26th Science Research Symposium

May 21, 2026

Celebrating Our Achievements and Future Researchers

Celebrating 30 Years of Science Research at Greeley



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26TH ANNUAL HORACE GREELEY SYMPOSIUM
SCHEDULE OF EVENTS

5:30 - 6:15
HS Cafe

LIGHT REFRESHMENTS & PRESENTATIONS
Food provided by current research students and their families

6:15 - 7:00
Main Gym

POSTER PRESENTATIONS ALL THREE YEARS
Freshmen must listen to 3 presentations and fill out form, all current students present



WELCOME & OPENING REMARKS
Mrs. Pirro, Ms. Priya Patel-Ma, Mr. Jerry Zupan



SENIOR PRESENTATIONS - ROUND #1
Sydney T, Emma T, Albert H, Katie P, Adam P, Ryan Z, Benjamin H, Eve L, Jonas B



"A DAY IN THE LIFE OF"- PHOTO MONTAGE
MCs: **Srihaan Seelam, Eddie Yang**



SENIOR PRESENTATIONS - ROUND #2
Sam S, Eve R, Naveen T, Cindy C, Samuel M, Brady W, Uma S, TingRay C, Dayuan C, Lorelai, N



SCIENCE COMPETITION - PHOTO MONTAGE
MCs: **Srihaan Seelam, Eddie Yang**



SENIOR PRESENTATIONS - ROUND #3
Mukul B, Meri L, Kevin G, Isabella G, Zoe G, Rudolf T, Jude A, Rishi K, Warren F, Stella M



SENIOR CELEBRATION & GIFTS
Emcees, Mrs. Pirro, Ms. Patel-Ma, & Mr. Zupan



ACKNOWLEDGEMENT OF INCOMING FRESHMAN
MCs: **Srihaan Seelam, Eddie Yang**



FINAL PHOTO OF ALL CURRENT STUDENTS
Mr. Jerry Zupan



CLOSING REMARKS & CLEAN UP
Mr. Jerry Zupan, Ms Patel-Ma, & Mrs Pirro

ACKNOWLEDGEMENTS

"NEVER DOUBT THAT A SMALL GROUP OF THOUGHTFUL, COMMITTED CITIZENS CAN CHANGE THE WORLD; INDEED, IT'S THE ONLY THING THAT EVER HAS."

— MARGARET MEAD

To the Parents, Guardians, Caregivers, and Friends of the Horace Greeley Science Research Program

Thank you for your unwavering support of our program. Whether it was helping assemble posters, serving as practice judges, listening to countless run-throughs, donating time, providing food, or contributing in countless other ways—you've played an *essential* role in the growth and success of our students. Your generosity, encouragement and belief in what our young scientists can do has been instrumental in their growth and success. This program thrives because of you.

Superintendent Dr. Christine Ackerman: Your commitment to providing meaningful, high-quality opportunities for students continues to shape and strengthen this program. Because of your leadership, the Science Research Program has grown, innovated, and expanded its impact in powerful ways.

Dr. Adam Pease: For your dedicated mentorship of students in the Greeley Sustainability Research Center—and for the time, energy, and care you continuously invest in its growth—thank you. Your guidance not only deepens students' understanding of environmental science but also empowers them to engage in meaningful, real-world research that extends far beyond the classroom.

Principal Dr. Sandra Sepe: Your leadership, encouragement, and unwavering support for academic exploration have fostered an environment where students can truly thrive as scientists. Thank you for consistently championing curiosity, innovation, and excellence.

Assistant Principal Team: *Dr. Ronald Gamma, Mrs. Karime Flores, Dr. Joseph Sullivan, Ms. Christina Mauricio*: For your support with logistics, your thoughtful feedback to students, and the countless behind-the-scenes efforts that keep this program running seamlessly, thank you. Your work does not go unnoticed.

Mr. Paul Bianchi & Dr. Haroula Argiros: For the times you spent teaching and supporting many of our students during your involvement with the program, as well as your continued guidance during practice sessions and as chaperones- thank you. Your impact on students' development as researchers and thinkers has been both meaningful and lasting

Student Mentors: Thank you for generously sharing your time, expertise, and resources. Your mentorship enables students to engage in authentic scientific research and experience firsthand the power of curiosity, rigor, and discovery.

Chappaqua Board of Education: *Ms. Cailee Hwang, Ms. Alissa Dorfman, Mr. Matthew Auerbach, Mr. Timothy McNamara, & Ms. Allison Steinbauer, and Mr. Matthew Wohlstadter:* Thank you for your continued support and advocacy of the Science Research Program. Strong community leadership is essential to initiatives like this, and your commitment ensures that students have the resources and encouragement to pursue meaningful scientific exploration.

Chappaqua School Foundation: For funding grants that directly enrich student learning, and for your generous support in providing resources such as our poster printer and presentation materials, thank you. Your investment in innovation continues to elevate the student experience in lasting ways.

Chappaqua Parent-Teacher Association: From coordinating volunteer judges to assisting with event setup to thoughtfully preparing care packages for our students, your contributions, both seen and unseen, help create a strong, supportive community that allows this program to thrive.

Science Department: Mr. DeBellis, Dr. DeMarie, Ms. Hannon, Dr. Prignano, Mr. McManus, Mrs. McDonnell, Mrs. Loprinzo, Mrs. Moore, Mr. O'Neill, Ms. Russo, & Mr. Lichorat, led by Mrs. McCarthy and Mr. Kuczma. It takes a great team of teachers that always willing to help.

Department Administrative Assistant: Pamela Tole, keeping all of our competitions, forms, and events organized.

Math Department, led by Glenn Wong & Tammy Korman, for their tremendous support with statistical analysis.

Art/STEAM Department not only helps with printing, but also helps print and sew numbers on all our posters.

STEM PTA for helping us find mentors & listening to practices.

Chappaqua Bus Company for getting us to our competitions.

Technology Team: Mr. Andrew Taylor, & Dr. Adam Schoenbart, Ms. Ann Marie Tetelman

Admin Assistants: Pamela Tole, Lora Radanovich, Gabrielle Giordano, Maura Olson

GLC Team: Ms. Pamela Schembri & Collette Briody

School Counseling Team: Rebecca Mullen, John Brennan, Joe Drew, Annalise Curtin, John Dunphy, Matt Frielder, Bernadette Kenny, Conor Lander, Sara Lewis, Stephanie Lia, & Patrick McAuliffe

Custodial Staff for allowing us to stay late for setting up our many local events, especially today.

Arjun Jangi & Athena Zhang for creating this year's booklet cover. **Emma Feig** for designing this year's invitation

WHAT IS HORACE GREELEY SCIENCE RESEARCH?

Introduction to Research Sophomore Year	This highly selective program is offered to motivated sophomores who will pursue a topic of interest and focus on that topic during the first year. The course covers literary search techniques, oral and written presentation skills, problem-solving, and experimental design. Students will be prepared to pursue independent research after finding a mentor and then plan out their research project together. Students must acquire a mentor to continue to advanced science research junior and senior year. Students will present a research plan at the Horace Greeley Symposium and at the Somers Science Fair in early June.
Advanced Research I Junior Year	This course is intended for students who have completed the Introduction to Science Research course. It offers them the opportunity to work on an independent research project. Students are encouraged to work with mentors from the scientific community. Students will complete a research paper in the fall and then create research presentations in poster format for WESEF and JSHS. In the spring, a research presentation will be required in poster format at the Horace Greeley High School Science Research Symposium. Students will check the Student Life Canvas page in June for the summer assignment. Students must work at least five hours outside of scheduled class per week.
Advanced Research II Senior Year	Students in this course will focus on communicating their science research projects in three formats: oral presentation, written paper, and poster presentation. Students must submit their research papers and posters to local, regional, statewide, and national competitions, including Regeneron Science Talent Search, JSHS, and WESEF is mandatory. Students must also participate in the Horace Greeley High School Science Research Symposium in the Spring. The time commitment in the Fall of Senior year can be significant. Seniors will also mentor the sophomores and juniors to ensure those just starting their research journey are provided another level of assistance.



Mrs. Amy Pirro, Ms. Priya Patel-Ma, Mr. Jerry Zupan

"One of the most rewarding parts of this program is the opportunity to truly get to know the students over the course of three years—not just as learners, but as individuals. Watching them grow and evolve as researchers, from the initial spark of choosing a topic to the increasing sophistication of their posters from 10th to 12th grade, is a unique and deeply fulfilling experience."

- Ms. Priya Patel-Ma

“I learn so much from each student as their complete their own research. The community of students work together so we can all achieve more together. I love when I see students helping each other prepare for competitions, or watching them grow over three years of their high school career.”

- Mr. Jerry Zupan

"Science research gives you an opportunity as an educator to not only be an instructor but also be a mentor and coach. In addition to this, you have the honor of watching kids grow over the three-year period of being in the program. AND...it brings great satisfaction in knowing you have the chance to help kids grow as scientists as well as decision-makers, problem-solvers, graphic designers, writers, and orators. I feel truly blessed to be on the fun-filled, challenging, and rewarding science research ride with HGHS students!

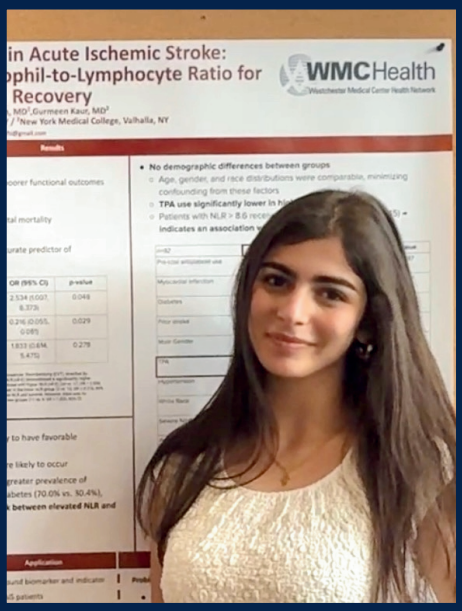
- Mrs. Amy Pirro


SENIOR


CLASS


2027

JUDE AL-MUFTI



GABAPENTIN AND COGNITIVE IMPAIRMENT AFTER TRAUMATIC BRAIN INJURY: A MULTINATIONAL COHORT OF 49,925 PATIENTS

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Stony Brook University
INTENDED MAJOR/CAREER PATH	Biology/Pre-med

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Creating two finalized researech projects with their corrsponding papers, and getting them published.

FAVORITE MEMORY

making (zu)pancakes in class

WORDS OF WISDOM

Learn as much as you can from this course, & have so much fun :)

PROJECT ABSTRACT

Traumatic brain injury (TBI) is a leading cause of long-term disability, and no pharmacologic therapy has reliably reduced the risk of chronic cognitive decline or death. Gabapentin, commonly prescribed for pain and agitation after TBI, may exert neuroprotective effects. We evaluated whether gabapentin use on the day of TBI is associated with risk of durable cognitive impairment and mortality in a retrospective cohort study using the multinational TriNetX Research Network, encompassing more than 150 million patients. Adults (⩾18 years) with a TBI and Glasgow Coma Scale (GCS) score recorded on the day of injury were included, and excluded those with prior cognitive impairment or gabapentin exposure. A total of 49,925 patients met the inclusion criteria and were stratified into mild TBI (GCS 13–15, n=34,376), moderate (9–12, n=4,035), and severe (3–8, n=12,845). The primary outcomes were durable cognitive impairment and all-cause mortality within two years of injury, with Cox proportional hazards models adjusted for demographics and factors present on the day of TBI predictive of poor outcomes following neurotrauma. After adjustment, gabapentin was associated with a 22% lower risk of cognitive impairment in mild TBI (HR=0.78; 95% CI, 0.62–0.98; P=.03) and a 46% lower risk of mortality in severe TBI (HR=0.54; 95% CI, 0.40–0.72; P<.001). Although causality cannot be inferred from a retrospective study, these findings suggest gabapentin, a widely available and inexpensive medication, may warrant prospective investigation as a neuroprotective therapy in TBI.

Gabapentin and Cognitive Impairment After Traumatic Brain Injury: A Multinational Cohort of 49,925 Patients

Introduction

Traumatic Brain Injury

- **Traumatic Brain Injury (TBI), is damage to the brain from an outside force affecting brain function temporarily or causing severe, long-term disability or death**



Figure 1: Visual Representation of Traumatic Brain Injury (https://brainline.org/2011/01/how-propel-helps-what-does-tbi-stand-for)

- **Each year, approximately 100,000 people die from TBI and 500,000 more are permanently disabled.**

Gabapentin

- **Gabapentin *(Neurontin, Gralise, Horizant)***
  - Originally developed as an antiseizure drug → has become prescribed for neuropathic pain and agitation
  - Increased survival, improved functional outcomes, and fewer autonomic complications



Figure 2: Gabapentins availability in a wide variety of forms. From National Library of Medicine, by Elaine J. Horn, 2014 (livescience.com/42323-gabapentin)

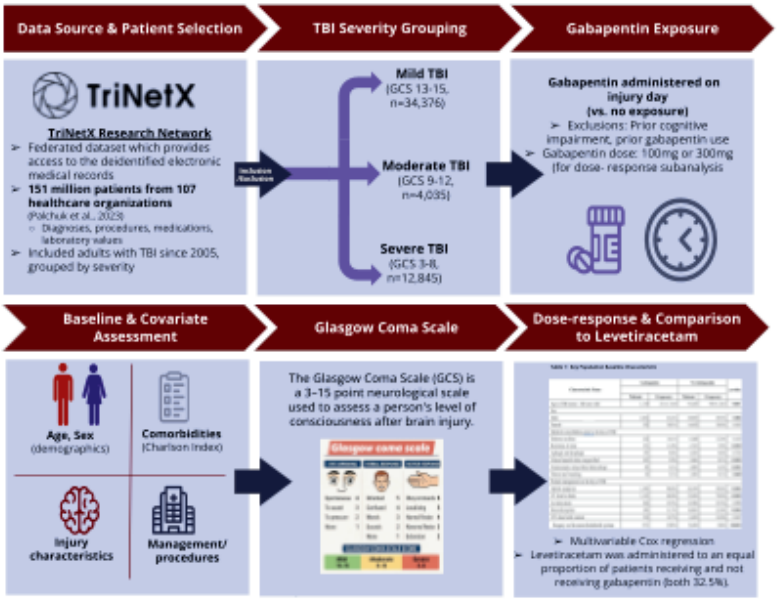


Figure 3: Gabapentin Capsules in Bottle From Camber Pharmaceuticals (https://www.camberpharma.com/products/gabapentincapsules/)

Hypothesis

Acute administration of gabapentin following traumatic brain injury reduces secondary injury processes and is associated with improved durable cognitive outcomes.

Methodology



Results

Table 2: All GCS, Risk of Mortality by 2 Years

Gabapentin was considerably protective against mortality. After full adjustment, gabapentin use was associated with a 39% reduction in overall two-year mortality (HR 0.67, 95% CI 0.56–0.80, p<0.0001). The effect was most pronounced in severe TBI, where mortality was reduced by nearly half (HR 0.54, 95% CI 0.40–0.72, p<0.0001). Figure made by student using Google Sheets, 2025.

Covariate	Hazard Ratio	95 % CI Lower	95 % CI Upper	P > |z|
Gabapentin (vs. no gabapentin)	**0.6682**	**0.5562**	**0.8028**	**<0.0001**
GCS 13-15	**0.3151**	**0.2737**	**0.3627**	**<0.0001**
GCS 9-12	**0.8300**	**0.7341**	**0.9384**	**0.0029**
GCS 3-8	**2.8464**	**2.4798**	**3.2673**	**<0.0001**
Age at Index [REF = patients 18–30 years old]				
30 - 35 Years	1.1974	1.0609	1.3515	0.0035
35 - 40 Years	1.3116	1.1542	1.4904	<0.0001
40 - 45 Years	1.3050	1.1426	1.4905	0.0001
45 - 50 Years	1.4971	1.3169	1.7019	<0.0001
50 - 55 Years	1.7198	1.5302	1.9329	<0.0001
55 - 60 Years	2.1941	1.9765	2.4434	<0.0001
60 - 65 Years	2.4685	2.2266	2.7366	<0.0001
65 - 70 Years	3.0241	2.7314	3.3481	<0.0001
70 - 75 Years	3.6192	3.2716	4.0037	<0.0001
75 - 80 Years	4.7687	4.3134	5.2721	<0.0001
≥80 Years	6.2541	5.6787	6.8879	<0.0001
Male (vs. Female)	1.1015	1.0463	1.1597	0.0002
Concussion	1.5695	1.4750	1.6701	<0.0001
Traumatic cerebral edema	0.9275	0.8707	0.9880	0.0196

- Low-dose gabapentin (100 mg) showed strongest cognitive protection
- **The results provide support for the hypothesis in adjusted analyses (reduced cognitive impairment risk in mild TBI and reduced mortality risk in severe TBI).**

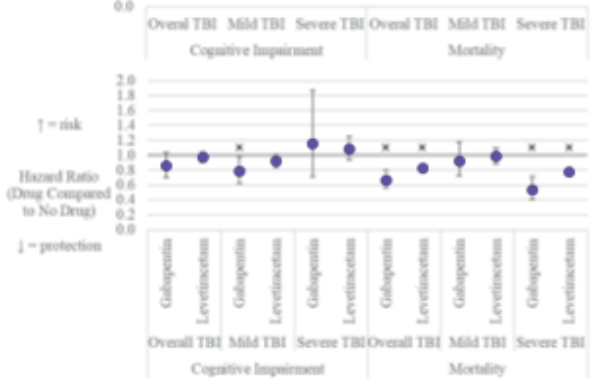


Figure 8: Hazards of Cognitive Impairment and Mortality by Gabapentin Status Hazard of cognitive impairment and mortality associated with gabapentin (Top) and associated with both gabapentin and levetiracetam (Bottom). * indicates significance at 95% confidence level. Figure made by student using Google Sheets.

