Shear Thickening and Jamming in Dense Suspension: Impact of Particle Rotation

Antonio Maia, School of Engineering; Rishabh More, Department of Chemical and Biological Engineering, Monash University, Clayton, Australia; Abhinendra Singh, Department of Macromolecular Science and Engineering

Discontinuous Shear-Thickening (DST) in dense suspensions is a phenomenon where viscosity increases abruptly under shear rate due to inter-particle interactions. Many recent studies have focused on the frictional contact network and non-affine linear velocities and their correlations. However, the role of particle rotation near or at jamming in influencing the onset and magnitude of DST remains poorly understood. In this study, we use Python-based simulations to model 3D dense suspensions and analyze how particle rotation, friction, and system size affect the formation of clusters that drive jamming. Preliminary results suggest that the number of counter-rotating particles increase with both packing fraction and applied stress. We observe that the counter-rotating particle clusters grow in size and number as the shear rate increases, correlating to earlier and more abrupt jamming. Understanding these mechanisms will provide new insights into the physics of DST and could enable the development of more efficient materials processing techniques.

Project Mentor: Abhinendra Singh, Department of Macromolecular Science and Engineering

Page 334: Design of Sensorized and Motor Actuated Biomimetic Turtle Flippers

Willa Vivar-Maas, Department of Mechanical and Aerospace Engineering; **Brock Joyce,** Department of Mechanical and Aerospace Engineering, CWRU

Biomimetic robots inspire the development of various technologies and have only become more popular in recent years. A sea turtle inspired robot is being developed by the CyPhi Lab at Case Western Reserve University in hopes of improving non-invasive exploration of marine environments, control and reinforcement learning methods, and amphibious locomotion. The goal of this project is to improve the design of a previously built robotic turtle by adding sensors and an actuation system to its flippers. Adding pressure and position sensors to the flipper allow for further analysis of the forces involved in a turtle's swimming stroke, potentially leading to improved function and efficiency. The actuation system will help the robot to more accurately mimic a sea turtle's propulsion technique, which have potential applications in the development of more efficient aquatic vessels and amphibious vehicles. The actuation system aims to achieve the twist and flexing involved for each stage of the swimming stroke using motor actuated tendons. The system will be tested by submerging the flipper in a water tank and analyzing its ability to complete a full swimming stroke continuously. Data measuring the flipper tip position, flipper twist, and speed of motion will be collected and compared with a five cycle swimming locomotion model previously developed by Nick Van der Geest.

Project Mentor: Professor Zachary Patterson, Department of Mechanical and Aerospace Engineering, CWRU

Capstone Instructor: Professor Ya-Ting Liao, Department of Mechanical and Aerospace Engineering, CWRU

Page 335: Outcome Coherence Modulates the Sense of Agency in a Virtual Hand Task

Lucas Vorkoper, Department of Neuroscience

The sense of agency (SoA) is the experience of initiating and controlling one's own actions. It is proposed as a key component of embodiment—the combined cohesive perception that one is the owner of their body (body ownership) and that the actions of their body are under their control (agency) [MP1] . Previous work with virtual hands has found that the SoA relies more on the ability to achieve an intended outcome than on the reliability of visual and proprioceptive feedback associated with the hand's movement. However, it is unclear if incongruencies in the outcome of an action can affect an individual's feeling of control over a virtual limb. We anticipate that coherent, predictable outcomes will lead to greater tolerance for sensory feedback disruptions related to body movement. Using a forced-choice paradigm in a virtual hand mixed-reality setup, we explore variations in the lag between a color change and an auditory tone that occur from the same causal event (a virtual hand making contact with a sphere). Greater transient alignment likely leads to a reduced perception of virtual hand movement lag. The goal is to potentially demonstrate a processing preference for external outcomes over body-based sensory feedback when internal predictions are compared with realized events to compute agency. The results will contribute to research on human–machine interaction by clarifying how external outcome predictability shapes the sense of agency.

Project Mentor: Paul Marasco, Department of Biomedical Engineering

Page 336: Testing Alternative Electron Transport Layers for use in Organic Photovoltaics

Kalli Wall, Chemistry B.S. major

The threat of climate change has made the development of renewable energy sources a priority. The optimization of organic solar cells has become a major goal in this process. An important part of these organic solar cell devices is the electron transport layer (ETL). This project aimed to find a replacement for our standard ZnO ETL with a new or treated ZnO ETL that would improve electron mobility in the devices. The ETLs tested were standard ZnO, UV Ozone treated ZnO, L-glutathione treated ZnO, TiO_2, and Mo doped SnO_2. The ETLs were tested in solar cell devices and achieved average efficiencies of 3.7%, 4.0%, 2.2%, 0.0%, and 3.1%, respectively. The standard ZnO, UV Ozone treated ZnO, L-glutathione treated ZnO, and Mo doped SnO_2 were then tested in electron mobility devices and achieved average mobilities of 5×10^{-5} $cm^2V^{-1}s^{-1}$, 3×10^{-4} $cm^2V^{-1}s^{-1}$, 4×10^{-6} $cm^2V^{-1}s^{-1}$, and 5×10^{-6} $cm^2V^{-1}s^{-1}$, respectively. Our results showed that devices incorporating ZnO treated with UV ozone consistently demonstrated the highest performance. While the exact mechanism is not fully understood, these findings indicate that UV ozone treatment of ZnO has a beneficial effect on device performance and may be a valuable step in future OSC fabrication protocols. We are currently exploring a selection of conjugated Self-Assembled Monolayers (SAM) to treat ZnO as another potential ETL alternative.