Mild TBI

- 22% lower risk of cognitive impairment in mild TBI (HR=0.78; 95% CI, 0.62–0.98; P=.03)
- Durable cognitive impairment → 5.7% with gabapentin vs 6.7%

Severe TBI

- 46% lower risk of mortality in severe TBI (HR=0.54; 95% CI, 0.40–0.72; P<0.001).
- Neither gabapentin nor levetiracetam was associated with cognitive outcomes
- 23.3% with gabapentin vs 39.4% without (P < 0.001)

Future Research

- Prospective trials to confirm gabapentin's effects on cognition (mild TBI) and mortality (severe TBI)
- Dose-response and timing analyses, particularly early low-dose initiation
- Moderate TBI cohorts require further study
- Long-term adverse effects need prospective monitoring.

Application

- Gabapentin serves as a low-cost adjunct in acute TBI management
- Significant mortality reduction suggests relevance in severe TBI and neurocritical care



Figure 9: Image of Gabapentin Pills. Image take from Recovered, by Dr. Sheridan Walker 2025. https://articles.mercola.com/sites/articles/archive/2025/08/14/gabapentin-dementia-cognitive-decline.aspx

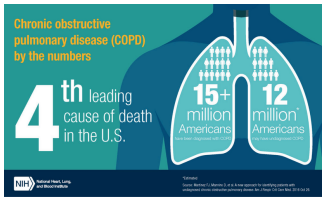
Enhancing Post Lung Transplant Outcomes through Pulmonary Rehab at a Free-standing Rehab center

Intro/Background

Lung Disease

34.7 Million Americans live lung diseas
- 1.8-2.4 Million with terminal lung disease
- Leading cause of disability,

hospitalization, and reduced quality of life



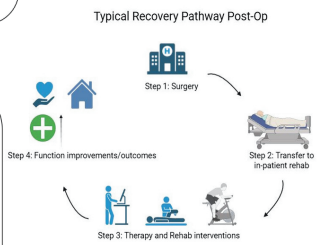
Transplantation

- Life-saving procedure for end-stage pulmonary disease [1]
- Patients experience decreased respiratory function [2]

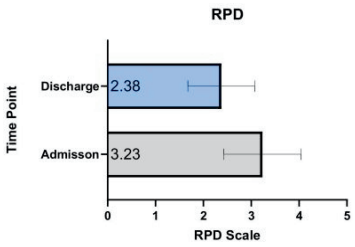
Post-Transplant Rehabilitation

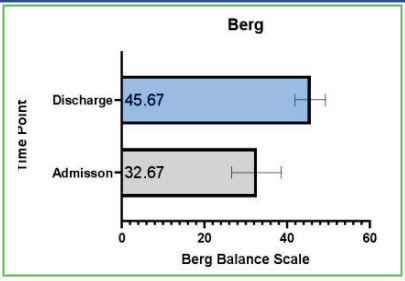
Acute-Care Rehabilitation [4]:
- Rehab within transplant hospital
- General care/extensive resources

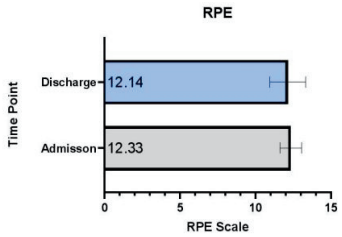
Freestanding Rehabilitation [4]:
- Rehab at auxiliary location
- Highly specialized care
- Perceived lack of resources

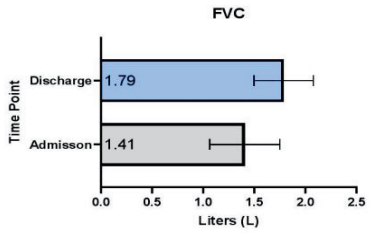


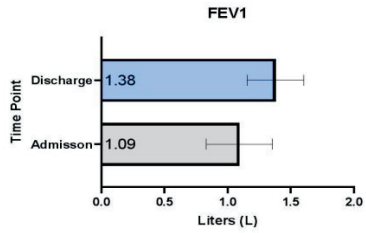
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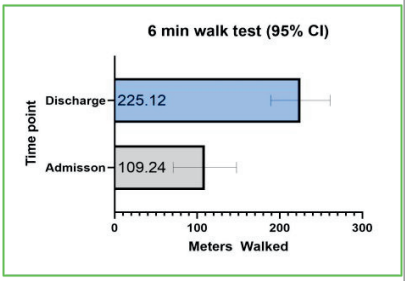








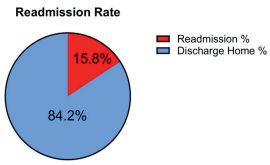




Significance of Results

Comparison Across Studies

- Readmission Rates
  - Previous studies: >56%
  - Our study: 15.8%
- Improvement Rates
  - Previous studies: Significant metrics
  - Our study: Partially Significant metrics



Method Constraints

- Small cohort size (N=18)
- Single rehab center setting
- Short time frame

Non-Significance

- Expected levels of variability
- Non-significant measures most likely caused by small size

Final Interpretation

- Understandable levels of variability found
- Insignificance skewed due to small sample size

Application

Clinical Impact

- Supports safe discharge
- Reduces hospital burden
- Enhances patient-centered care

Health System/Policy Impact

- Expands rehab capacity
- Improves care access
- Supports cost-efficient care

Future Steps

Research Expansion

- Direct comparison with matched acute-care cohorts
- Expand follow-up duration
- Increase sample size

Clinical implementation

- Develop standardized pulmonary rehab protocols
- Evaluate patient satisfaction and QOL outcomes

Major Finding/Novelty

- Lung transplant patients demonstrated meaningful improvements
- Comparable outcomes to established acute-care benchmarks
- Overrides assumptions about freestanding rehab

JONAS BALCETIS

ENHANCING POST-LUNG TRANSPLANT OUTCOMES THROUGH INPATIENT PULMONARY REHAB AT A FREE-STANDING REHAB CENTER



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Emory University
INTENDED MAJOR/CAREER PATH	Pre-Med: Chem and Public Health

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

My proudest moment is finishing my final WESEF poster and finishing my presentation to receive an award! Hard work payed off

FAVORITE MEMORY

My favorite memory would be playing cards on the four hour bus ride on the way to JSHS with people I've never met

WORDS OF WISDOM

My best word of advice for incoming kids is that the workload is super easy as long as you don't start the work the night before

PROJECT ABSTRACT

Although inpatient pulmonary rehabilitation following lung transplantation has been studied extensively in hospital-based programs, limited research and small stigma exists on the safety and effectiveness of rehabilitation within free-standing facilities. Historically, most post-transplant recovery data has emphasized acute care outcomes rather than function progress during later stages of rehabilitation, accompanied by high readmission rates of over 40%. This study evaluates pulmonary function and patient readmission rates among lung transplant recipients completing a rehabilitation program in a free-standing facility. Using an analysis of 18 patients admitted during a single summer period, this study compared admission and discharge values for various performance function tests (PFTs) such as the Six-Minute Walk Test (6MWT), Berg Balance Scale (BBS), Forced Expiratory Volume in one second (FEV_1), Forced Vital Capacity (FVC), Rate of Perceived Exertion (RPE), and Rate of Perceived Dyspnea (RPD). Statistically significant improvements were observed in both the 6MWT and BBS scores, indicating enhanced aerobic capacity and balance stability. FEV1 and FVC both demonstrated moderate gains, though not all reached statistical significance due to overlapping confidence intervals, most likely due to the small patient size. No adverse events were reported, and 84.2% of patients were discharged home on the planned date, with only 15.8% being readmitted to acute care, a value much lower than the national average for early post-transplant readmissions. These findings suggest that free-standing rehabilitation can provide feasible, safe, effective, and functionally meaningful recoveries for lung transplant recipients, outperforming outcomes achieved in hospital-based programs.

MUKUL BATTU



ASSISTED CYCLING THERAPY (ACT) IMPROVES MOTOR AND COGNITIVE FUNCTIONS IN ADOLESCENTS WITH AUTISM SPECTRUM DISORDER (ASD)

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Columbia University
INTENDED MAJOR/CAREER PATH	Neuroscience & Behavior

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Writing my STS essays and submitting to STS. Getting 3rd place at Somers 2024 and seeing all my friends and peers get their awards at WESEF!

FAVORITE MEMORY

Doing the escape rooms with my classmates and playing cards during free time in class! Sneaking into the greenhouse with my friends to do "work!" These were all great bonding experiences.

WORDS OF WISDOM

Through all the inevitable ups and downs you will experience throughout the research process, make sure to enjoy what you are doing! Make sure to ask a bunch of questions and most importantly, have fun!

PROJECT ABSTRACT

Autism Spectrum Disorder (ASD) is characterized by persistent deficits in motor and cognitive functioning, including impairments in cognitive flexibility and motor coordination. Current interventions offer limited improvement in these areas, highlighting the need for alternative therapies that target neurological mechanisms impacted by ASD. Assisted Cycling Therapy (ACT), a form of forced/assisted exercise in which participants pedal motorized bikes at a specific rate above their voluntary cycling rate, has previously demonstrated benefits in neurodevelopmental conditions but has not been evaluated in adolescents with ASD, specifically assessing both motor and cognitive functions. This study used a within-subjects pre-post testing design to investigate whether ACT could improve motor and cognitive functioning in adolescents with ASD. 2 adolescent participants completed 4 ACT sessions over 1 week. Each session involved a warm-up, 12-15 minutes of assisted cycling at 75-85 RPM, and a cool-down period. Pre and post-intervention assessments measured motor skills (Timed Up and Go, 10-meter walk, and Static Balance) as well as cognitive functions through the web application psytoolkit (Flanker, Go/No-Go, Corsi Block Span, Tower of Hanoi, and Visual Reaction Time tests). Participants demonstrated consistent improvements in motor and cognitive functioning from pre to post-intervention. These results align with prior evidence that assisted exercise increases dopamine release, supporting neural efficiency and plasticity. Overall, findings indicate that ACT is a promising, non-pharmacological intervention capable of enhancing motor and cognitive functions in adolescents with ASD. Future studies should expand sample size, lengthen study duration, and possibly incorporate neuroimaging to elucidate underlying neural mechanisms.

Assisted Cycling Therapy (ACT) Improves Motor and Cognitive Functions in Adolescents with Autism Spectrum Disorder (ASD)

Introduction

Autism Spectrum Disorder (ASD)

- Prevalent **neurodevelopmental** disorder
- 3.4x more common in males than females
- Associated with:
  - Reduced nerve fiber densities
  - Altered nerve pathways
  - Reduced **cerebellar Purkinje cell** density
  - Abnormal brain volume growth
- Current treatments are **ineffective**





Assisted Cycling Therapy (ACT)

- Form of "assisted exercise" (AE)
- Cycling with assisted motors
  - **Pace above** participant's voluntary cycling (VC) rate
- Enhances functioning
  - Executive
  - Motor
  - Cognitive
- Benefits various populations
  - ADHD
  - Parkinson's disease
  - Down syndrome





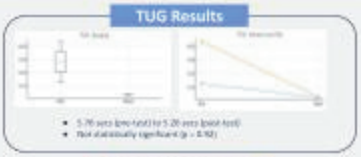


Problem, Goal, Hypotheses (PGH)

- Little research has been done on ACT's impact on motor and cognitive functioning domains in ASD individuals
- Multiple functioning domains haven't been tested **SIMULTANEOUSLY**
- We want to investigate ACT's impact on both motor and cognitive functioning in adolescents with ASD
- We hypothesize Participants will show **significant** improvements in cognitive functions and motor functioning
  - ACT will significantly improve working memory, cognitive flexibility, and inhibitory control
  - ACT will significantly enhance **gross and fine motor coordination** in children with ASD

Results & Discussion

TUG Results



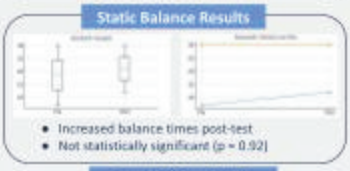
- 5.76 secs (pre-test) to 5.20 secs (post-test)
- Not statistically significant (p = 0.92)

10 Meter Walk Results



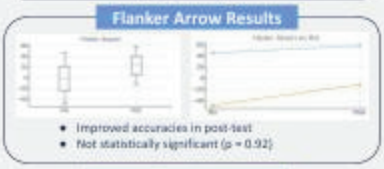
- Decreased post-test times
- Not statistically significant (p = 0.92)

Static Balance Results



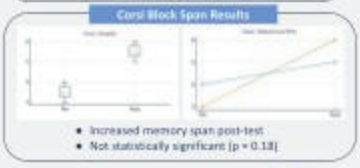
- Increased balance times post-test
- Not statistically significant (p = 0.92)

Flanker Arrow Results



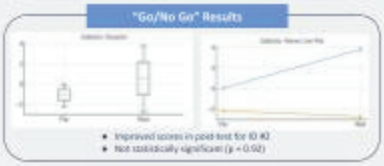
- Improved accuracies in post-test
- Not statistically significant (p = 0.92)

Corsi Block Span Results



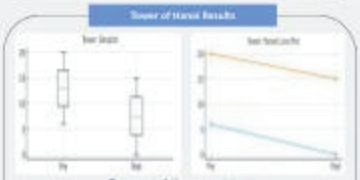
- Increased memory span post-test
- Not statistically significant (p = 0.18)

"Go/No Go" Results



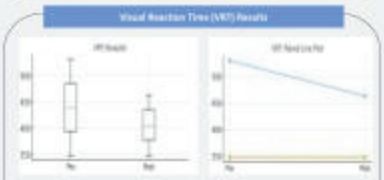
- Improved scores in post-test for ID #2
- Not statistically significant (p = 0.92)

Tower of Hanoi Results



- Decreased times post-test
- **Possible large individual differences**
- Not statistically significant (p = 0.18)

Visual Reaction Time (VRT) Results



- Decreased mean times post-test
- Greater change in Participant 2
- Not statistically significant (p = 0.18)

Consistent, non-significant improvements show **"proof-of-concept"**

Methodology

Timed "Up and Go" (TUG) Test



10-Meter Walk Test



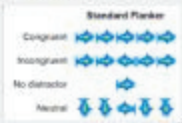
Static Balance Test

- Eyes open up to 30 seconds
- Focused on fixed object
- Failed trial: moving feet, losing balance



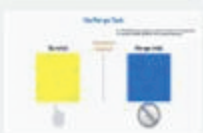
Flanker Arrow Task

- focusing on target stimulus
- Accuracy/reaction time
- Indicate middle arrow direction



"Go/No Go"

- Cognitive control
- Impulsive inhibition
- Time only for "go" trials



Corsi Block Span

- Working memory
- visuospatial awareness
- Reproduce 9 block sequence
- Trial ended at two consecutive fails
  - Same length



Tower of Hanoi

- Tower of London [15]
- One disk at a time
- No bigger disc before smaller disc
  - maximum 50 moves



Visual Reaction Test (VRT)

- Reaction time: response - stimulus
- Distraction minimized setting



All cognitive tasks were **digital** on psytoolkit.org

Conclusion

Findings:

- Hypothesis **partially** supported
  - **Consistent** improvements
- Shared neurophysiological improvements
- "Proof-of-concept"

Applications:

- Clinical settings
- Educational use
- Additional intervention

Future Research:

- Larger sample size
- Longer duration
- Neuroimaging

Determining the Influence of Mutations in the Tumor Suppressor Gene LKB1 on Cancer-Associated Neutrophils

Research Question

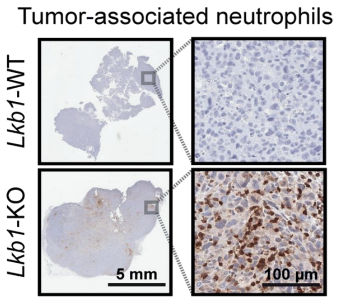


Figure 1. *Lkb1*-KO tumors have significantly higher levels of associated neutrophils than *Lkb1*-WT tumors.

→ Mutations in *LKB1* affect ~20% of lung adenocarcinomas

→ *LKB1* mutations drive resistance to common immunotherapies

→ *LKB1*-mutant tumors recruit abundant tumor-associated neutrophils (TANs)

→ TANs in *Lkb1*-KO tumors have altered gene expression (phase one, 2024)

How do LKB1 mutations influence the behavior and composition of tumor-associated neutrophils and promote tumor evasion?

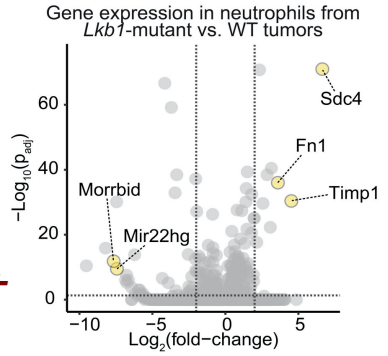


Figure 2. Phase one (2024) — Neutrophils from *Lkb1*-mutant tumors have numerous differences in gene expression compared to neutrophils from *Lkb1*-WT tumors. The horizontal dotted line corresponds to an adjusted p-value (p_{adj}) of 0.05. The vertical dottedlines mark Log2(fold-change) values of -2 and 2.

Methodology

Data

Pre-processing and dimensionality reduction for single-cell RNA sequencing data of immune cells extracted from mouse LUAD

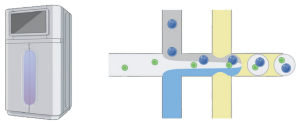


Figure 3. Illumina Novaseq X and the isolation of cells for generating scRNAseq data *biorender.com*

Cell Assignment

Assign immune cell identities using SingleR

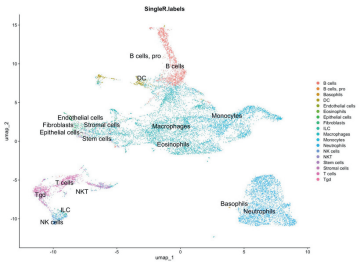


Figure 4. Cell type identification plotted on UMAPs

Sub-clustering & Gene Ontology

- Isolate neutrophils
- Identify neutrophil subpopulations and their unique genetic markers
- Perform gene ontology analysis to determine functional significance

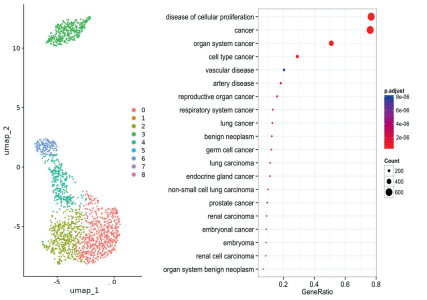


Figure 5. Seurat sub-clustering and Gene Ontology dotplot

Results

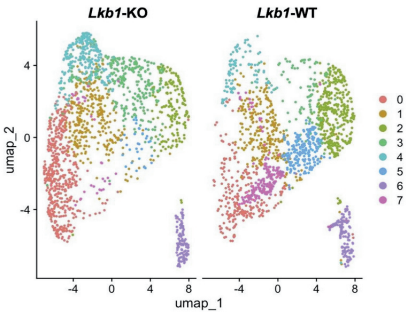


Figure 6. Neutrophils exhibit compositional changes in sub-population abundance. Neutrophil clusters 7 is observably less abundant in *Lkb1*-KO compared to *Lkb1*-WT conditions.

- Neutrophil subpopulations, clustered by genetic similarity, are significantly altered
- Loss of neutrophil cluster with unique genetic markers that indicate functionality in **interferon beta response**

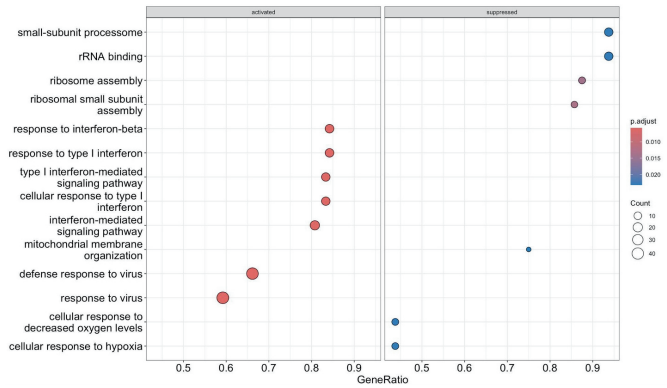


Figure 7. Dot plot visualization of Gene Ontology (GO) enrichment analysis for cluster seven gene markers reveals a functional influence of neutrophil cluster seven in interferon response.

Discussion

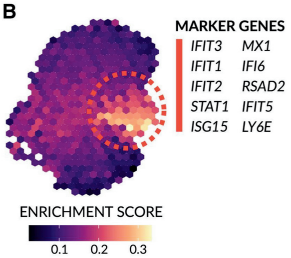


Figure 8. Unique genetic markers of immune-promoting interferon-stimulated neutrophil population; Benguigui et al. (2024).

- Benguigui et al. (2024) identified an interferon-stimulated neutrophil population that **promotes T-cell activity** and **immunotherapy response**
- Our interferon-stimulated neutrophil population shares genetic similarities with the population in Benguigui et al.
- The loss of this population of neutrophils is a **potential mechanism by which *LKB1* drives immune suppression**

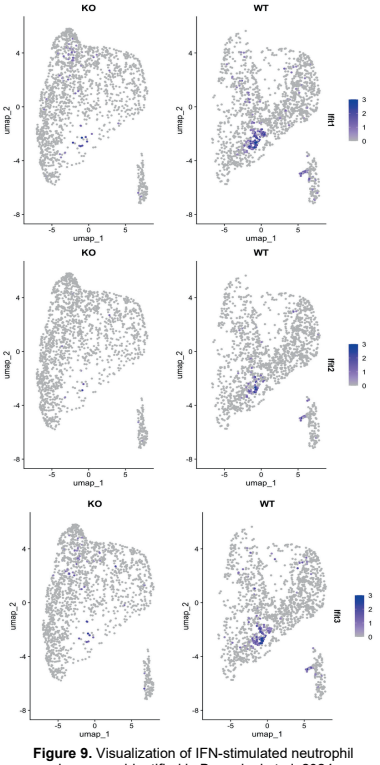


Figure 9. Visualization of IFN-stimulated neutrophil marker genes identified in Benguigui et al. 2024 on neutrophil UMAP reductions. Specificity to neutrophil cluster 7 is observed.

CINDY CHEN

DETERMINING THE INFLUENCE OF MUTATIONS IN THE TUMOR SUPPRESSOR GENE LKB1 ON CANCER-ASSOCIATED NEUTROPHILS



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Barnard College
INTENDED MAJOR/CAREER PATH	Chemistry & Sociology

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Cheering for my classmates at award ceremonies, and seeing how far we've come since sophomore year!

FAVORITE MEMORY

Hanging out with my friends after competitions and awards.

WORDS OF WISDOM

Always do what you're passionate about and be open to learning in unexpected moments!

PROJECT ABSTRACT

Liver kinase B1 (LKB1) is a tumor suppressor gene that is frequently mutated in lung adenocarcinoma (LUAD). Previous research demonstrates that *LKB1* mutations facilitate resistance to PD-1-targeting antibodies—cancer therapies that promote an immune response against tumors. However, the mechanism by which *LKB1*-mutant tumors evade the immune system and promote resistance to anti-PD-1 treatment is poorly understood. To identify potential mechanisms of immune-resistance, we analyzed a single-cell-RNA sequencing dataset of CD45 immune cells derived from *Lkb1*-wild-type (WT) and -mutant mouse LUAD tumors. We focused our attention on neutrophils given that prior studies and phase one of this study have shown that tumor-associated neutrophils are influenced in *LKB1*-mutant LUAD. Consistent with phase one of this research, we found differences in the expression of genes in neutrophils from *Lkb1*-mutant tumors relative to WT tumors. Additionally, we identified a subpopulation of interferon-stimulated neutrophils that appears to be suppressed under *Lkb1*-mutant conditions. Previous research (Benguigui et al., 2024) identified an interferon-stimulated neutrophil population that promotes response to anti-PD1 treatment, and we identified many genetic similarities between our neutrophil populations. These findings suggest that our subpopulation of interferon-stimulated neutrophils could provide a potential mechanism by which *LKB1*-mutant tumors evade immune response.

DAYUAN CHENG



BATTERY-AWARE ENERGY OPTIMIZATION FOR UAVS BASED ON LI-PO BATTERY CHARACTERIZATION

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of Chicago
INTENDED MAJOR/CAREER PATH	Mathematics + Economics

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Winning an award at Somers Science Fair and WESEF and being able to experience that with my friends.

FAVORITE MEMORY

Solving the cryptic crossword every morning in class and playing card / board games with classmates.

WORDS OF WISDOM

Stay on top of your work and you will have a great experience!

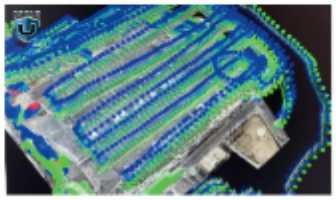
PROJECT ABSTRACT

This paper addressed the energy efficiency challenges of unmanned aerial vehicles (UAVs) by proposing an optimization framework that maximized onboard battery utilization to achieve the minimized mission duration. We first characterized the performance of a widely used Li-Po battery (Gens ace 5000mAh 11.1V 3S 50C) under diverse discharge profiles, and employed a hybrid NDCTNet model to generate experimental training data. Leveraging machine learning techniques, we developed a C-rate-dependent remaining discharge energy (RDE) model for real-time prediction of the battery behavior. Building on this RDE model, we formulated a constrained optimization solution that determines the optimal velocity profile to minimize mission duration of a predefined task while ensuring completion within the available battery capacity. The framework integrated detailed UAV energy models for horizontal and vertical motion and accounts for environmental factors such as wind and turbulence. Simulation results demonstrated that the method enabled adaptive, energy-aware flight planning, significantly improving both battery utilization, operational efficiency and task completion rate, with particular benefits for UAV deployment in disaster response.

Battery-Aware Energy Optimization for UAVs Based on Li-Po Battery Characterization

Introduction

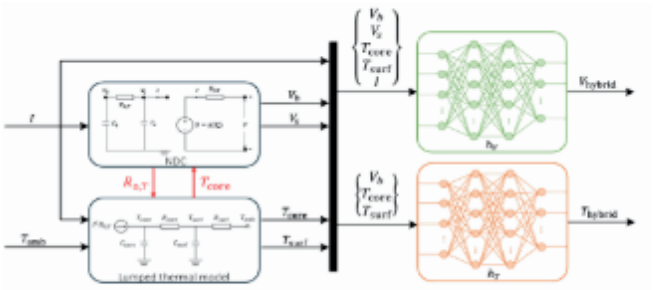
- Rising presence of EVs in many industries
- UAVs (drones) rely heavily on battery systems for propulsion
- Problem: How can UAVs complete tasks as fast as possible while operating within the constraints of limited battery capacity?



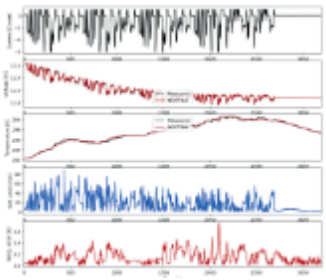


- Goal: Identify algorithm for operating UAVs at their highest possible speed while conserving battery
- Hypothesis: Algorithm will enable a UAV to complete tasks at the fastest possible speed with higher success rate than traditional methods.

Methodology



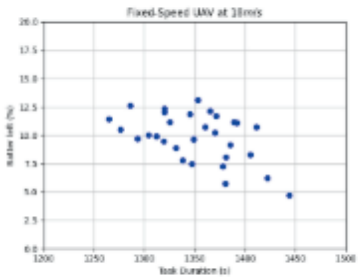
- Feed and analyze data into hybrid battery model to create model of battery being used

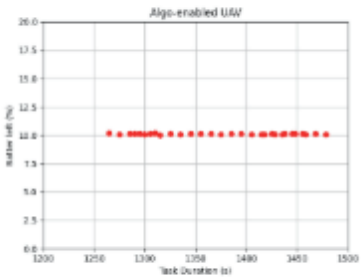




- Algorithm calculation workflow, position and environmental data estimates energy demand, suggests best flying speedv

Results + Discussion





- Algorithm-enabled UAV has consistent remaining battery energy levels
- The algorithm-enabled UAV consistently selects the fastest speed of 18.0 m/s
- Achieving a task completion rate of 96.67%

Speed set up	$T\,(s)$ Task time	$v\,(m/s)$ Average speed	$B\,(\%)$ Battery left	$C\,(\%)$ Completion rate
Algorithm-enabled	**1364**	**18.03**	**10.103**	**96.67**
$14\ m/s$	1783	14.23	6.732	50.00
$15\ m/s$	1650	15.04	21.90	100.00
$16\ m/s$	1582	15.97	15.18	100.00
$17\ m/s$	1429	17.01	12.21	100.00
$18\ m/s$	1355	18.07	9.869	100.00
$19\ m/s$	1299	18.94	5.375	66.66

Conclusion

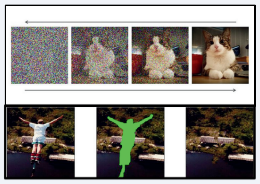
- Algorithm was able to find optimal speed to operate at, battery floor was maintained consistently through different tests
- Reduce risk in real world flying by providing UAVs with safer battery security after flight, ensuring success, relief / aid missions
- More UAVs can be utilized efficiently, optimal amount of battery used without waste
- Future research
  - Obstacle-aware routing for UAVs during flight time or mission duration
  - Adaptive mission planning under unpredictable conditions (turbulence).



The Unreasonable Effectiveness of Test-Time Compute Scaling for Image Generation

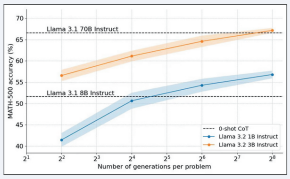
Introduction

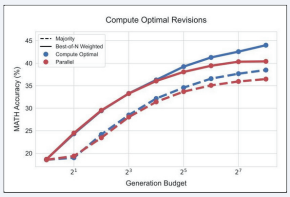
- Increase in image generation models:
  - Stable Diffusion, Flux, Openjourney, etc.



Large Language Model Scaling Patterns

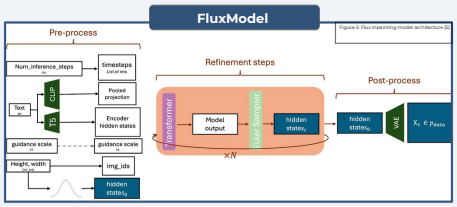
- **Test-time compute scaling**
  - More opportunities -> better results (Zhang et al., 2025)
  - Trades latency and cost for accuracy and reasoning quality

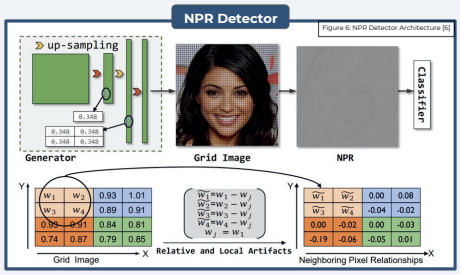




Hypothesis: Image generation models will perform similarly using **test time compute scaling**

Methodology





Saliency Map Generation

1. **Generates N randomized masks** to systematically obstruct image regions.
2. Pixel importance based on Intersection over Union (IoU) and probability.
3. Produces a **heatmap** to visualize exactly **where the detector identifies forgery**.

1. Saliency Map Generation



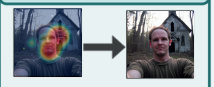
Saliency Mask **M** highlighting the top 20% of regions to inpaint

Tool: NPR Realism Detector (Tan et al. 2023)

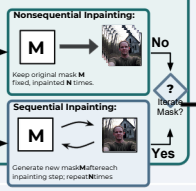
Process:
1. Inputimage→ NPRDetector (outputs scalar 'realism' score)
2. Black-box patch-wise saliency mapping (perturb patches, compute score drops)
3. Overlay heatmap (saliency map S)

Label: "Black-box Saliency Attribution & Mask Generation"

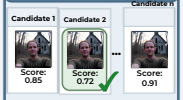
2. Inpainting & Candidate Generation



Process:
- Masked regions (from M) are inpainted by FLUX
- For each image, generate N candidate refinements (N = {0, 1, 2, 4 ..., 128})



3. Selection & Iterative Refinement

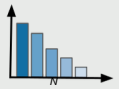


Feedback Loop: Each candidate image passed through NPR detector (scored for realism)

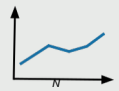
Selection: Candidate with lowest 'fake' score is selected as output

Iterative Step: For sequential inpainting, mask is re-generated after each inpaint

4. Evaluation & Analysis



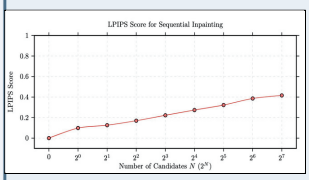
NPR Detector Score: lower = classified as more realistic

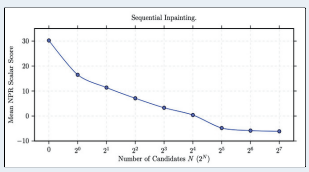


LPIPS: Images similarity to original; lower = less perceptible change

Results & Analysis

Sequential Inpainting



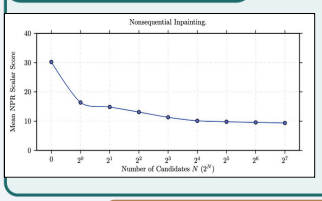


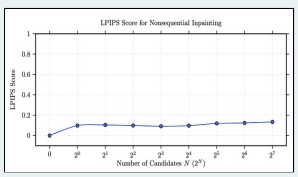
Detector: rating scores drastically decrease

83% Fooling Rate

Image similarity: The changes in the image become more obvious a

Nonsequential Inpainting



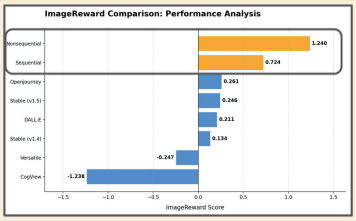


Detector: rating scores steadily decrease

14% Fooling Rate

Image similarity: Image changes are nearly imperceptible

Model Comparisons



ImageReward: Determineshowclosely generated images match human judgments on quality (Xu et al., 2023)

Our method outperforms many modern image generators

Discussion & Conclusion

Review

- Increased **test-time compute improves image** realism and reduces detector confidence.
- Sequential inpainting is more effective than non-sequential, lowers NPR scores with fewer iterations.
- **Current detectors are inadequate against these optimizer attacks**

Novelty

- **Deepfake detectors can be bypassed** without any knowledge of their internal gradients
- Developed a pipeline that **uses the detector's own output as a "reward signal"** to steer the Flux inpainting model.
- **Applied LLM-style test-time scaling principles to the domain of image forensics** (Argawal et al., 2025).