Project Mentor: Genevieve Sauve, Department of Chemistry, CWRU

Page 337: A Literature Review of Sleep in Childhood ADHD and ASD

Liwen Wang, Department of Psychological Sciences, Case Western Reserve University

Sleep is crucial for physical development, cognitive functioning, and emotional regulation. When sleep is insufficient or disrupted, it can lead to multiple complexities, including decreased concentration, poorer executive functioning, and difficulties managing emotions. Sleep problems are especially prevalent and a prominent issue in children and adolescents with neurodevelopmental disorders (NDDs), which affect the health and quality of life in both the child and their caregivers. Children with Attention-deficit hyperactivity disorder (ADHD) and Autism spectrum disorder (ASD) are particularly vulnerable to sleep problems. Research estimates that up to 80% of ADHD children and two-thirds of those with ASD experience sleep difficulties (Richdale & Schreck, 2009; Becker, 2020). Sleep is rarely addressed in ADHD or ASD treatments and often overlooked despite a consistent pattern between the two. With the steady rise in the prevalence of ADHD and ASD, with associated sleep difficulties, there's a need for holistic and targeted interventions. This literature review aims to examine the relationship between sleep problems and cognitive, emotional, and social outcomes in children with ADHD and ASD. A literature search was conducted using Google Scholar, PubMed, and PsycINFO using the following keywords in mixed combinations: sleep, ADHD, neurodevelopmental disorder, ASD, melatonin, and stress. Findings suggest that sleep problems predict quality of life, emotional and behavioral dysregulation, and elevated parental stress (Darweesh et al.,2021; Becker, 2020; Bar et al., 2016). These results highlight the importance of implementing effective sleep-focused interventions in the context of these NDDs' complexities. However, existing studies are cross-sectional, limiting causal conclusions. Further longitudinal studies are needed to determine how improving sleep can potentially alleviate ADHD and ASD symptoms, ultimately enhancing overall developmental and family outcomes.

Project Mentor: Joshua Wilt, Department of Psychological sciences

Page 338: Examining the Association between Food Resource Management and Food Security

Erik Watka, Department of Nutrition, Sarah R. Morrison, M.A., Brenna Ellison, PhD, and Melissa Pflugh Prescott, PhD, RDN

In the United States, 13.5% of all households experienced food insecurity in 2023. Trends over the past decade have shown that food insecurity remains a persistent public health issue, negatively impacting individuals and households' ability to maintain a sufficient, healthy, and nutritious diet. Based on prior studies, certain behavioral food resource management skills, including meal planning, grocery shopping, food storage, cooking, and utilizing leftovers may be factors in improving food utilization and subsequently, food security. This study examines the association between baseline food security status and food resource management behaviors in adults who participated in a culinary intervention program. Participants completed a survey examining behaviors and attitudes towards food management, along with the USDA Food Security questionnaire. We hypothesize that food secure individuals will display stronger food resource management behaviors compared to those who are food insecure. Analyzing and understanding these associations is important for helping dietitians and public health professionals design more effective nutrition education and intervention programs that promote healthier food behaviors among food-insecure individuals.

Project Mentors: Dr. Melissa Prescott, Department of Nutrition; Sarah R. Morrison, Department of Nutrition

Page 339: Custom Linear Actuators for Usage in BAJA SAE Driver Training

Laith Wattar, Mechanical Engineering; **Yousef Khalaf,** Mechanical Engineering; **Diego Acosta-Felix,** Mechanical Engineering

Driver training is an essential component of success in off-road racing, where unpredictable terrain and obstacles challenge even the most experienced competitors. Simulators provide a safe and repeatable environment to study and refine vehicle control, yet there are very few commercial solutions available that are tailored to replicate the harsh conditions encountered in BAJA SAE competitions. Existing motion systems are often unaffordable, have limited actuator travel, and lack the capability to reproduce the rapid accelerations characteristic of off-road driving. Thus, this project addresses the question: How can a linear actuator be engineered to realistically reproduce BAJA SAE suspension travel and provide terrain feedback, all while maintaining safety and affordability?

To explore this problem, our team designed and constructed a custom linear actuator assembly to be mounted on the CWRU BAJA Model H frame. This actuator works in coordination with Simhub and Simtools software to send game motion data to our servo controller. An actuator assembly consists of a motor, encoder, coupler, and ball screw that converts rotational motion into precise linear displacement, allowing the system to replicate car movements in real time. Simulator speeds and accelerations will be gathered using sensors mounted to the car, and the collected data will be compared to our predicted performance calculations to ensure that the system meets its intended specifications. Our actuator design and findings from this research will aid in creating a reliable motion platform tailored to BAJA SAE, improving driver performance and preparedness.

Faculty Mentor: Dr. Richard Bachmann, Department of Mechanical and Aerospace Engineering

Capstone Instructor: Dr. Ya-Ting Liao, Department of Mechanical and Aerospace Engineering

Page 340: Time to Report: Demographic Patterns in Crime Reporting, Los Angeles (2020–2024)

Nathan Webb, Finance, Weatherhead School of Management; **Matias Facchinato-Sitja:** Economics, College of Arts and Sciences; **Sabrina Feldberg:** Economics, College of Arts and Sciences; **James Calipetro III:** Economics and English, Weatherhead School of Management

We investigate the relationship between crimes and victims' demographic characteristics. Accordingly, we ask the following questions: Does a victim's race and ethnicity impact how long s/he reports an incident? Subsequently, does a correlation exist between the type of crime committed and how long each racial and ethnic group takes to report it? We found a dataset that tracks crimes committed in Los Angeles County, California, between 2020 and 2024. The dataset includes (a) the type of crime, (b) where it occurred, (c) against whom it was committed (including demographic characteristics), and (d) the dates the offense occurred and when it was reported to law enforcement.