Future Work + Defense

- Subject incoming images to slight perturbations
  - Optimized images are often highly brittle
- Iteratively refined images often exhibit a high reconstruction error (Diffusion Anomaly)
- There should be a **detectable statistical mismatch between the newly generated regions** and the original synthetic background.

TINGRAY CHUNG

THE UNREASONABLE EFFECTIVENESS OF TEST-TIME COMPUTE SCALING IN IMAGE GENERATION



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Carnegie Mellon University
INTENDED MAJOR/CAREER PATH	Materials Science + Artificial Intelligence

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

My proudest moments were writing and finishing my papers. I was lucky to have been accepted into multiple conferences and loved sharing my work with others.

FAVORITE MEMORY

Going to the award ceremony and watching my friends win many awards!

WORDS OF WISDOM

Research is hard, but if was easy, then the world's problems would have already been solved.

PROJECT ABSTRACT

This paper introduces a system that applies test-time compute scaling to AI-generated images, building off of techniques from language model reasoning and extending them to images. The system works to improve realism under automated deepfake detection. Given an input image, the study uses a Neighboring Pixel Relations (NPR) detector developed by Tan et al. (2023) as a verifier. The study employs the detector in conjunction with a black-box explanation method to localize regions deemed fake, which are then refined using the FLUX inpainting diffusion model to produce N alternative versions. Each candidate is scored by the detector, and the most realistic output is selected. Next, the study also examined whether repeated detector feedback enabled the inpainting model to eventually bypass the detector. Ultimately, the results show that as N scales higher, higher quality results emerge. Furthermore, providing the inpainting model with more detector feedback allows the inpainting model to eventually outscore the detector.

WARREN FU



BIOPHYSICAL AND GENOMIC DRIVERS OF TARGETED THERAPY RESISTANCE: ANALYSIS OF GROWTH DYNAMICS IN NON-SMALL CELL LUNG CANCER

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Columbia University
INTENDED MAJOR/CAREER PATH	Mathematics & Philosophy

REGENERON ISEF
A PROGRAM OF SOCIETY FOR SCIENCE
PHOENIX | 2026

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Hearing that I had become a Regeneron STS Scholar. I was in the library, and didn't realize the emails had been sent until 5 minutes after. I opened it, saw the word "Congratulations," and screamed my way out of the GLC.

FAVORITE MEMORY

Definitely eating Chick-Fil-A on the way to JSHS 2024, although in close second there's the WESEF 2026 Awards Ceremony.

WORDS OF WISDOM

You can't do this just for the results. Science fairs—and science competitions at large, really—have a lot of luck involved. I'm saying this as someone who used to be very, very, *very* results-oriented, and who's gotten both the short and "long" end of the stick; I didn't try any harder when I won, nor any less when I didn't. Make sure you can be proud of your work after all these years, even if you don't get the medal or the trophy.

PROJECT ABSTRACT

Resistance to targeted therapies in non-small cell lung cancer (NSCLC) limits treatment efficacy. Mathematical models have shown promise in predicting resistance development by capturing biophysical parameters, such as treatment efficacy, or the conversation rate from sensitivity to resistance. Last year, we discovered that treatment efficacy positively correlated with faster relapse and conversion rate from sensitivy to resistance, suggesting aggressive treatment may accelerate resistance. However, whether genomic profiles predict response patterns consistent with these contributions has also not been established. This year, we examined the genomic and treatment data of 824 NSCLC patients treated with osimertinib, gathered from MSK-IMPACT and MSK-CHORD; 172 initial responders were analyzed. Mann-Whitney U-tests with Benjamini-Hochberg correction were employed to examine differential response between clusters. Kaplan-Meier survival analysis and Cox regression were used to evaluate differences in progression-free survival (PFS). Compared to EGFR-only patients, EGFR+TP53 patients had 61% higher risk for progression events (HR=1.61, p=0.033), EGFR+RB1+TP53 patients had 159% higher risk (HR=2.59, p=0.025), and EGFR+SMAD4+TP53 patients had 182% higher risk (HR=2.82, p=0.033). Notably, EGFR+RB1+TP53 patients showed the strongest initial response (p<0.01 vs. four other clusters) despite extremely poor PFS, linking genomics to the parameter contributions we identified in last year's project. The findings of this study may inform the development of genome-conscious treatment strategies, and call more broadly for treatment regimens that intentionally balance tumor reduction with resistance management, so as to avoid accelerating resistance development.

Biophysical and Genomic Drivers of Targeted Therapy Resistance: Analysis of Growth Dynamics in Non-Small Cell Lung Cancer

Background & Research Question

Problem Overview

Resistance to EGFR-TKIs is **practically inevitable.**

Biophysical Parameters

Treatment efficacy ↑ → resistance development ↑

Research Question

Are mutational states clearly linked to biophysical parameter contributions? Can they confirm our previous research?

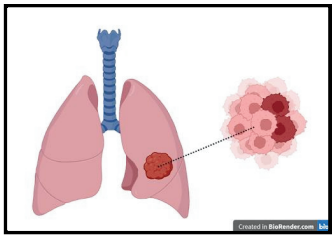


Fig 1. Simplified Lung Adenocarcinoma Tumor
Created by Fu 2025 in BioRender

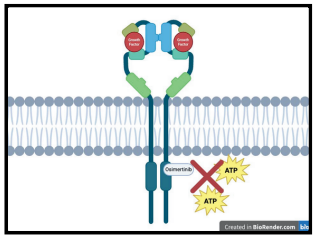


Fig 2. Simplified EGFR-TKI (Osimertinib) Activity
Created by Fu 2025 in BioRender

$$\frac{dS}{dt} = r_s S - u(conv)S$$
$$\frac{dR}{dt} = r_r R + u(conv)S$$

Fig 3. Simple ODE System Modeling Tumor Heterogeneity
Created by Fu 2025 using LaTeX

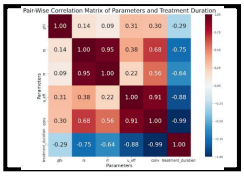


Fig 4. Correlation Matrix of Biophysical Parameters
Created by Fu 2025 with Matplotlib and Seaborn

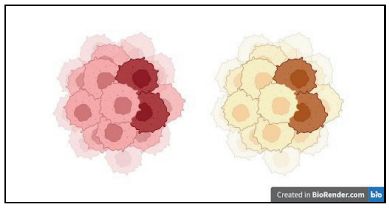


Fig 5. NSCLC's Genomic Heterogeneity.
Created by Fu 2025 in BioRender

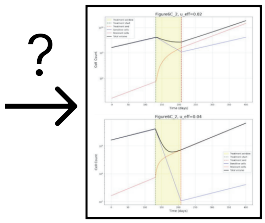


Fig 6. Hypothetical different patterns of resistance development.
Created by Fu 2025 with matplotlib

Data Analysis & Results

Mann-Whitney U-Test

EGFR, TP53, RB1 mutants have uniquely excellent *initial* treatment response...

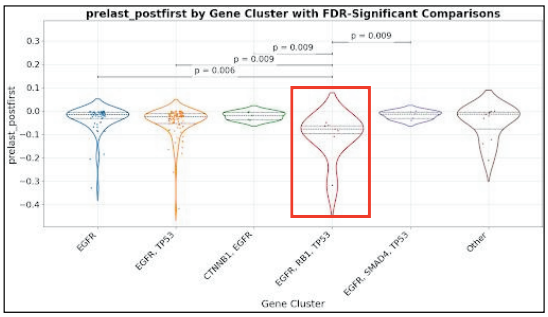


Fig. 5 Distribution of prelast-postfirst across clusters.
Created by Fu 2025 with Matplotlib.

KM Survival Analysis

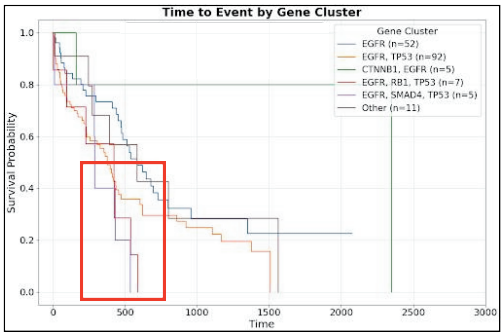


Fig. 6 Kaplan-Meier curves
Created by Fu 2025 with Matplotlib.

Quickly develop resistance, with extremely poor progression-free survival.

Methodology

We introduce a novel computational pipeline:

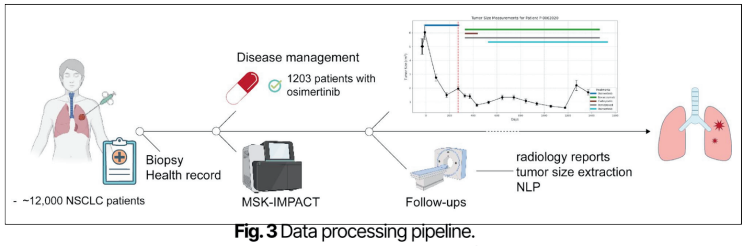


Fig. 3 Data processing pipeline.
Created by Fu 2025 in Adobe Illustrator w/ BioRender.

Step 1: Compile genomic, pathological, treatment data.

Step 2: Calculate init. response: "Prelast-postfirst."

Step 3: Analyze differences in prelast-postfirst by genome

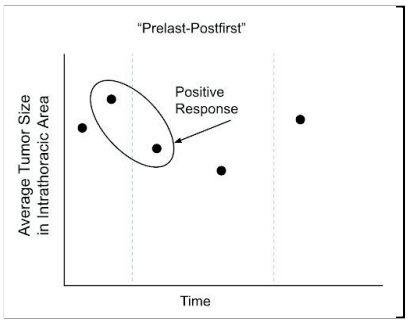


Fig. 4 Prelast-postfirst.
Created by Fu 2025 with Figma.

Interpretation & Conclusions

Mutational states may be clearly linked to and confirm **biophysical parameter contributions.**

Applications:

Preemptively **time treatment regimens** around known **mutational states.**

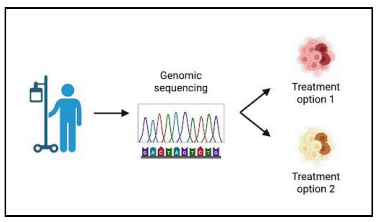


Fig. 7 Accounting for genome.
Created by Fu 2025 in BioRender

Future Research

Validate findings in-vitro; expand to other mutants, or other treatments than osimertinib.

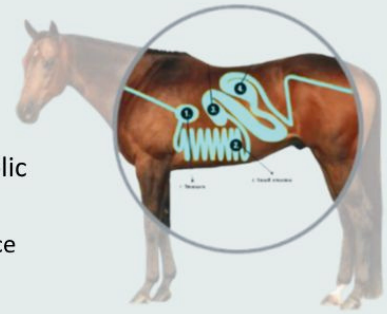
Examine associations across **clinical data,** such as race, gender, smoking status, etc.

Weathering Colic: Investigating the Impact of Environmental Factors on Equine Colic Clinical Sign Severity

Isabella Garcia

Research Question

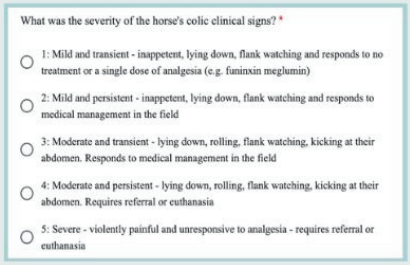
Do environmental factors have an effect on the clinical sign severity of colicking horses?



Problem:

- More than 64,000 horses in the United States die from colic or colic related issues each year
  - Multiple studies reference the possibility of environmental effects
  - Lack of actual data
  - Do not categorize colic by severity
- Not across a broad location range
- Further understanding on the effects of the environment is needed

Methodology



- Contacted >1,700 veterinarians around the United States
- Asked veterinarians to report severity, date, and location of colic cases
- n=57
- Used NOAA weather database to collect environmental data

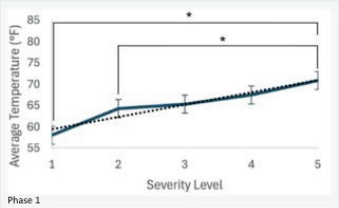
Dependent Variable:

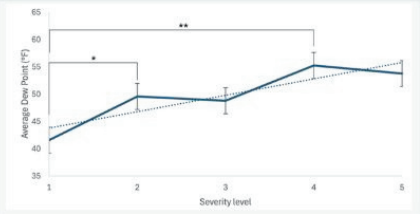
- Severity of colic clinical signs measured on a scale of 1-5

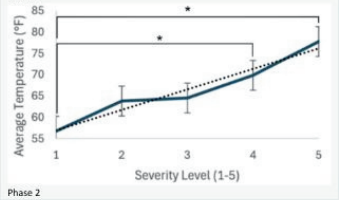
Independent Variables:

- Temperature, humidity, precipitation, and sea level pressure in the location of diagnosis

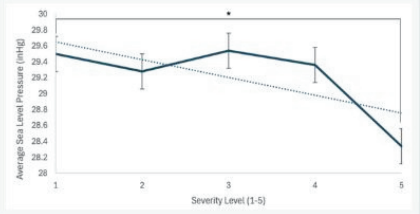
Results



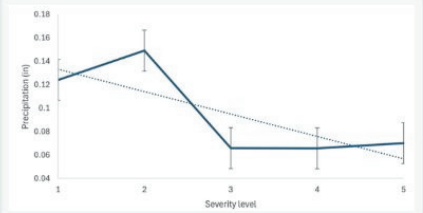




- As temperature and dew point increased, colic severity increased significantly



- As sea level pressure decreased, colic severity increased significantly



- As precipitation decreased, colic severity increased with no significant differences

Conclusion

Major Findings

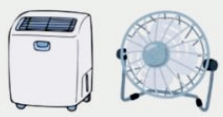
- Temperature, dew point, and sea level pressure likely have an influence on colic severity

Application

- Equine veterinarians can prepare for more severe colic cases

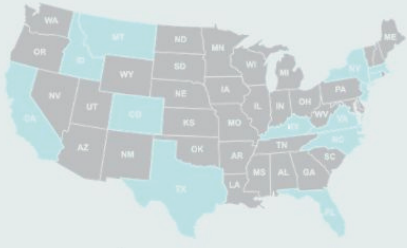
WHAT MIGHT HELP LESSEN THE EFFECTS?

Proper ventilation, fans, and dehumidifiers



Future Research

- Expand research across all states
- Research how the environment influences physical parameters like heart rate and blood cortisol levels



ISABELLA GARCIA

WEATHERING COLIC: INVESTIGATING THE IMPACT OF ENVIRONMENTAL FACTORS ON EQUINE COLIC CLINICAL SIGN SEVERITY



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Cornell University
INTENDED MAJOR/CAREER PATH	Animal Science, Pre-Vet

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Some of my proudest moments were winning second place and a spot to the International GENIUS Olympiad at WESEF junior year and winning fourth place at WESEF this year.

FAVORITE MEMORY

One of my favorite research memories was decorating pens at the science research winter celebration!

WORDS OF WISDOM

Research something you are genuinely interested in. This course is a lot of work, but if you are passionate about your research it will be such a fun and rewarding experience.

PROJECT ABSTRACT

Equine colic is abdominal pain in horses caused by issues in the gastrointestinal system and has a broad range of severity across cases. A handful of studies have looked at the relationship between the environment and colic but overlooked severity differences, so understanding remains incomplete. 1,700 veterinarians across the United States were contacted to provide the location, date, severity, and results of colic cases that occurred in between September 2022 and September 2025. Severity was put on a scale of one through five with one as mild and five as severe. Then, the NOAA weather database was used to find the average temperature, dew point, precipitation, sea level pressure, and short-term change in temperature of the environment for each day a case occurred. It was found that as temperature and dew point increased, colic cases became significantly more severe. Additionally, it was found that as sea level pressure decreased, colic cases became significantly more severe. However, no significant correlation between precipitation or short-term change in temperature and colic severity was found. Findings on the impact of environmental temperature from 2025 were compared to phase 1 of the study, performed in 2024, where the significance and trends of the datasets were found to be very similar. From these results, it was concluded that the hypotheses were partially supported, so it is likely that temperature, dew point, and sea level pressure have an impact on colic severity but unlikely that precipitation and short-term change in temperature have an effect.

ZOE GOLUB



DIETARY DIVERSITY AND ALLERGEN EXPOSURE IN INFANTS WITH AND WITHOUT SEVERE ECZEMA: A SECONDARY ANALYSIS OF THE LEAP TRIAL

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of Texas at Austin
INTENDED MAJOR/CAREER PATH	Health and Society (pre-med track)

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Some of my proudest moment from science research include competing at WESEF, completing a full research paper by junior and senior year and winning 3rd place in Medicine and Health at Somers.

FAVORITE MEMORY

Competitng at WESEF with everyone and meeting new people.

WORDS OF WISDOM

Find something you are passionate in and run with it. Doing research on something you are interested in won't feel like busy work. I have learned so much through this course that I will take with me to my next steps.

PROJECT ABSTRACT

Food allergies affect over 33 million Americans, with peanut allergies being the most common. Infants with eczema are at a particularly high risk of developing food allergies, yet caregiver hesitancy may limit early dietary exposure. This study conducted a secondary analysis of data from the Learning Early About Peanut (LEAP) trial to examine whether eczema severity influences dietary diversity in infants. Using data from 601 infants with complete dietary and eczema information, participants were categorized by caregiver-reported eczema severity and SCORAD score (>40 indicating severe eczema). Median number of foods introduced at baseline was compared across groups, and t tests were used to assess statistical significance. Infants with severe eczema had a median of 10 foods introduced, compared to 13 among those with mild to moderate eczema. This is a highly significant difference (p= 0.000006). Similar trends were observed when the caregiver reported eczema status. These findings support the hypothesis that infants with severe eczema are exposed to fewer foods at baseline, likely reflecting caregiver caution due to prior skin reactivity. Reduced dietary diversity during infancy may hinder immune tolerance and contribute to higher allergy risk. This study underscores the importance of addressing caregiver hesitancy and integrated early feeding guidance into eczema management to support allergy prevention. Further research using the LEAP dataset could clarify how eczema severity and caregiver behaviors interact to shape early dietary patterns and allergic outcomes.

Dietary Diversity and Allergen Exposure in Infants with and without Severe Eczema: A Secondary Analysis of the LEAP Trial

Zoe Golub

Does eczema severity affect dietary diversity (number of foods introduced) in infants?

- Over 33 million Americans have food allergies
- Infants with eczema are at higher risk of developing food allergies
- The **LEAP study** showed early peanut introduction reduces allergy risk
- Less is known about **overall diet diversity** in these infants



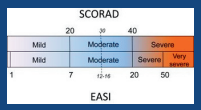
Infants with severe eczema will be introduced to **fewer foods** because caregivers may be more cautious due to skin reactions.

Secondary data analysis of the LEAP randomized controlled trial

601 infants (ages 4–11 months) with complete data, high-risk for peanut allergy

Severe eczema vs. mild/moderate eczema

→ Defined by:



- SCORAD score (>40 = severe)
- Caregiver-reported eczema status

Data collected: # of foods introduced at baseline and eczema severity (SCORAD + caregiver report)

Analysis: Calculated median # of foods introduced, Used **t-tests** to compare groups, Significance threshold: **$p < 0.05$**

Key Findings: Severe eczema group: Median = 10 foods, Mild/moderate eczema group: Median = 13 foods, Difference is highly statistically significant (p = 0.000006)

Interpretation of Data: Infants with severe eczema are exposed to fewer foods early in life, Supports idea that caregivers may limit diet due to fear of reactions

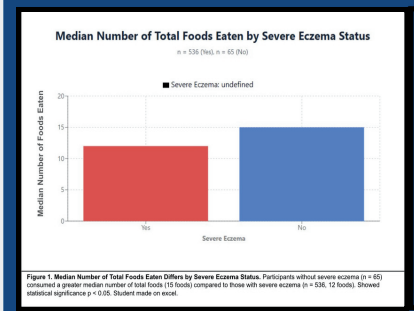


Figure 1. Median Number of Total Foods Eaten Differs by Severe Eczema Status. Participants without severe eczema (n = 65) consumed a greater median number of total foods (15 foods) compared to those with severe eczema (n = 536, 12 foods). Showed statistical significance p < 0.05. Student made on excel.

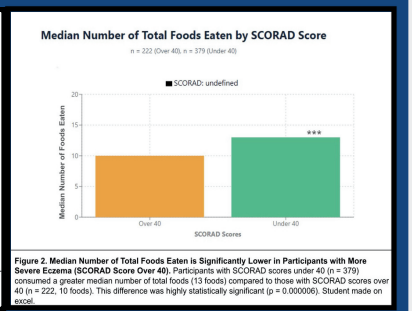


Figure 2. Median Number of Total Foods Eaten is Significantly Lower in Participants with More Severe Eczema (SCORAD Score Over 40). Participants with SCORAD scores under 40 (n = 379) consumed a greater median number of total foods (13 foods) compared to those with SCORAD scores over 40 (n = 222, 10 foods). This difference was highly statistically significant (p = 0.000006). Student made on excel.

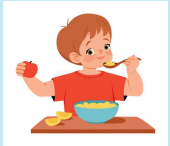
Results support the hypothesis: Infants with severe eczema are introduced to **fewer foods**

Reduced diet diversity may:

Limit immune system development

Increase risk of food allergies

Supports findings that early and diverse food exposure helps prevent allergies



Integrate dietary guidance into eczema treatment plans

Help reduce future food allergy risk

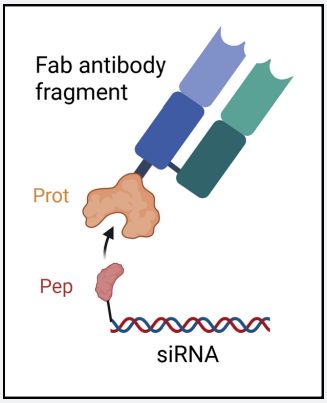
Early food diversity matters—**avoiding foods may actually increase allergy risk**

Development of an Antibody-siRNA Conjugation Method and Internalization Assay for High-Throughput Screening

Background and Objectives

- Safe, specific delivery is needed for siRNA
- Antibody-siRNA conjugates (AOCs) used for delivery
- Identification of most effective antibodies for siRNA delivery is difficult
- Lack of efficient process for high-throughput screening
- No efficient conjugation method to rapidly form AOCs
- Pep/Prot: peptide/protein pair, rapidly form an irreversible isopeptide bond under flexible conditions

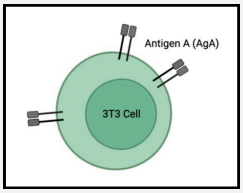
1. Confirm effectiveness of modified cell line (3T3-AgA) to evaluate AbA-siRNA1 uptake
2. Evaluate 3T3-AgA tolerance to CHO media
3. Determine ideal conjugation conditions for Pep/Prot-AOCs
4. Evaluate knockdown of Pep/Prot-AOCs
5. Evaluate binding of Pep/Prot-AOCs



Methodology

Part 1: AbA-siRNA1/3T3-AgA Evaluation

- 3T3-AgA cells transfected with AbA-siRNA1
- Target mRNA (Gene1) extracted
- RT-qPCR to quantify mRNA
- Analysis in Prism via 2-ΔΔCt method

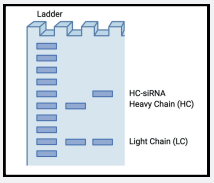


Part 2: 3T3-AgA CHO Media Tolerance

- 3T3-AgA cells used
- Cells placed in varying amounts (0-100%) of CHO media
  - Eventual Pep/Prot conjugation takes place in CHO media
  - Neg ctrl: 0% CHO media
- CellTiter-Glo (CTG) assay to quantify cell viability
- Analysis in Prism via Welch's ANOVA and Dunnett's multiple comparisons test, ***p<0.001, ****p<0.0001

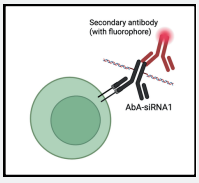
Part 3: Optimization of Conjugation Conditions

- Pep/Prot-AOCs conjugated at varying timepoints, concs, and siRNA:Fab ratios
- SDS-PAGE to evaluate conjugation efficiency
- Analysis in Prism



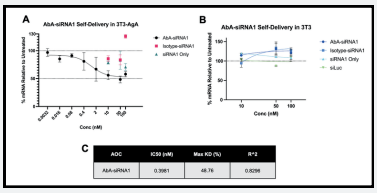
Part 4/5: Evaluate Knockdown and Binding of Pep/Prot-AOCs

- Pep/Prot-AOCs used, conjugated based on pt. 3
- RT-qPCR to evaluate target gene knockdown
- Flow cytometry to evaluate binding

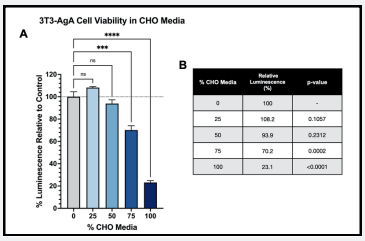


Results

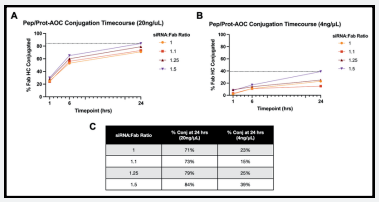
Pt. 1: AbA-siRNA1/3T3-AgA Evaluation



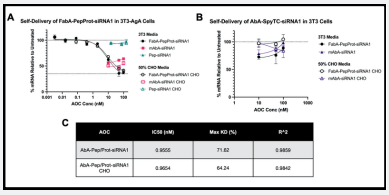
Part 2: 3T3-AgA CHO Media Tolerance



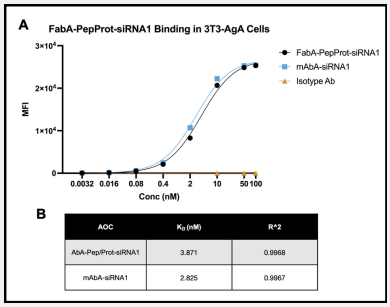
Part 3: Optimization of Conjugation Conditions



Part 4: Evaluate Knockdown of Pep/Prot-AOCs



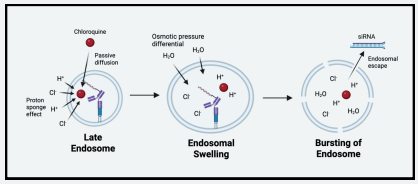
Part 5: Evaluate Binding of Pep/Prot-AOCs



Conclusions

Future Research

- Improve assay sensitivity with chloroquine
- Determine and quantify assay scalability



Applications

- Improve the safety of siRNA-based drugs by reducing off-target effects
- Allow for faster and more accurate identification of antibodies for AOC delivery
- Speed up and improve development of siRNA-based drugs

Conclusions

- Problem:
  - Lack of efficient AOC internalization assay
  - Need fast/efficient conjugation method
- Goals:
  - Establish baseline AOC/cell line
  - Optimize cells and conditions for internalization assay
  - Test efficacy of Pep/Prot-AOCs

Major Findings

- Pep/Prot ideal conjugation conditions
- Pep/Prot-AOCs maintain overall efficacy vs. more conventionally conjugated AOCs
- A Pep/Prot internalization assay is viable

KEVIN GUO

DEVELOPMENT OF AN ANTIBODY-SIRNA CONJUGATION METHOD AND INTERNALIZATION ASSAY FOR HIGH-THROUGHPUT SCREENING



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Case Western Reserve University
INTENDED MAJOR/CAREER PATH	Molecular Biology

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- **Regeneron ISEF Finalist**
- **Regeneron STS Scholar**
- American Society of Human Genetics Essay Contest Honorable Mention
- WESEF 1st in Medicine and Health
- WESEF 4th in Cell/Molecular Biology
- Somers 1st in Medicine and Health

FAVORITE MEMORY

Listening to I AM MUSIC for the first time with everyone on the bus back from WESEF 2025

WORDS OF WISDOM

Trust the process.

PROJECT ABSTRACT

In recent years, therapeutic siRNA has risen in popularity as a means to induce gene silencing. However, due to the nucleic acid's need for delivery, antibody-siRNA conjugates (AOCs) have become increasingly common, and thus identification of antibodies suited for delivery has become increasingly important. However, screening for AOC internalization to identify antibodies currently only exists on a small scale and is highly inefficient. In this study, I present a high-throughput method to screen for AOC internalization by introducing a highly efficient conjugation method using interactions between a peptide and a protein (Pep/Prot). An initial baseline evaluation of the AOC and modified cell line was performed using RT-qPCR, and the modified cell line developed for the assay was then evaluated for its tolerability to CHO media, which Pep/Prot would be conjugated in, using a cell viability assay. The conditions for the Pep/Prot conjugation were then optimized with SDS-PAGE, and the final Pep/Prot-AOCs were evaluated for their knockdown and binding potency using RT-qPCR and flow cytometry. Modified cells were found to tolerate up to 50% CHO media, and the reaction most notably favored a high concentration and siRNA:Fab ratio. Additionally, Pep/Prot-AOCs were found to maintain their knockdown and binding efficacy compared to a more conventional conjugation method, all while being much easier to conjugate and produce in bulk. The sensitivity of the assay could still be improved in future work, however an efficient Pep/Prot-based internalization assay as described in this study could be used to drastically speed up siRNA drug development.

BENJAMIN HARRIS



A NOVEL METHODOLOGY FOR CLIMBING IN DIVERSE PIPES WITH A SOFT TENSEGRITY ROBOT

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Boston University
INTENDED MAJOR/CAREER PATH	Mechanical Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- Seeing the first prototype work close to intended
- Getting certified to and working in a professional lab for the first time
- Collecting the data that made my robot the state of the art

FAVORITE MEMORY

- Sitting on animal-themed mats with my friends, working through our STS essays together in class.

WORDS OF WISDOM

If you don't fail, you won't succeed

PROJECT ABSTRACT

Pipeline spills stemming from deterioration can result in devastating impacts on the industries that rely on them as well as the surrounding environment. For this reason, regular inspection is necessary, typically conducted by robots due to conditions in the pipes. In order to improve the range of pipes which they are usable, it is important for a robot to be able to climb in a large variety of pipe diameters and conditions. This paper discusses the novel application of a tensegrity structure as the frame of a pipe inspection robot designed to maximize the range of diameters in which it can function. The constraints imposed by the pipe enable us to develop a simple model to relate the dimensions of the system to the diameter of the pipes it can work in. The key to the robots function is a tensegrity frame that's equilibrium form is larger than the pipes it must function in, creating a restoring force that provides better gripping to the pipe walls. The prototype robot was capable of climbing vertically and moving horizontally in a large range of diameters from 102 to 305 mm (4 to 12 inches). This is the highest recorded range of any pipeline inspection robot. The robot was also able to overcome transitions between different pipe diameters at tapers up to 28°. When fitted with inspection tools such as cameras, LIDAR sensors, x-ray sensors, and other non-destructive testing (NDT) devices, this robot could help save money, prevent the loss of access to essential resources, and prevent irreversible ecological damage. Additionally, The methods developed in this paper to understand a tensegrity structure in a constrained form could be used in other situations to take advantage of the properties of tensegrity.

A Novel Methodology for Climbing in Diverse Pipes with a Soft Tensegrity Robot

Background



Fig. 1. Pipeline spill in Oehler Nature Preserve [1]

-Pipes form the backbone of chemical, oil, and water industries

-**2.6 millions miles** of gas pipelines in the U.S.

-Failure results can result in enormous economic and ecologic damage

-Inspection is important to prevent failure

-Existing robots are unable to achieve

-High speeds for lower inspection downtimes

-High adaptability (through a large ratio of operable diameters) so one robot can be used in multiple pipes

-Low mass for fragile pipes, acceleration, and energy efficiency

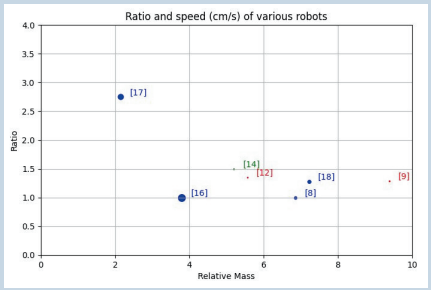
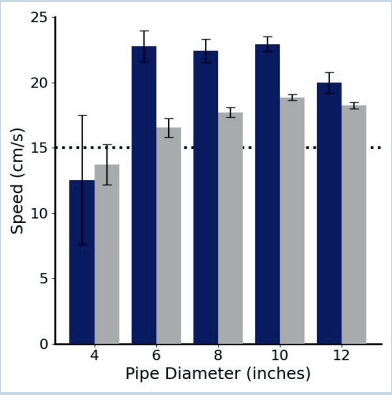


Fig. 4. Comparison of previous pipe-climbing robots. The size of the dots are scaled to the square root of the speed. The color represents the type, blue is wheeled, red is inchworm, and green is legged. Compiled and graphed by student with MatPlotLib, 2026

Results



-From speed tests in various diameter pipes it can be seen that the robot performs in a ratio of diameters of **3.0**

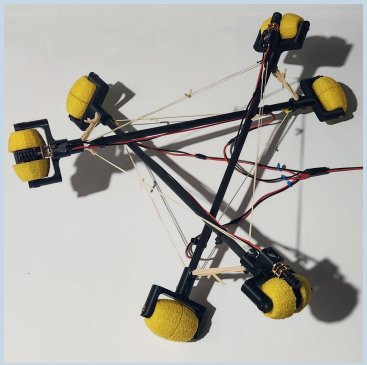
-3.0 is the highest known ratio in the literature

-Slight drop-off in speed observable in smaller diameters likely caused by increased friction thanks to compact space

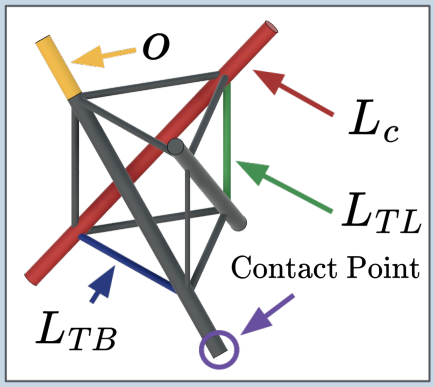
-Robot also exhibits the ability to climb through multiple pipe diameter transitions