Project Mentor: David Clingingsmith, Economics

Page 341: Effect of early-life circadian rhythm disruption on myeloid cell reprogramming subsets in neonatal mouse pups

Katherine Wen, Biochemistry; Sarah Cioffi, Statistics, and Devashis Mukherjee, Dept. of Pediatrics, CWRU SOM

Circadian rhythm (CR) are evolutionarily conserved systems entrained by the light cycle. CR regulates oscillations of transcription factors BMAL1, influencing major physiological processes. In utero, fetuses lack intrinsic CR due to absence of light cues, hence are entrained by maternal CR. Preterm birth elicits abrupt transition from a dim, maternal-entrained environment to a light-intensive NICU coinciding with a critical window of immune development, however the effects of this disruption on immune defense are unclear. In a myeloid cells-restricted fashion, we have shown that postnatal P4 pups lacking KLF2, an anti-inflammatory transcription factor, have increased endotoxemic mortality (lipopolysaccharide, LPS) compared to controls, attributable to pro-inflammatory neutrophils. To model CR disruption, KLF2 KO and control (Cre) mouse pups were randomized at birth to standard lighting (SC, 12h light/12h dark), constant light (LC), or constant dark (DC). At P4 endotoxemia was induced by 5μg/g LPS injection followed by mortality monitoring, serum procurement, and polychromatic flow cytometry. In Cre pups, LC increases LPS mortality significantly, whereas DC confers near 100% survival. In contrast, KO pups have uniformly high mortality across all circadian conditions without the protective effect of DC conditions. Mirroring the mortality data, the circulating neutrophil fraction is significantly higher and the monocyte population is significantly lower in Cre LC pups, and in KO pups across all circadian conditions. Furthermore, circulating IL-1β levels were higher in Cre LC pups, as well as in KO pups across all circadian conditions. RNA-seq of neutrophils showed that Bmal1 gene expression is significantly lower in KO mice, explaining the absence of DC protection for KO pups against endotoxemic mortality due to its role in suppressing IL-1β release. In conclusion, our findings demonstrate that early-life circadian rhythm disruptions critically shape neonatal inflammatory responses and survival following endotoxemic challenges.

Project Mentor: Devashis Mukherjee (CWRU SOM)

Page 342: Computer Control for Individuals with Cervical Spinal Cord Injuries

Amith Chitneni, Biomedical Engineering; **Kailee Kee,** Biomedical Engineering; **Brian Chang,** Biomedical Engineering; **Brianna Ross,** Biomedical Engineering; **Cooper West,** Biomedical Engineering

Cervical spinal cord injuries are primarily caused by motor vehicle accidents or falls, affecting over 300,000 people in the United States. The severity of the injury can range from deficiencies in motor and sensory controls, to total paralysis or even death. Unfortunately, no pharmacological treatments are able to restore the functions lost. Rather, rehabilitation and adaptive technology are being utilized to improve the quality of life for affected individuals. This project seeks to address the inaccessibility of computers for those with cervical spinal cord injuries (SCIs) by creating a novel method of computer control for individuals with C6 SCIs and below. We developed a control system that utilizes electromyography (EMG) signals from large muscles located in the forearm to select the type of click (left click, right click) and infrared sensing to implement eye tracking that manipulates the cursor's location on the computer screen in real time. The accuracy and response time of this system were assessed using a custom dexterity test to determine if the performance is competitive with similar technology. This multimodal device combines the strengths of biosignal processing and eye tracking to create an intuitive, high-performing tool. While biosignal-based devices often have better accuracy than eye tracking solutions, they are associated with higher costs because they require additional electrical components. Current solutions on the market are limited and expensive, often costing thousands of dollars. Therefore our project aims to develop a more affordable and accessible solution to help individuals with cervical SCIs regain greater independence in daily activities.

Project Mentor: Dr. Christopher Pulliam, Department of Biomedical Engineering

Capstone Instructor: Dr. Matthew Williams; Dr. Colin Drummond, Department of Biomedical Engineering

Page 343: Improvements to Background Oriented Schlieren Imaging for Field Imaging

Enzo Wood, Mechanical and Aerospace Engineering, Nolan Haeger, Mechanical and Aerospace Engineering

Background Oriented Schlieren Imaging (BOS) is an imaging technique used for detecting changes in the optical index of transparent media, which in gases is directly proportional to the density. BOS has several characteristics that make it the best option for imaging large-scale compressible flow phenomena outside of a laboratory, i.e. field testing. BOS requires image post-processing to produce usable images, and the algorithm used to do so has a significant impact on the quality of the data.. At the request of the DoD this research aims to improve existing BOS software in a variety of ways. Some improvements will enhance the user experience, automating previously tedious and unreliable user inputs. Other improvements aim to improve the image quality when imaging natural backgrounds as would be present in field testing. Work will be done to improve the algorithm itself, as well as create guidance for enhancing the use of natural backgrounds. Research will be ongoing, as the project is in the first few months of a year-long endeavor.

Project Mentor: Dr. Bryan Schmidt, Department of Mechanical and Aerospace Engineering, CWRU

Page 344: Economic Determinants and Decoupling Dynamics of Global CO_2 Emissions: A Statistical Analysis

Ian Xu, Department of Mathematics, Applied Mathematics, and Statistics

Understanding the drivers of global carbon emissions is critical for designing effective climate policy and evaluating progress toward sustainable growth. This study investigates the extent to which population, gross domestic product (GDP), and energy consumption explain national CO_2 emissions, and whether countries have achieved economic growth without proportional increases in emissions—a phenomenon known as decoupling. Using a panel dataset covering over 100 years of global economic and environmental indicators, the data were filtered, standardized, and log-transformed to address skewness. A multiple linear regression model was constructed to predict national CO_2 emissions from socio-economic and energy variables. Stepwise model selection based on the Akaike Information Criterion identified population and primary energy consumption as the strongest predictors, with an adjusted R^2 of 0.95, indicating that these two variables account for the vast majority of the variation in emissions. Residual analysis revealed consistent over- and under-emitters relative to the model's expectations, suggesting that factors such as industrial structure and energy efficiency significantly influence deviation from global patterns. In a second stage, the project examined decoupling dynamics by modeling the temporal slope of CO_2 emissions per GDP for each country. Results indicate that most nations show significant negative trends (decoupling), particularly post-industrial economies, while developing or resource-dependent nations often exhibit recoupling, where emissions rise with economic growth. These findings highlight the central role of energy intensity and structural economic change in shaping emission trajectories and underscore the need for differentiated policy approaches to achieve global carbon reduction targets.