-Achieves mass of 314g, lowest mass relative to diameter ever

	Contract	Expand
12-10	100%	100%
10-8	100%	100%
8-6	100%	100%
6-4	50%	0%



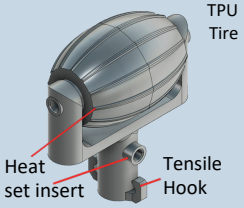
Design

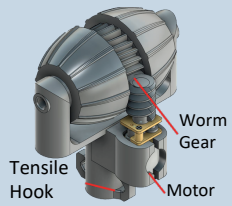


-Uses 3-bar tensegrity structure as the frame

-With an equilibrium larger than the pipe diameter, the frame improves friction through the restoring force

-Motion is facilitated by wheels at 6 contact points on the compressive elements



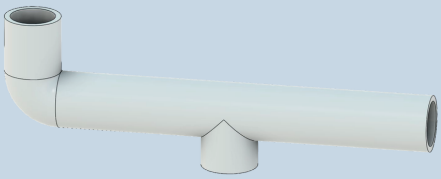


-Approximations of a equilateral triangle of tensile elements allows for optimization of tensile element lengths

	L_{TB}	L_{TL}
D_{min}	2R	$\sqrt{(L_c^2-4R^2)}$
D_{max}	$\sqrt{(L_c^2-4R^2)}$	2R

$$D = \frac{\sqrt{3}}{3}\sqrt{o^2 + 4(L_c - 0)^2 + 2o(L_c - o)}$$

Future



-Test the robot in pipe elbows, pipe t-junctions, and more complex pipe surfaces

-Experiment with attaching different types of sensors

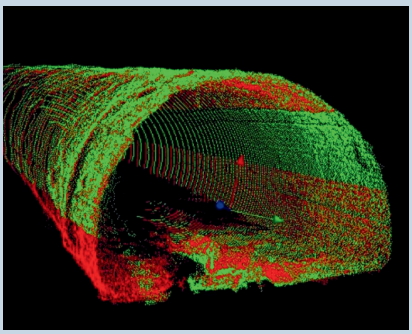
-Robot could be fitted with a variety of sensors
- LIDAR/RADAR
X-Ray Devices
- Transducers
- Profilometers

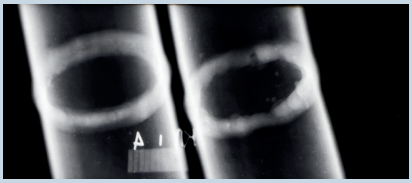
-Optical cameras

-Other NDT devices

-Could inspect many pipe types

-Oil pipelines/wells -Water pipelines/wells -Steam generators
- Nuclear/aerospace
- Waste/sewage
- More





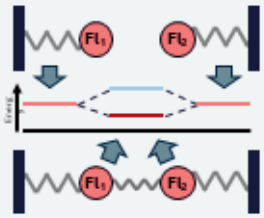
Towards a Potential Route for Single Photon Generation: Observing Exciton Coupling Between 2D Materials and Molecules

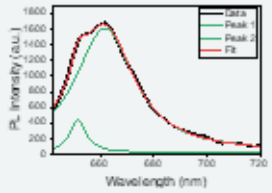
Albert Huang

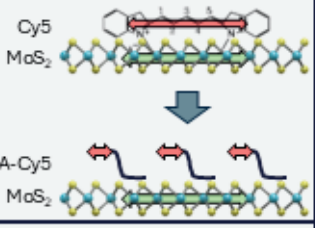
Introduction

- Single photons can be used for quantum communication
- Many single photon sources require cryogenic temperatures
  - Cost and space-prohibitive
- Fluorescent molecules can "exciton-couple"
  - May lead to higher emission rate
  - Increasing brightness
- 2D semiconductor materials like MoS_2 also form excitons
- Limited research on coupling between 2D materials and fluorophores
- Previous research found evidence of coupling between Cy5 (fluorophore) and MoS_2 (2D material) in the form of peak splitting
- Current research will focus on improving coating method by using DNA-Cy5









Results

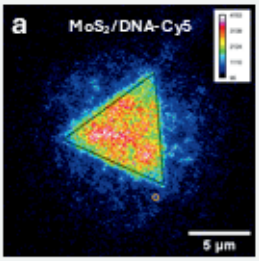
a) **Isolated DNA-Cy5 (orange circle)**

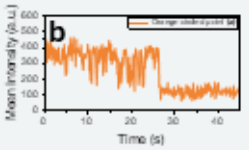
b) **Time trace shows one-step bleaching**
- Sharp drop at ~25s
- Suggests DNA-Cy5 isolation

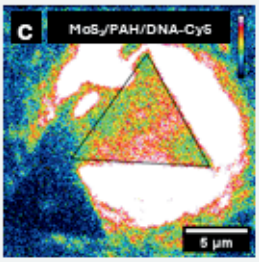
c) **DNA-Cy5 adsorbs onto quartz and MoS_2 with PAH**
- More fluorophore on quartz
- Incomplete potential reversal

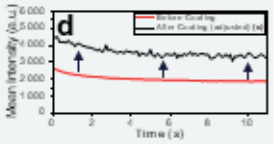
d) **Emission intensity increases after PAH assisted coating**
- DNA-Cy5 adsorbed onto MoS_2

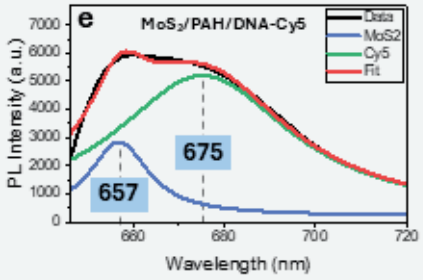
e) **No evidence of coupling**
- No change in peak energies











Methodology

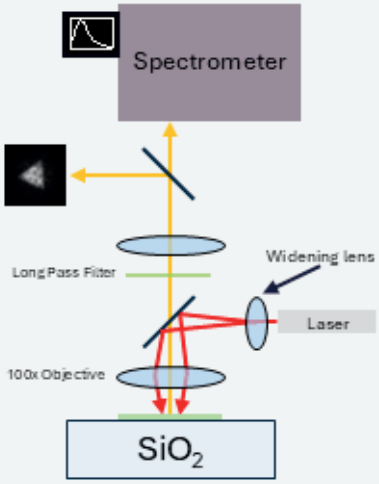
Coating

- DNA-Cy5 coating
  - Negatively charged
  - Molecule isolation caused by charge allows for single photon source creation
- Surface potential adsorption
  - Novel PAH^+ assisted method



PL Spectroscopy and Mapping

- Collecting Cy5 emission data (coupling evidence)
- 633 nm He-Ne excitation
- LPF removes laser light
- Emitted light could go into an EMCCD for mapping or spectrometer for spectroscopy
- Widening lens
  - Lowered power density for reduced photobleaching
  - Enabled widefield mapping



Discussion and Conclusion

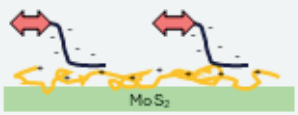
Discussion

No Coupling

- PDMS residue during transfer
  - Incomplete curing (1h vs 4h)
- Increased physical distance between MoS_2 and DNA-Cy5
- Caused larger peak distance between MoS_2 and DNA-Cy5
  - 20 nm vs 4 nm
  - May have inhibited coupling

Notable Findings

- One-step bleaching
  - DNA isolation
- PAH assisted DNA adsorption
- Need for longer PDMS curing
  - Ensure minimal residue





Applications

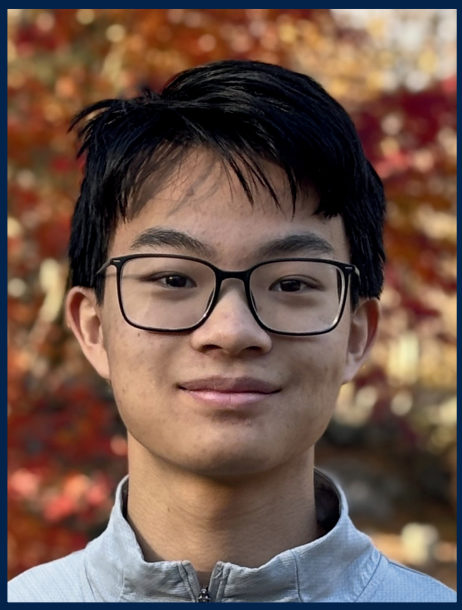
- Single photon source
  - Quantum computing
  - Quantum information transfer
  - Research applications





ALBERT HUANG

TOWARDS A POTENTIAL ROUTE FOR SINGLE PHOTON GENERATION: OBSERVING EXCITON COUPLING BETWEEN 2D MATERIALS AND MOLECULES



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of California, San Diego
INTENDED MAJOR/CAREER PATH	Physics

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Getting a signal from single Cy5 molecules

FAVORITE MEMORY

Eating pancakes in class

WORDS OF WISDOM

Make sure you get enough sleep

PROJECT ABSTRACT

Molybdenum disulfide (MoS_2) is a 2D material widely studied for its direct bandgap at the monolayer scale and excitonic photoluminescence. An unexplored property of 2D materials is the ability of their excitons to couple with external molecules, or exciton coupling. Exciton coupling could potentially be exploited to create high emission rate, room-temperature, single-photon sources that would expand the scope and power of quantum computing. For both phases of this study, MoS_2 was transferred onto quartz substrates for experimentation. During phase 1 of this study, MoS_2 was spin-coated with Cy5 fluorophores and observed with angled photoluminescence (PL) spectroscopy, where the excitation laser was directed at a shallow angle to the sample. Some of the coated MoS_2 exhibited peak splitting in their PL spectrums, but peak splitting was not seen for all samples, probably because of an imbalance between the concentration of unbleached Cy5 and excitons within the MoS_2. The peak splitting strongly suggested that there was exciton coupling between the MoS_2 and Cy5. During phase 2, the MoS_2 was coated using Cy5-coupled DNA (DNA-Cy5) with the assistance of polyallylamine hydrochloride (PAH). The results showed that coupling between the DNA-Cy5 and MoS_2 was not present. This was likely due to residues left over from the MoS_2 transfer process or the PAH thickness inhibiting coupling. Under widefield mapping, the data showed that the DNA-Cy5 isolated itself within the solution, which suggests this method could more reliably create single photon sources. Overall, these results open a new avenue for exploring the interactions between 2D materials and molecules, potentially offering improvements in single photon emission properties.

ADAM KAMAL



QUANTUM-DRIVEN NEGOTIATION PROTOCOLS FOR ENERGY TRADING IN PEER-TO-PEER MICROGRIDS

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	
INTENDED MAJOR/CAREER PATH	Electrical Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Conceptualizing and completing my research projects.

FAVORITE MEMORY

Finding my passion in the field of energy.

WORDS OF WISDOM

Help others

PROJECT ABSTRACT

Contemporary smart grids are plagued by systemic inefficiencies in energy loss, operational cost, and inequitable access. In this work, a quantum-driven negotiation protocol is developed for P2P microgrids that enables the fair and efficient local trading of energy. Extending prior hybrid quantum-classical work, an agent-based simulation written in Python with the Mesa package was created by incorporating quantum optimization through QAOA with stochastic parameter tuning using SPSA on IBM's Brisbane backend. Agents representing individual households dynamically negotiate trades in test scenarios of balanced, surplus, and deficit conditions. The algorithm produced stable market equilibria with fast post-feasibility recovery, improving efficiency (+12%), fairness (+13%), and runtime (-78%) over classical baselines. Results showed that quantum assisted solvers can assure equitable energy access when reducing curtailment below 10% and unmet demand under 5% in regimes with surplus resources. These results present the first evidence that quantum optimization may improve energy equity within decentralized markets. Future efforts will expand the protocol to multi-microgrid networks with income-tier weighting and storage systems. Furthering the vision of computationally fair, carbon neutral community power systems

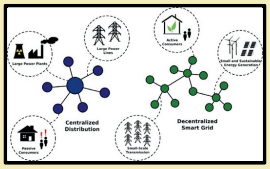
Quantum-Driven Negotaion Protocols for Energy Trading in Peer-to-Peer Microgrids

Adam Kamal

Introduction

- **1 in 3** Americans struggle to pay electricity bills
- More than **90%** of countries utilize electric grids

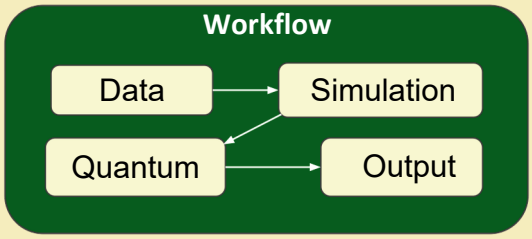


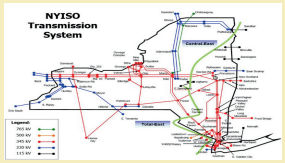


- Waste renewable energy [3]
- Create unequal access [4]

- Rooftop solar and local generation increase decentralization
- Stranded renewables
- Traditional grid coordination cannot efficiently integrate these
- Renewable generators are left in surplus

Methodology





- Synthetic profiles from NYISO load + EIA irradiance
- Min–Max scaling to [0,1]
- Incidence matrices define feasible trades
- Prepares agent states for QUBO

Agent-Based Market Simulation (Mesa)

- Agents post buy/sell offers each round
- Strategies: greedy + tit-for-tat
- Prices updated dynamically
- Trade requests exported to QUBO

[8]

QUBO Formulation

- Binary variables represent trades
- Objective: maximize efficiency + fairness
- Penalties: volatility + unmet demand
- Constraints: supply limits, demand balance, exclusivity

[9]

QAOA Optimization Pipeline

- QUBO sent to QAOA Hamiltonian
- SPSA tunes parameters
- Executed on IBM Brisbane
- Returns trade-matching decisions

[10]

Trade Feasibility Encoding

- Builds adjacency matrix of valid agent pairs
- Encodes supply/demand compatibility
- Filters infeasible trades before optimization

Simulation tested under three regimes

1. Balanced
2. Surplus
3. Deficit

[11]

Performance Metrics

1. Efficiency
2. Fairness
3. Price stability
4. Unmet demand
5. Runtime

[12]

Results and Discussion

>0.9

Market Efficiency

High steady-state plateau; rapid recovery from feasibility gap at round ~25

≥0.70

Fairness Index

Left-tail CDF lift; balanced distribution across prosumers & consumers

<0.10

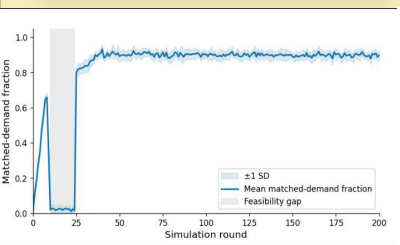
Rate

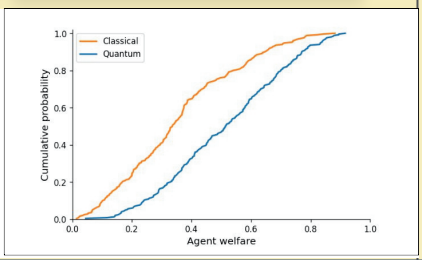
Outperforms classical 15-25%; served load >0.9; efficient local generation use

~0.6s

Median

vs. classical 2-3s; near real-time capability; narrow variability across runs





Conclusion

Need Greener Cheaper Energy

Problem

Utilize Quantum Classical Hybrid Approach

Approach

Testing Depicts success in lowering electricity price with greater results compared to classical

Results

Proteomic Drivers of Lupus Nephritis in Type 2 SLE: Integrating Olink with PROMIS-29 Outcomes

By Rishi Kumar

Background

Non-inflammatorymechanisms **aren'tcaptured** by standard markers thatcontribute tosymptom burden

Proteomics

- **Reflects real-time cellular states**
- **Insight into current disease biology**

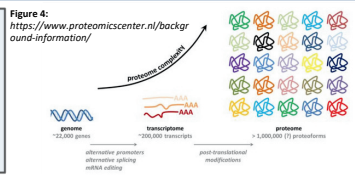


Figure 4: *https://www.proteomicscenter.nl/background-information/*

Goal

1	Identify	Serum proteins associated with Type 2 SLE symptoms
2	Integrate	Olink Proteomics with Clinical Data
3	Assess	Shared vs Domain-specific Proteomic Signatures

Hypothesis

LN patients with Type 2 SLEexhibitdistinct proteomic signatures compared to classicinflammatory activation

Methodology

Student

Conductedall the computational elements

Mentor

Set PROMIS-29 Threshold And gave access to Data

Olink

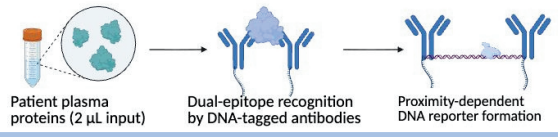


Figure 5: Flowchart of the Olink PEA Explore HT technology. Patient plasma proteins are recognized by pairs of DNA-tagged antibodies that bind distinct epitopes on the same target protein. When both antibodies bind in proximity, their DNA tags hybridize to form a reporter sequence, enablinghighly specific and sensitive protein quantification. Created by the student using bioRender.com, 2026.