Project Mentor: Jenny Brynjarsdottir, Department of Mathematics, Applied Mathematics, and Statistics

Page 345: Natural and non-toxic removal of microplastic from tap water

Elizabeth Moody, Orange High School; **Annie Wei,** Orange High School; **April Yao,** Solon High School

Microplastics are present across various domains of human activity and exposure. Most drinking water facilities use aluminum-based compounds to remove suspended particles. However, aluminum exposure has been associated with neurological disorders. We develop a natural and non-toxic method to remove microplastic from tap water and measure its removal efficiency. Our results show that chia seed mucilage offers a sustainable, plant-based alternative for reducing microplastic contamination in drinking water. Tests conducted in collaboration with the Ohio State University showed that the chia seed mucilage flocculant was not only safe but also much more effective than traditional chemical flocculants, including aluminum oxide, aluminum chloride, and ferric chloride.

Project Mentor: Longhua Zhao, Department of Mathematics, Applied Mathematics, and Statistics

Page 346: Proteomic Analysis of the Effect of Complement Factor 3 Depletion on Neuroinflammation Following Intracortical Microelectrode Implantation

Sydney S. Song, Johnathan Huff, **Zeynep Ekin Yayci,** Lindsey N. Druschel, Jeffrey R. Capadona
Department of Biomedical Engineering, CWRU

The neuroinflammatory response to chronically implanted intracortical microelectrodes (IMEs) is one of the major modes of failure influencing the recording performance of IMEs. The short functional lifetime of IMEs limits their implementation in clinical applications such as brain-computer interface (BCI) systems. IMEs can record neural signals only from neurons within approximately 50 - 150 μm of the implant site, making neuronal health and proximity critical for signal quality. The insertion of the electrode into the cortex causes mechanical trauma to the neural tissue, disrupts the blood-brain barrier and initiates an inflammatory cascade, resulting in the isolation of the electrode both physically and electrically. Previous studies have shown that activation of the complement cascade contributes to this neuroinflammation, with complement factor 3 (C3) serving as the central convergence point of all three complement initiation pathways. Previous transcriptomic studies from our lab observed a delayed but persistent neuroinflammatory response in C3 knockout ($C3^{-/-}$) mice following IME implantation. However, characterization of protein expression is necessary to expand upon these findings and elucidate the molecular mechanisms involved. To evaluate the potential of C3 as a therapeutic target to attenuate neuroinflammation, we performed cell-specific spatial profiling of protein expression in $C3^{-/-}$ mice implanted with nonfunctional probes. Protein expression between $C3^{-/-}$ and wild-type (WT) mice was compared using a panel of 63 proteins related to autophagy, neuronal health, glial activation and peripheral immune signaling. We examined the spatial distribution of the neuroinflammatory response within 270 μm of the implant site, segmented into 90 μm intervals at 4, 8, and 16 weeks post-implantation. We further segmented by cell-type using NeuN and GFAP morphological markers to distinguish neuronal (NeuN+), astrocytic (GFAP+) and remaining ("Else") regions. The largest changes in protein expression are expected near the implant site, while cell-type segmentation enables identification of cell-specific pathways contributing to IME failure.

Project Mentor: Dr. Jeffrey Capadona, Case Western Reserve University Department of Biomedical Engineering

Page 347: Polyamine Functionalization of Polymer Enzyme Mimics and its Effects on Catalysis Rates

Benjamin Yekelchik, Polymer Science and Biomedical Engineering

Enzymes are biological catalysts constructed from natural amino acids arranged in unique combinations. These molecules are critical in speeding up chemical reaction and have major industrial applications such as in the detergent industry to break down proteins, fats, and starches that contribute to stains. However, their natural complexity, limited stability in harsh conditions, and high production costs motivate the search for synthetic alternatives. This study investigates how polyamine functionalization contributes to catalytic performance of polymer enzyme mimics. Styrene maleic anhydride (SMA) backbone polymer was first functionalized with selected amino acid combinations identified from prior work as strong performers in protease and lipase catalysis. Utilizing combinatorial chemistry, these polymers were then co-functionalized with eight polyamines capable of inducing crosslinking with the aim of altering the tertiary structure of the polymers to investigate corresponding catalytic activity. Catalytic activity was evaluated using fluorescent protease and lipase assays, and top performers from each assay were identified. Results showed several promising polyamine-amino acid combinations that improved reaction efficiency in comparison to corresponding controls. Certain polyamines such as ethylenediamine and spermidine repeatedly presented as top performers while cadaverine was present in several of the worst-performing combinations. Our findings suggest that polyamine-induced crosslinking modulates polymer structure in a manner that allows tuning of catalytic function. Understanding this relationship between polymer structure and resulting catalytic performance will advance the development of stable, cost-effective, and customizable synthetic catalysts.

Project Mentor: Professor Valentin Rodionov, Department of Macromolecular Science and Engineering

Page 348: Knockout of C19orf12 Gene Affects Misfolded Alpha Synuclein in Mouse Brain

Alexander Yin, Biology BS

Abstract: Mitochondrial membrane protein-associated neurodegeneration (MPAN) is characterized by abnormal iron accumulation in the midbrain, leading to severe neurological symptoms in juvenile and adult patients. MPAN is linked to mutations in C19orf12, whose function remains unclear. Given the reported α-synuclein (α-syn) aggregation in MPAN brains, we investigated whether loss of C19orf12 influences α-syn pathology in a mouse model lacking the C19orf12 homolog. Hemibrains from knockout and wild-type mice were homogenized and sequentially extracted into RIPA-soluble, urea-soluble fraction I (without sonication), and urea-soluble fraction II (with sonication). Protein levels of total α-syn and phosphorylated α-syn at Ser129 (p-syn, a marker of misfolded α-syn) were analyzed by Western blot. Expression levels of p-syn (Ser129) and total α-syn were unchanged in RIPA and urea-soluble fraction I. In knockout brains, however, p-syn was increased in urea-soluble fraction II without a corresponding change in total α-syn levels. These findings indicate that loss of C19orf12 promotes α-syn phosphorylation at Ser129 within protein aggregates, suggesting a mechanistic link between MPAN and synuclein-related pathological pathways.

Faculty Project Mentor: Wenzhang Wang, Department of Pathology, Case School of Medicine

Capstone Instructor: Elliot Gardner, Department of Biology, Case Western Reserve University

Page 349: 53BP1's Role in Chromatin Remodeling: A Tumor-Suppressive Strategy Utilizing CRISPR-Guidance Systems

Logan Yu, Department of Biochemistry; Eric Zheng, Department of Biochemistry (graduated in May 2025); Brayden Beathe-Gatley, Biomedical Sciences Training Program; Yen-Jui Su, Department of Pharmacology; Dr. Fangfang Wang, Department of Pharmacology; Dr. You-Wei Zhang, Department of Pharmacology

53BP1 is a tumor-supressor binding protein to the p53 gene involved in the DNA damage response, driving the non-homologous end joining (NHEJ) pathway for DNA double-strand break (DSB) repair. In a 2022 study, Zhang et al. demonstrated a previously undiscovered role of 53BP1 in mutually dependent liquid-liquid phase separation (LLPS), where biomolecular condensates form between proteins, with heterochromatin protein 1 alpha. This led to 53BP1's distinct role in forming heterochromatin, a tightly compacted region of transcriptionally silent DNA, helping stabilize the genome and cell under stress. However, whether LLPS is necessary and sufficient on its own to drive heterochromatin formation remains unclear, which this study aims to address using a CRISPR-based guidance system. A CRISPR-based fusion protein was engineered housing a nuclease-deactivated dCasmini system fused to various domains of 53BP1 with either LLPS proficiency or deficiency. Furthermore, an FKBP12-derived peptide was included as well to bind Shield-1, a small ligand that can bind to 53BP1 and allow for tunability of 53BP1 abundance. Complementary single-guide RNA (sgRNA) plasmids targeting Myc, Kras, and ERBB2 oncogenes were also developed to target respective oncogenic loci. Currently, the 53BP1 expression vectors and sgRNA plasmids have been developed with their sequences confirmed, followed by initial attempts at generation of stable lines. The plasmid constructs were first transfected into HEK293T cells alongside psPAX2 and VSV-G Lentivirus vectors, followed by lentiviral transduction into HCT116 and U-2 OS cancer cell lines for stable cell line creation. However, due to challenges with stable fusion protein expression, transient transfection protocols were adopted which are continuing to be tested. If 53BP1 were successfully tethered onto oncogenic regions, it would be expected for LLPS to induce heterochromatin formation, therefore inactivating downstream transcriptional activity, and suppressing tumor cell activity.

Project Mentor: Dr. You-Wei Zhang, Department of Pharmacology

Page 350: Decentralized Social Media Network Analysis

Arturo Muñoz, Computer Science; **Harry Hillsdownley,** Computer Science; **Benjamin Kramer,** Computer Science; **Ruslan Zabarov,** Computer Science; **August Matkov,** Computer Science

We introduce Bluesky Constellations, a web-based visualization tool that showcases the social dynamics that emerge within online conversations on the decentralized Bluesky Network. We focus on exploring subtopics emerging within conversations, the influence of users, and communities of users within a conversation topic. This platform seeks to answer the question: How can computational network analysis and visualization methods reveal patterns of interaction, influence, and community formation within social platforms? This information is relevant to researchers, journalists, and marketers to visualize information flow and other key social aspects within a network of participants. The study contributes to ongoing research in computational social science by offering an open and transparent framework for examining public online discourse. By analyzing user interactions and conversation structures, the project provides insight into how digital communities self-organize and how information flows between participants. Data from a social media platform is collected, processed, and modeled as a network graph that represents relationships among users and topics. Visualization and clustering techniques are used to identify influential participants, thematic clusters, and the overall structure of discussions. Preliminary results indicate that online conversations tend to form recognizable “social constellations,” reflecting both shared interests and broader patterns of engagement. The project aims to demonstrate that network-based analysis offers a powerful lens for understanding social interaction and information diffusion in contemporary digital spaces.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences

PAge 351: Determining The Effectiveness of Number Lines and Fraction Comparison Strategies to Rank the Magnitudes of Fractions

Asiya Zaidi, Department of Psychological Sciences, Case Western Reserve University

Mathematical cognition, specifically the ability to comprehend and manipulate fractions, creates the foundation for higher-level quantitative reasoning in adolescents and young adults. Extensive research has highlighted the impact of working memory and attentional control on mathematical processing. However, the effect of contextual variables, such as auditory interference, on these cognitive mechanisms has been underexplored. The present study investigates whether background music affects college students' accuracy and efficiency in ranking fractions by magnitude. Participants are randomly assigned to one of three auditory conditions: 1) self-selected music, 2) standardized researcher-selected music, or 3) no music/silence (control). Each participant is asked to complete two timed worksheets requiring them to rank sets of five fractions, ranging from 0–1, from least to greatest under their assigned auditory condition. Fraction sets vary in numerical complexity to assess differences in strategy use across difficulty levels. Accuracy is scored as the number of correctly ordered fractions out of total attempted. It is hypothesized that students in the self-selected music condition will demonstrate higher accuracy compared to those in the standardized or no-music conditions, due to enhanced familiarity and focus effects. Findings from this study are expected to contribute to the broader understanding of how environmental auditory stimuli influence cognitive efficiency, working memory, and mathematical reasoning in academic contexts.