Visual Proteomic Workflow

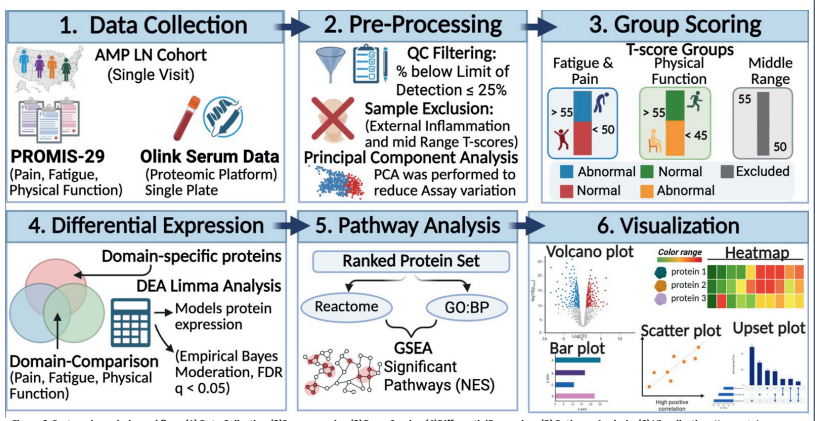


Figure 6: **Proteomic analysis workflow: (1) Data Collection:(2)Pre-processing:(3)GroupScoring:(4)DifferentialExpression: (5) Pathway Analysis: (6) Visualization:** Key protein and pathway results were displayed using volcano plots, heatmaps,andoverlap-basedanalyses.Createdbythestudentusing Biorender.com [15, 16, 17,18], 2026.

Results

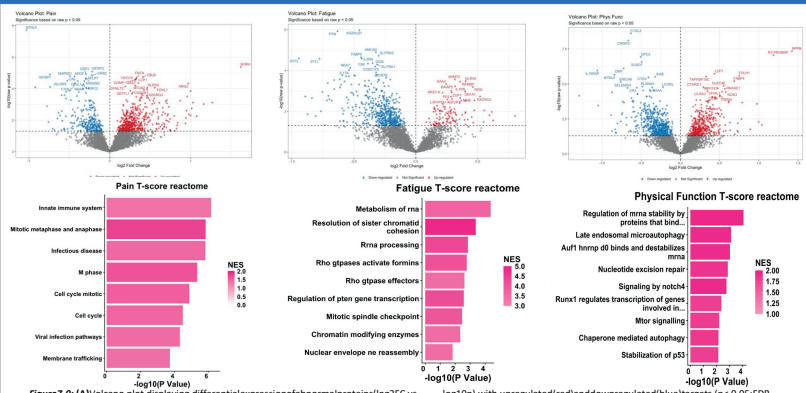


Figure7-9: **(A)**Volcano plot displaying differentialexpressionofabnormalproteins(log2FC vs. −log10p),with upregulated(red)anddownregulated(blue)targets (p< 0.05;FDR q<0.05for follow-up). **(B)** Reactome PathwayEnrichmentAnalysisidentifyingsignificantly enrichedpathways (FDRq<0.05).GeneratedbythestudentusingR, 2026.

Non-inflammatory drivers with significant pathways in energetic imbalance and cardiometabolic stress

Table 1: Significant proteins **(FDR q < 0.05)** were identified as proteins significantly expressedthroughthedifferential expressionanalysis inallthreedomains(Pain, Fatigue, andPhysicalFunction).Each protein'sfullnamewas annotated viatheHUGO Gene NomenclatureCommittee(HGNC), andtheBiological Functionwasannotatedby Gene Ontology,biological pathway (GO:BP).The table is madeby the Student using R, 2026.

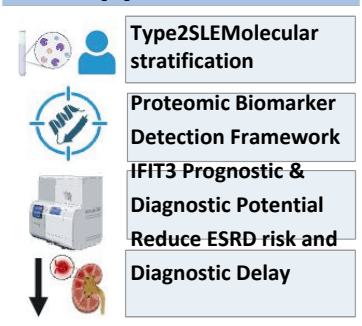
Protein	Full Name	Biological Function
CA6	carbonic anhydrase 6	detection of chemical stimuli involved in the sensory perception of bitter taste.
IFIT3	interferon induced protein with tetratricopeptide repeats 3	Negative regulation of cell population proliferation and the apoptotic process.

Conclusion

Study Summary

Proteomic	Pathway	IFIT3	Hypothesis
• Individual & Shared Proteins • PROMIS-29 & Type 2 SLE-LN Drivers	• Cellular Energetic Imbalance • Neuro-Immune convergence	• IFIT3 Downregulation • Interferon Axis Disruption	• Partially Supported • Energetic pathway • Secondary Immune element

Applications



- **Type2SLEMolecular stratification**
- **Proteomic Biomarker Detection Framework**
- **IFIT3 Prognostic & Diagnostic Potential**
- **Reduce ESRD risk and Diagnostic Delay**

Figure 16: Identified protein signatures may enable molecular stratification of Type 2 SLE patients, support biomarker-based diagnostics, highlight IFIT3 as a potential prognostic marker, and improve early detection of lupus nephritis progression to reduce ESRD risk. Graphic created by the finalist using bioRender.com, 2026.

Future Work



Figure 17: Future research directions including multi-assay validation, expanded covariate modeling across PROMIS-29 domains, andmachinelearningbased diagnosticprediction tools.Createdbythe student usingbioRender.com,2026.

- **Multi-assay validation**
- **Limma covariate analysis to examine**
- **more PROMIS-29 domains**
- **ML-IntegratedDiagnostic Prediction Tools**

Limitations

- **Treatment & LN Activity not controlled**

RISHI KUMAR

PROTEOMIC DRIVERS OF LUPUS NEPHRITIS IN TYPE 2 SLE: INTEGRATING OLINK WITH PROMIS-29 OUTCOMES



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of Illinois
INTENDED MAJOR/CAREER PATH	Chemical & Biomolecular Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- Finishing my Somer's Poster
- Completing my Research Project on time
- JSHS State Finalist
- NYSSEF Finalist
- Innovations in Biological Sciences Award at WESEF

FAVORITE MEMORY

- Pen Making
- Learning about other people's projects at WESEF
- Making pancakes in class
- Bus Ride to JSHS & NYSSEF
- Award Ceremony at WESEF

WORDS OF WISDOM

" The leaping frog doesn't need wings to soar."

-Adam Kamal

Try not to procrastinate all your Sci Res work, and make sure to thank ur Sci Res teachers :)

PROJECT ABSTRACT

60% of patients with Systemic Lupus Erythematosus (SLE) develop Lupus Nephritis (LN), a kidney complication that increases the risk of kidney failure by a factor of 45 and triples the mortality rate. Traditional serologic tests for diagnosing LN do not fit Type 2 SLE patients, who often have low-to-non-inflammatory symptoms. This study aimed to identify proteomic signatures for LN from Type 2 SLE manifestations. LN patients with Abnormal PROMIS-29 T-scores for Pain, Fatigue, and Physical Function were predicted to exhibit unique proteomic signatures reflecting a bioenergetic imbalance defining a unified Type 2 SLE profile. Data were collected from the Accelerating Medicines Partnership (AMP), including Serum proteomics from the Olink Explore HT platform and PROMIS-29 T-scores. Patients were classified as Abnormal or Normal; after Limit of Detection filtering, normalization was performed. The Individual PROMIS-29 Domain Analysis was performed using differential expression, visualized in a Volcano plot ($p < 0.05$), a complex heatmap (FDR $q < 0.05$), and Pathway analysis. Comparison Analysis included Scatterplots, UpSet plots, and a Common Protein List. Individually, the domains identified an immune-metabolic imbalance and cellular energetic dysregulation. Across all domains, IFIT3 was significantly downregulated. IFIT3 was a novel finding, as it is typically upregulated in inflammation. An Interferon imbalance can allow IFIT3 to serve as a mediator of renal inflammation and a driver of LN. These findings can enable the development of non-invasive biomarker prognostics, improve early diagnosis, and reduce the severity of LN. Future work should use a covariate limma matrix to incorporate other PROMIS-29 Domains.

EVE LANSFORD



PERSPECTIVES ON COLLEGE TRANSITION: AN EXPLORATORY STUDY OF AUTISTIC YOUTH AND THEIR PARENTS

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of Pennsylvania
INTENDED MAJOR/CAREER PATH	Health and Societies

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Finishing my research paper and presenting at competitions

FAVORITE MEMORY

Practicing presentations with friends before competitions

WORDS OF WISDOM

Keep working even when it's hard, because when the year is over and you stand back to look at your project and everything you've accomplished, it's worth it.

PROJECT ABSTRACT

The transition to secondary education can be challenging for everyone, but for those with autism, this transition can be more difficult. Parents play an especially important role during this transition, as they can either support or hinder the transition for the youth. Therefore, comparing autistic student and parental views on this transition is very important. Much of the research in this area has focused on comparing autistic student and parental perspectives on the transition to adulthood, but little has focused on the transition to secondary education. The goal of our study was to compare autistic student and parental perspectives (n=8) on the transition to secondary education by using a survey. We examined four areas and thirteen subareas and used a Likert scale of 1-5 for each of the questions. We analyzed our results through t-tests for each area and subarea. We found no significant difference between views of the two groups for each area and subarea ($p>0.05$), possibly indicating alignment and similarity of views. This research is important as it can help inform transition program planning and parents' involvement in IEPs. Overall this study marks important progress in the examination of autistic student and parental views on the transition to college, which is an under-researched topic, and prompts future research on this topic.

Perspectives on College Transition: An Exploratory Study of Autistic Youth and Their Parents

Eve Lansford

Introduction

- Autism: neurological and developmental disability
- Growing number of people with autism entering college
- People with autism have a harder time transitioning/undergoing change
- Need more support to be successful → parents play an especially important role during this time

Goal

Identify areas where the views between parents and autistic student differ on the transition to college process

Hypothesis

Views between parents and autistic students will differ in the areas of self care and social interaction

Results

Analysis

Unpaired t-tests conducted for each area and subarea

- Determine if there's a significant difference in views between the two groups

Area Results

No significant p-values→ **Indicate levels of similarity among the views**

Subarea Results

No significant p-values for each of the sub-areas → **Indicates level of similarity among the views**

- 3 general trends



Subarea	Parents (M ± SD)	Youths (M ± SD)	p-value
Navigating campus	4.5 ± 0.58	3.75 ± 0.96	0.228
Interacting with classmates	4 ± 1.15	3.75 ± 0.96	0.75
Adjusting to accomodations and campus environment	4 ± 1.15	3 ± 0	0.154
*Getting to class on time and coursework	3.25 ± 1.26	2 ± 0.82	0.147
Organizing study schedule	3.5 ± 1.29	3 ± 1.41	0.62
Balancing school and personal time	3.75 ± 0.5	3.5 ± 1	0.67
*Starting conversations	3 ± 0.82	2.5 ± 1	0.47
Talking to teachers	3.75 ± 0.96	4.25 ± 0.957	0.49
Making friends	2.5 ± 1	3.5 ± 0.58	0.13
Getting ready for class	3.75 ± 0.96	3.75 ± 0.96	1
Eating	3.5 ± 1	3.5 ± 0.58	1
Late waking up for class	2 ± 1.15	2 ± 0.82	1
Managing good mental health	3.5 ± 0.58	4 ± 1.15	0.47

Hypothesis not supported: found no significant difference between the views for any area/subarea

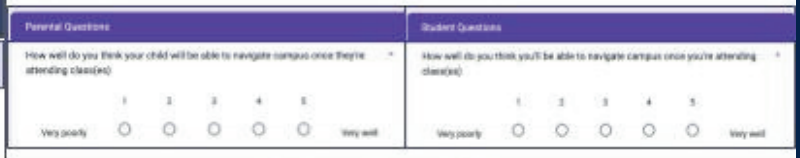
Methodology

Participants

- Juniors/seniors in high school, have a diagnosis of autism, parent agreed to take survey with student
- n=8 (4 youths, 4 parents)
- Emailed over 100 autism organizations, schools, and PTA organizations nationwide
- Limitations: relatively small sample size due to narrow selection criteria

Survey

- Anonymous survey, different sections for parents and youth
  - Same questions phrased differently, Likert scale of 1-5
- 4 areas & 13 sub areas examined
  - Areas: Living arrangement, managing time, social interaction, self care



Application

- Creating additional college transition programs focused on subareas where views slightly differed
  - Bridge minor communication gaps
- Further incorporate parents' into Individualized Education Program (IEPs)
- Create pamphlet with tips and guidelines on certain aspects of college, and ways to talk about certain topics



Future Research

- Larger more diverse group of students and parents
- Qualitative and quantitative methods

Environmental Drivers of Phytoplankton Structure: Assessing Salinity and Thermal Controls on Diatom and Flagellate Populations

Introduction, Purpose, & Hypothesis

- Phytoplankton are primary producers that **directly impact the carbon and nitrogen cycle**
- Countless organisms depend on them in freshwater ecosystems



Figure 2. Image of copepod under microscope, (Dinkey, 2023)

- Focused on direct measurements of phytoplankton biomass along the Northeast Coast
- Examined **diatoms** (strictly photosynthetic) and **dinoflagellates** (photosynthetic or heterotrophic, motile), the two most dominant recorded phytoplankton.

Hypothesis: Warmer temperatures and stronger sunlight in summer will cause both chlorophyll-a and phytoplankton abundance to peak compared to spring or fall.

Results

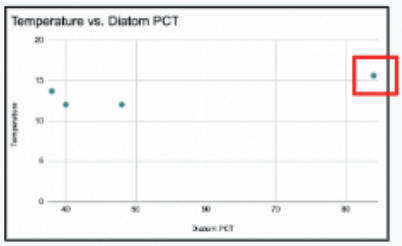
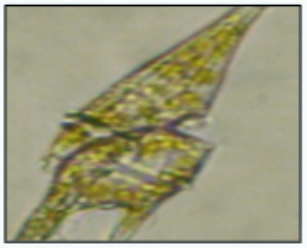


Figure 6. Pearson Correlation - Temperature and Diatom PCT
Figure made by student using GoogleSheets. (Levine, 2025)



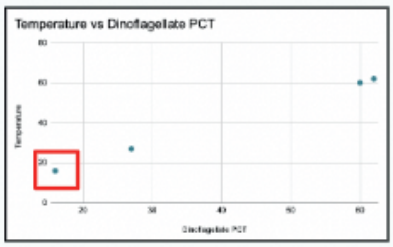
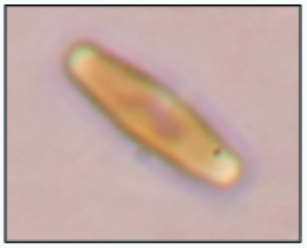


Figure 7. Pearson Correlation - Temperature and Dinoflagellate PCT
Figure made by student using GoogleSheets. (Levine, 2025)



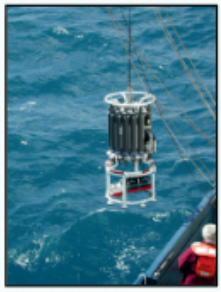
- **Temperature emerged as the key variable** due to variation and climate relevance
- Phase 2 found a **strong temperature-diatom relationship** similar to Phase 1
- Phase 2 had **stronger correlations despite less data**

Methodology

- Plankton nets were deployed from a research vessel to collect diatom and dinoflagellate samples across multiple Northeast Coast locations
- **Temperature, salinity, and chlorophyll-a fluorescence** were recorded as |variables and cross-examined against phytoplankton abundance
  - Used 9 Pearson correlation tests and linear regression models in Python.



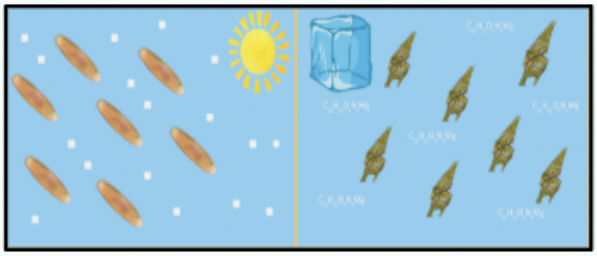




Conclusions

- Diatoms prefer warmer, saltier conditions but decline as biomass increases, likely due to nutrient depletion
- Dinoflagellates thrive in cool, nutrient-rich waters and dominate during high chlorophyll-a bloom events

Hypothesis supported: summer warmth and sunlight drove peak chlorophyll-a and phytoplankton abundance



Phytoplankton underpin all ocean life and serve as **early warning indicators for ecosystem disruption** Disruptions have economic consequences across fishing, tourism, and seafood industries

MERI LEVINE

OYSTER REEFS AS NATURAL BREAKWATERS MITIGATE SHORELINE LOSS AND FACILITATE FISHERIES



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of Plymouth, England
INTENDED MAJOR/CAREER PATH	Marine Biology and Oceanography

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

I am the most proud of the lifelong friendships I have made and the continuous passion I have developed for marine science. I am excited to continue and further delve into my interests at university.

FAVORITE MEMORIES

- Watching reels with my pals in junior year
- Making connections across Westchester and in my field
- Making pancakes in class
- Almost hitting Ryan with my car after WESEF this year

WORDS OF WISDOM

Science Research can be very stressful at times but I have learned that it is most important to have trust in yourself and your support system (Zupan, friends, and family).

PROJECT ABSTRACT

Phytoplankton are magnificent organisms that help maintain the stability of marine ecosystems. As of recently, there have not been updated studies tracking phytoplankton abundance regarding changing ocean conditions, leaving a gap in the research. We aimed to establish a relationship between various environmental variables and the abundance of phytoplankton (specifically diatoms and dinoflagellates) in specific locales. Our primary means for getting data was our deployments of the phytonet aboard the ship. The phytonet was performed to collect hands-on, real time data of the plankton. We found a sufficient relationship between temperature and abundance with regards to the phytoplankton as there were positive correlational trends found. Due to the limited data received for analysis, it was difficult to establish true relationships, the results displayed more trends. This created a gap in my research as the main aim now is to further research the variables and their relationship with phytoplankton, hopefully in a multitude of areas and over a longer duration. We concluded that there is more of a correlation between temperature and phytoplankton and that when there is an increase in temperatures (usually lingering around 24-25 degrees C), there should be more phytoplankton in the net. This research is becoming more applicable as our Earth's oceans are rising and heating. Climate change upon us and phytoplankton play a major role in monitoring these changes. To stray away from phytoplankton research would be to endanger our ocean environments and endanger the species we rely so heavily on.