Project Mentor: Lee Thompson, Department of Psychological sciences

Page 352: The Psychology of MAGA Republicans

Elliot Zerbe, Psychology

Since Donald Trump took office as president, federal funding for healthcare has been cut, cost of living has increased, and disadvantaged groups including LGBTQ+ individuals, women, and students have suffered further injustice through weakening the Equal Employment Opportunity Commission, removing certain protections under Title IX, and making unprecedented cuts to the Department of Education. Trump supporters have exacerbated these issues by pushing Donald Trump's harmful rhetoric, including an "us versus them," attitude, normalizing calls for violence, and maligning criticism of "woke" culture. The unyielding support of Trump's supporters has allowed him a platform to speak on and to brazenly amplify his message. As seen on the January 6th attack on the Capitol, Trump devotees are willing to fight in his name, and commit unbridled acts of violence. American society is becoming more precarious because of this drastic polarization. The purpose of this presentation is to examine factors that contribute to people becoming and remaining Trump supporters. By identifying the foundation of their political identity, we may understand how these individuals can be depolarized and renew America. This presentation also explores what makes Trump a favorable candidate for a political cult leader, including his psychological characteristics and public persona. Literature from the fields of psychology, sociology, political science, and social epistemology were reviewed. Surveys, observational research, and focus group data served as tools to collect information and allow the analysis of Donald Trump and the MAGA population, studying personality makeup, attitudes, and group adhesion. Methodologies from Personal Construct Theory, Constructivist Model of Radicalization, Big Five framework, Social Capital Theory, and large group regression aided in explaining the psychology of MAGA Republicans on both the individual and group level. The findings reflect a time where the United States has never been more divided, resulting in an array of issues across American society.

Project Mentor: Rachel McClaine, Department of Psychological Sciences

Page 353: Defining Critical Residues Mediating the Interaction Between Human VPS39 and SARS-CoV-2 ORF3a

Michelle Zhang, Biology; Dr. Brianna Busscher, Department of Reproductive Biology.

SARS-CoV-2, the causative agent of COVID-19, encodes multiple accessory proteins that facilitate viral survival and pathogenesis. Among them, ORF3a disrupts host autophagy, an essential cellular degradation pathway, by preventing autophagosome–lysosome fusion. This inhibitory activity has been linked to ORF3a's ability to bind and sequester the human protein VPS39, a key component of the HOPS tethering complex, which facilitates the assembly of the SNARE complex for fusion of amphisomes with lysosomes. While structural data suggest potential binding interfaces, the exact residues critical for this interaction require experimental validation. In collaboration with Dr. Alexandria Miller's lab at the University of Iowa, we identified candidate interface residues in both SARS-CoV-2 ORF3a and human VPS39 based on preliminary CryoEM structural models. On the viral side, the selected mutants were D173K, H182A, W193R, and D222K; on the host side, the VPS39 mutants were K13A, Y40F, K60D, and H290E. Site-directed mutagenesis was used to evaluate the role of specific residues in mediating complex formation. Mutant constructs were expressed in HEK293T cells with binding efficiency assessed relative to wildtype proteins. Co-immunoprecipitation assays were used to examine their respective interactions based on different combinations of the mutants. The results would demonstrate that specific residues in both host and viral proteins govern the stability of the VPS39–ORF3a interaction and would help to validate structural predictions from CryoEM studies. The project aims to highlight potential molecular targets for therapeutic intervention aimed at restoring normal autophagic flux in infected cells.

Project Mentor: Dr. Tsan Sam Xiao, Department of Pathology
Capstone Mentor: Dr. Emmitt Jolly, Department of Biology

Page 354: The Role of DNA Origami Nanostructures in Drug Delivery

Yubo Zhao, Department of Chemistry

The modern medicine faces significant challenges in delivering drugs effectively. These challenges include poor targeting, low efficiency, and harmful side effects. The whole project discusses about the potential of DNA origami—a technique that folds DNA into precise nanoscale shapes—to develop drug delivery. This review paper mainly researches on how the physical and chemical properties of these nanostructures, such as their shape, size, and responsiveness to the acidic environment of tumors, influence their ability to deliver therapeutic cargo like proteins and nucleic acids directly to cancer cells by examining recent scientific literature. The analysis can ensure that DNA origami offers remarkable control over drug targeting and release, which can enhance treatment efficacy and reduce toxicity. However, the main limitation contains the structural instability of these nanostructures within the body, where they can degrade prematurely. The solution that are provided in present include protective polymer coatings, which are discussed as a path forward. The conclusion is that while DNA origami presents a powerful platform with different functions for next-generation drug delivery, overcoming its stability challenges is the important point to unlocking its full clinical and medicinal potentials.

Project Mentor: Professor Divita Mathur, Department of Chemistry, Case Western Reserve University

Page 355: Abstract Comparative Study of Corrosion Behavior in Additively Manufactured and Wrought Stainless Steel

Zhansar Zhaparov, B.S. Mechanical Engineering

Corrosion, the chemical deterioration or destruction of materials, is a multi-billion-dollar industry problem that directly impacts the safety of our daily lives. It affects critical systems such as bridges, vehicles, planes, water supply networks, and medical implants. The issue is especially pressing in the aggressive marine environments, where highly acidic and chloride-rich substances can alter the chemical properties and mechanical behavior of the materials and structures (1). If left unchecked, corrosion can lead to severe health consequences and serious monetary losses. It was estimated that the total direct cost of corrosion in the US is over $276 billion annually (2). Despite extensive studies of metal corrosion behaviour, the corrosion processes of additively manufactured metals are largely unexplored, with most research focused on mechanical properties and ex situ observations. This study applies fluorescence microscopy to characterize in situ and localized corrosion processes in additively manufactured steels. Samples of both 3D-printed and wrought stainless steel 304L and 316L were fabricated and prepared using a standardized epoxy mounting and polishing process. Bulk corrosion measurement was taken in a 3.5 wt% NaCl solution buffered with HEPES on Jasco FP-8350 fluorimeter. Pre- and post-corrosion scanning electron microscopy (SEM) and X-ray dispersive spectroscopy (EDS) characterized surface morphology and elemental distribution after immersion. Results indicate that SS316L corrodes more slowly than SS304L, consistent with its molybdenum-enhanced passive film. It was shown that the corrosion rate of SS316L is generally slower than that of SS304L, consistent with the literature. Moreover, the 3D-printed SS316L exhibited a slower corrosion rate than its wrought counterpart, whereas the opposite was true for SS304L. These results can be attributed to the surface morphology, where it was generally observed that traditional SS316L had more surface precipitates and potential cracks than 3D-printed SS316L, which was opposite for SS304L.

Project Mentors: Dr. Zechariah Pfaffenberger, Department of Physics Prof. Lydia Kisley, Department of Physics and Chemistry

Page 356: Relationship Between Hours Worked and Burnout in Resident Physicians: A Literature Review

Carolyn Zhu, Psychology and Biology

The Accreditation Council for Graduate Medical Education (ACGME), the governing body for medical residency training policy in the United States (US), implemented reforms in 2003 after growing concerns on the impacts of long hours in training on quality of patient care. However, the impacts of long hours on the well-being of physicians themselves also need to be explored, as half of respondent medical residents in a national survey scored significantly higher on burnout and depression than the general US population. The literature review process consisted of finding quantitative and qualitative studies from Google Scholar, Web of Science, and PubMed, using keywords like “resident physician,” “hours,” “mental health,” and “burnout.” Further analyses were later obtained through cited articles in studies found from the preliminary literature search. Results suggest that longer weekly working hours are correlated with depression and burnout in resident physicians. The correlation between long hours and poor mental health may be mediated by decreased sleep, decreased time for health-promoting activities, and increased exposure to psychological occupational hazards. A main limitation of this review was that many studies on mental health in trainee physicians are from various countries outside the United States, and each country’s training systems may have unique sets of regulations and occupational stressors. More research is needed to explore possible further reforms and to develop novel interventions for US medical residency programs to mitigate their effects.

Project mentor: Dr. Joshua Wilt, Psychological Sciences

Page 357: Nudgie: Productivity “Nudge” and Habit-Tracking Extension

Tanuj Kannan, Computer Science and Mathematics; **Ruby Lin,** Data Science and Computer Science; **Khoa Luong,** Computer Science; **Isabelle Zhang,** Computer Science and Anthropology; **Crystal Zhu,** Data Science and Economics

Constant digital engagement has made it increasingly difficult for individuals to maintain focus and build consistent habits. Many productivity tools rely on restrictive measures such as website blocking or rigid timers, which can feel intrusive and discourage long-term use. This project explores how a digital platform can encourage sustainable productivity through supportive and goal-oriented feedback rather than control. The purpose of Nudgie is to design and evaluate a browser-based habit-tracking system that helps users stay focused and intentional through subtle, personalized nudges delivered within their browsing environment.

Nudgie is significant because it reframes digital productivity as an interactive and reflective process. Rather than interrupting the user, the system promotes self-awareness through progress tracking, light reminders, and data visualization. Users can define custom goals, record completions, and view summaries of their consistency, allowing them to build a sense of accountability and accomplishment over time.

The platform features an AI-driven component that assists users in evaluating their progress and identifying strategies to achieve their goals more effectively. By analyzing trends in user activity and outcomes, Nudgie can provide tailored insights that help individuals refine their objectives and adjust their approaches to habit formation. This adaptive feedback is designed to encourage reflection and support decision-making without imposing rigid structure or judgment.

It is expected that users who engage with Nudgie will demonstrate improved self-regulation and greater consistency in maintaining personal goals. By combining lightweight habit tracking, meaningful feedback, and AI-assisted guidance, Nudgie aims to provide a balanced framework for digital focus and sustainable habit development.

Project Mentor: Shuai Xu, Department of Computer and Data Sciences

Page 358: Analysis of Shared Risk Factors & Alternative Treatments in Sleep Apnea: A Literature Review of Nerve Stimulation as Potential Treatment in Obstructive & Central Sleep Apnea for Adolescents

Ethan Zhu, Biology Major, CWRU 2026

Sleep-disordered breathing (SDB) within adolescents, regarding obstructive sleep apnea (OSA) and central sleep apnea (CSA), is particularly overlooked when considering how structural risk factors for sleep apnea could be managed to reduce the prevalence of sleep apnea. Common structural risk factors for OSA, such as obesity, adenotonsillar hypertrophy, and other physical abnormalities, while CSA in adolescents can be the result of brainstem dysfunction, neurological disorders, heart defects, etc. Traditional treatments for sleep apnea in adolescents would involve positive airway pressure (PAP) or adenotonsillectomy, or a combination of both. While effective for a significant percentage of patients, a considerable number have a rejection or ineffective result of the traditional treatment, which now requires an alternative method. This literature review collects data from multiple sources on the effectiveness of traditional treatments and on the potential for nerve stimulation as an effective treatment for OSA and CSA, focusing on different nerves respectively. Research regarding hypoglossal nerve stimulation (HGNS), which is approved for adults, was performed on adolescents with Down Syndrome (DS) and severe OSA who have rejected traditional treatment. The experiment had concluded that there was ~80% reduction in Apnea-Hypopnea Index (AHI), with no major complications (Diercks et al. 2016). Similar research that is still limited to adults with CSA shows a similar positive result with phrenic nerve stimulation (PNS) that allowed for a 60-80% reduction in the Central-Apnea Index (CAI) for all patients that received treatment (Abraham et al. 2015). Potential future studies can be conducted using PNS for adolescents who reject traditional treatments, along with further research on nerve stimulation in adolescents with OSA without DS.

Project Mentor: Professor Richard Drushel, Department of Biology, CWRU

Page 359: College Major and Job Satisfaction

Jiayi Zhu, Department of Economics; **Ha Vy Dam**, Department of Marketing; **Nathaniel Clark**, Mechanical Engineering

This study investigates whether graduates from Science, Technology, Engineering, and Mathematics (STEM) fields report higher levels of job satisfaction compared to those from non-STEM fields such as the arts, social sciences, or humanities. While STEM graduates are widely recognized for securing higher-paying jobs, less is known about how their overall career fulfillment compares to non-STEM peers. The research aims to explore whether the financial advantages of STEM careers translate into greater personal satisfaction or if other factors, such as creativity, autonomy, or social engagement, play a larger role in shaping job contentment.

The primary dependent variable is JOBSATIS, which measures respondents' self-reported job satisfaction. The key explanatory variable is NBAMEBG/NBAMEMG/NBAMENG, representing the respondent's bachelor's degree major field, which is categorized into STEM and non-STEM groups. Control variables include SALARY, AGE, SEX_2023, and years since degree derived from BAAYR3. Data will be analyzed using scatter plot and regression models to assess how field of study shape job satisfaction levels

Preliminary expectations suggest that while STEM graduates may report higher earnings, their job satisfaction may not significantly exceed that of non-STEM graduates. This potential discrepancy highlights the complexity of career satisfaction and suggests that financial rewards alone do not guarantee happiness at work. Understanding these patterns could inform students, educators, and policymakers about the broader implications of pursuing specific fields of study and challenge assumptions about the relationship between career choice, income, and fulfillment.

Project Mentor: David Clingingsmith, Department of Economics, Case Western Reserve University

Page 360: How Ethnic and Racial Identity Shapes Math Anxiety Among College Students

Isabella Zolikoff, Department of Psychology

Math anxiety affects many college students, though it is not recognized as a formal anxiety disorder. Understanding its place within the broader anxiety spectrum requires examining sociocultural factors that shape anxiety development and expression. This study investigates how ethnic and racial identity influences math anxiety among undergraduates at Case Western Reserve University, with a focus on interactions between identity experiences and parent-child dynamics related to anxiety and academic expectations. Stronger ethnic/racial identity is hypothesized to buffer against math anxiety, whereas parenting behaviors characterized by high anxiety or pressure are expected to increase it. Participants from the university subject pool completed validated surveys assessing math anxiety, ethnic/racial identity, general anxiety symptoms, anxiety-related attitudes, and perceptions of parenting relevant to math and emotional support. Additionally, participants will engaged in a semi-structured clinical interview to assess anxiety-related characteristics and their relevance to math-specific fears. Correlations and multiple regression models will evaluate how identity and parenting factors predict math anxiety individually and in combination. Findings may clarify overlaps between math anxiety and clinical anxiety, identify culturally relevant predictors, and inform future research and interventions for diverse student populations.

Project Mentor: Amy Przeworski, Department of Psychological Sciences, CWRU

Page 361: A Bioresorbable Rib Fixation Prototype and Mechanical Fatigue Simulation Device

Mark Aoun, Department of Biomedical Engineering; **Brandon Kim,** Department of Biomedical Engineering; **Andrew Menson,** Department of Biomedical Engineering; Rishit Mitra, Department of Biomedical Engineering; **Evan Zurow,** Department of Biomedical Engineering; and Matthew Williams, Department of Biomedical Engineering, CWRU

Rib fractures present a unique mechanical challenge due to the continuous cyclic loading of respiration, leading long-term metallic fixation devices to failure. These devices often experience failure in the form of breakage or loose screws, resulting in potential damage to the patient and subsequent surgeries. To address this, we are developing a fully bioresorbable rib fixation system composed of a poly(lactic-co-glycolic acid) (PLGA) matrix reinforced with poly-L-lactic acid (PLLA) fibers to provide immediate stabilization and gradual load transfer during bone healing. The composite rib plate and annealed high-crystallinity PLLA screws are designed for staged degradation to eliminate secondary surgery and to retain over 80% mechanical strength during the first six months post-implantation. The prototype is designed and fabricated using CAD modeling, fiber weaving, and polymer molding techniques. To evaluate fatigue performance under physiologically relevant conditions, we are constructing a motorized mechanical testing device that replicates cyclic forces generated by lung expansion and contraction. The device applies controlled flexural and compressive loads to simulate multi-directional stress and assess fatigue life and mechanical retention over time. The rib fixation device should aim to endure these tests, as otherwise it would not survive the repetitive fatigue within the body. Together, this system integrates material science, biomechanics, and device design to create a practical framework for validating bioresorbable fixation technologies and advancing the study of polymeric implants in thoracic applications.

Project Mentor: Professor Matthew Williams, Department of Biomedical Engineering, CWRU