SAMUEL MULLEN



ASSESSING A NEW GRPR-ANTAGONIST PEPTIDE AS A NEAR INFRARED IMAGING AGENT FOR PROSTATE CANCER

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	California Institute of Technology
INTENDED MAJOR/CAREER PATH	Bioengineering + Pre-med & Men's Soccer

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

When I submitted the STS application.

FAVORITE MEMORY

Getting to hang out with friends and play cards at WESEF after judging finished.

WORDS OF WISDOM

Don't take not winning a prize too seriously. It'll all work out.

PROJECT ABSTRACT

Prostate cancer (PC) is the fourth most common cancer in the world and responsible for around 35,000 deaths each year in the US. Fluorescent probes are powerful imaging agents that highlight malignant tissues. Current PC fluorescent probes target PSMA. However, around 10% of PC cases do not express PSMA, meaning there is an absence of fluorescent probes for those cases. GRPR1 is overexpressed in PSMA negative PC cases, and the peptide BIM26226 has a strong binding affinity for it. It was expected that a novel fluorescent probe FNIR-BIM26226 could be synthesized and would show high binding to GRPR1. BIM26226 was bonded with a fluorescent dye, creating FNIR-BIM26226. Mass spectrometry and HPLC was performed to analyze the products. Prostate cancer cell line PC-3 was cultured and was used to conduct flow cytometry. FNIR-BIM26226 was successfully synthesized, confirmed by the mass spectroscopy, and the HPLC purified the sample. The flow cytometry showed low fluorescence on the PC-3 cells, with almost no difference from the control group, suggesting a lack of receptor-specific binding. Fluorescent dyes can affect a peptide's binding so an alternative fluorophore motif, RME-4 was designed and synthesized. The steps included a fischer-indole synthesis, a reaction in potassium hydroxide, a reaction in methyl iodide, and a final reaction in an acetic anhydride solution. The product was isolated via HPLC and lyophilization, and analyzed using nuclear magnetic resonance spectroscopy. This smaller dye holds great promise to preserve peptide binding and for future testing to create the first non-PSMA PC fluorescent probe.

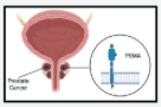
Assessing a New GRPR-Antagonist Peptide as a Near Infrared Imaging Agent for Prostate Cancer

Samuel Mullen

Introduction

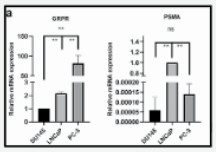
Prostate Cancer and PSMA Fluorescent Probes

- 35,520 deaths due to prostate cancer(PC) in 2024 in the US
- Prostate specific membrane antigen(PSMA) is overexpressed in PC
- **Current PC fluorescent probes target PSMA**



PSMA Target Limitations

- Existing PC research is limited to PSMA targeting fluorescent probes
- PSMA is heterogeneously expressed and not expressed in about 10% of cases
- **PSMA cannot serve as the only target for PC fluorescent probes**

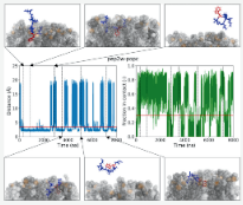


GRPR and BIM26226

- **Gastrin releasing peptide receptor(GRPR) is expressed in PSMA negative PC cases**
- Bombesin peptide **BIM26226 has shown a high binding affinity to GRPR**
- Inhibited tumor growth in pancreatic cancer after binding to GRPR

Optimizing Fluorescent Dyes

- Targeted dyes can have deeper penetration depth and clear imaging resolution[12]
- Larger dyes can limit a targeting peptide's function due to their size[13]



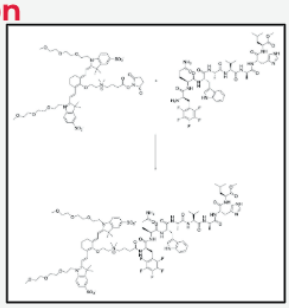
Goals

- Synthesize a Novel Fluorescent Probe
- Test the fluorescent probe *in vitro*
- Design and Synthesize a smaller novel fluorescent dye

Methods

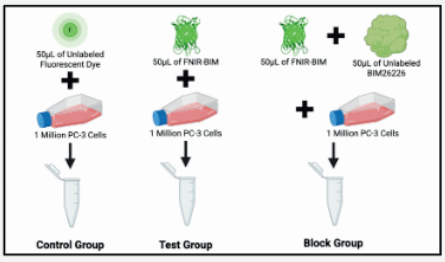
1. FNIR-BIM Synthesis and Isolation

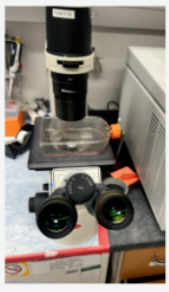
- Chemically bonded BIM26226 and Fluorescent Dye
- Reaction confirmation: mass spectrometry analysis
- Isolation and purification using HPLC and rotary evaporation



2. *In Vitro Testing*

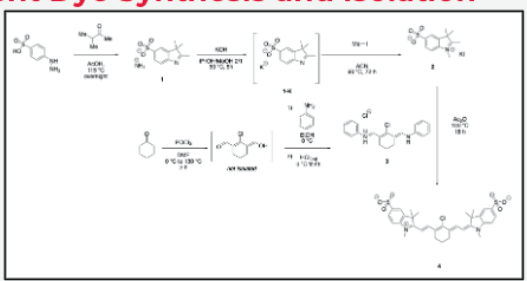
- Culture PC-3 prostate cancer cell line
- Prepare a control, test, and blocking arm for the flow cytometry
- Conduct flow cytometry to measure cell fluorescence and analyze scatter plots and histogram





3. Novel Fluorescent Dye Synthesis and Isolation

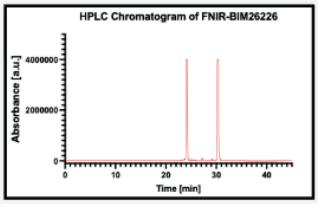
- RME-4 chemical synthesis reactions
- Analysis with nuclear magnetic resonance imaging
- Isolation with HPLC and lyophilization

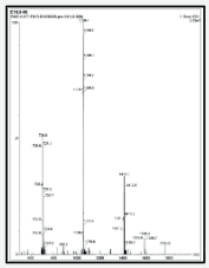


Results

FNIR-BIM Analysis

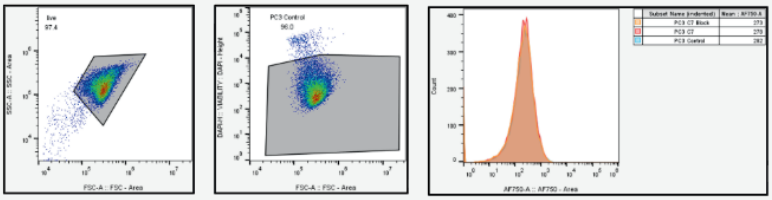
- Mass spectrometry and HPLC confirmed that the reaction was successful





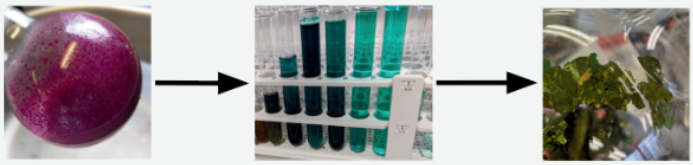
Flow Cytometry

- Removed dead cells and doublets from analysis with scattergram gating
- Analyzed difference between peaks in the histogram



RME-4 Isolation

- RME-4 reactions were successful
- Products were analyzed and isolated to a pure sample



Discussion

FNIR-BIM Synthesis

- FNIR BIM synthesis and isolation was an important step in developing an imaging agent

Flow Cytometry

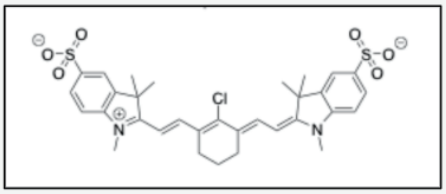
- Few cells were gated out, providing a strong sample for analysis
- Little to no difference across study groups suggest minimal binding of FNIR-BIM to GRPR[15]
- Fluorescent dye likely inhibited BIM26226 binding

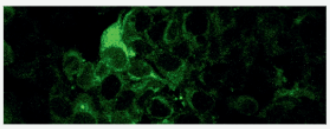
RME-4 Synthesis

- Fluorescent green of RME-4 following isolation confirmed synthesis
- Viable synthesis was a significant step towards future research

Conclusion

- The smaller size of RME-4 holds great promise for future fluorescent probes
- RME-4 has the potential to be applied to imaging of other types of cancer
- Important information on BIM26226 binding when fluorescently labeled
- RME-4 holds great promise in future
- Closer to developing a novel and vital fluorescent probe for PC





StrokeMind

Memory Training App Targeting Prospective, Temporal, and Source Domains for Post-Stroke Recovery

Stella Myers — Horace Greeley High School — Chappaqua, NY

Research Background



Stroke → disruption of cerebral blood flow → neuronal death
- **36-55%** of survivors → post-stroke cognitive impairment **(PSCI)**

Damage to specific neural networks disrupts **specialized memory systems**



Existing tools focus on general cognition & lack real-world applicability

Critical gap: limited tools targeting:

- **Prospective memory** *(future tasks)*
- **Temporal memory** *(sequence/timing)*
- **Source memory** *(context recall)*

Goal	Hypothesis
Create *StrokeMind*, a memory training app for prospective, temporal, source memory.	StrokeMind training will improve memory accuracy (≥10%, $p < .05$) in 3 domains.

Methodology

1 StrokeMind App Development

Task flow: encoding → interference → retrieval

Automated scoring + adaptive difficulty

Average uses of **5,000+ in 15+ countries the past *30* days**



Visual Studio Code + ExpoGo development

2 Beta Testing & Final Deployment

Beta testing (n=10)

Optimized performance + usability

Final web deployment



3 Participant Validation Testing

n=15 adults (ages 50–80)

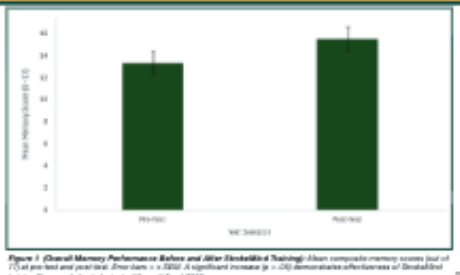
5-day protocol: pre → 3 days training, 20 minutes → post

Aim to measure memory increases

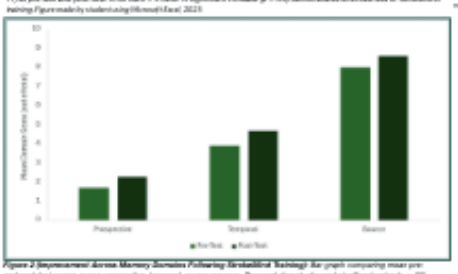


Analysis with paired sample t-tests in Microsoft Excel

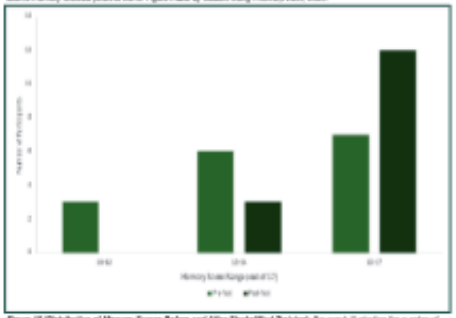
Results & Discussion



Mean score: **13.4 → 15.6 (out of 17)**
+16.4% increase ($p = .004$)
14/15 participants improved
Significant overall gain after training



Score distribution shifted upward
No scores <13 post-training
Mean improved: +2.2 points
Reduced variability (SD: 1.7 → 1.2)
Consistent improvement across participants



Temporal: 3.9 → 4.7 ($p = .007$)
Source: 7.8 → 8.6 ($p \approx .07$)
Prospective: 1.7 → 2.3 ($p \approx .24$)
Largest gains: temporal + source
Smaller gains: prospective memory

Conclusion

Future Research

- Clinical validation in stroke populations (PSCI)
- Extended training (8–12 weeks) → long-term outcomes
- EMS-informed applications
- Cognitive recovery tracking tool
- Potential to reduce 911 reliance + supervision

Applications

- At-home stroke rehabilitation
  - Targets: prospective • temporal • source memory
- Outpatient therapy support
  - Progress tracking between sessions
- Remote cognitive monitoring
  - Scalable, long-term rehab tool

Conclusion

- StrokeMind designed, engineered, deployed
- Significant memory improvement (pre → post)
- Hypothesis supported
- Novel: 3-domain targeted training
- Scalable, accessible cognitive rehab solution

STELLA MYERS

STROKEMIND: A MEMORY TRAINING APP TARGETING PROSPECTIVE, TEMPORAL, AND SOURCE DOMAINS FOR POST-STROKE RECOVERY



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Vanderbilt University
INTENDED MAJOR/CAREER PATH	Biomedical Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

This year, I placed 3rd in Biomedical Engineering at NYSSEF, 2nd in Medicine and Health Sciences at WESEF, and was invited to and presented at two research conferences.

FAVORITE MEMORY

The award ceremonies. It feels really rewarding, both for your own work and seeing your friends and classmates succeed.

WORDS OF WISDOM

Talk to and become friends with the people next to you at every competition, it makes the experience even better!

PROJECT ABSTRACT

Stroke is a leading cause of long-term disability, and over half of survivors experience post-stroke cognitive impairment (PSCI), with memory loss among the most debilitating symptoms. Existing rehabilitation programs largely emphasize attention or general cognition rather than the domain-specific memory systems—prospective, temporal, and source memory—crucial for everyday independence. This study presents StrokeMind, a digital rehabilitation app designed to strengthen these three domains through memory exercises delivered in a calming "Memory Garden" interface. Fifteen adult participants (ages 50–80) completed a within-subjects pre-post validation study following three 20-minute training sessions. Accuracy scores from standardized pre- and post-tests were analyzed using paired-samples t-tests. Results showed a significant overall improvement in total memory performance, increasing from 13.4 ± 1.7 to 15.6 ± 1.2 ($p = 0.004$), a 16.4% mean increase. Domain analysis revealed significant improvement in temporal memory ($p = 0.0069$), a near-significant increase in source memory ($p = 0.0679$), and positive trends in prospective memory ($p = 0.244$). Participants reported high engagement, describing the training as enjoyable and cognitively stimulating. These findings demonstrate that short, domain-targeted digital interventions can measurably enhance specialized memory functions in older adults within days rather than weeks. StrokeMind introduces an accessible, evidence-based approach for at-home cognitive rehabilitation, offering a scalable model that integrates neuroscience, design, and technology to support post-stroke recovery. Future work could extend training duration, incorporate neuroimaging validation, and evaluate clinical implementation within hospital discharge and community-care programs.

LORELAI NOCCA



CRYSTALLIZING GALACTOSE FOR EXTRACTION FROM UPCYCLED CHEESE WHEY PERMEATE: A NOVEL METHODOLOGY

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of Nebraska-Lincoln
INTENDED MAJOR/CAREER PATH	Food Science and Technology

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

My proudest moments were every time I was able to reach an audience whether it was a judge, a parent, or a classmate. Despite the lack of a food science category, I was glad to share my research and its importance.

FAVORITE MEMORY

My favorite memory was when we all gathered around to look at pictures from WESEF. With the weight of the competition lifted from our shoulders, it was nice to feel a collective sense of bittersweet relief.

WORDS OF WISDOM

Make sure to find passion in any aspect of your life. Whether this is an activity that will set you up for success in the future or one that will make you happy in the moment, always choose passion.

PROJECT ABSTRACT

Wasted food materials contribute heavily to the declining condition of the environment. Upcycling cheese whey permeate for the recovery of previously wasted materials has been researched; however, collective understanding specifically regarding galactose recovery remains incomplete. Phase 1 of this study focuses on discovering the optimal settings for process parameters during simultaneous hydrolysis and fermentation to statistically maximize the recovery and purity of galactose. The goal for phase 2 of this study addresses the actual utilization of galactose from a synthetic solution modeling the hydrolyzed and fermented cheese whey permeate solution by developing a novel methodology for crystallization and extraction. By centrifuging the solution, galactose, ethanol, and water were separated from all impurities. After centrifugation, a water bath was used to evaporate the water and ethanol to isolate and crystallize galactose for extraction. Massing the crystallized galactose resulted in a yield of 38.4 grams or 68.52% of the available galactose, supporting the phase 1 goal. To collect qualitative data, the color change in solutions containing extracted galactose crystals and Benedict's solution with control concentrations of galactose and Benedict's solution was observed. Benedict's solution testing successfully resulted in a near 50% concentration of galactose in the experimental samples containing the extracted crystals, supporting the phase 2 goal. With efficient methods for galactose extraction, galactose can be recovered rather than wasted and effectively be used as an ingredient in the food industry and as added revenue for cheese producing companies.

Crystallizing Galactose for Extraction from Upcycled Cheese Whey Permeate: A Novel Methodology

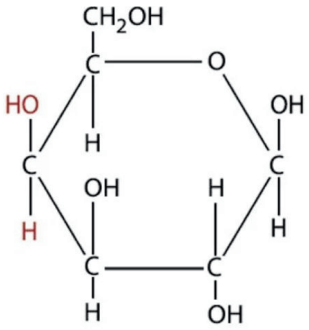
Introduction

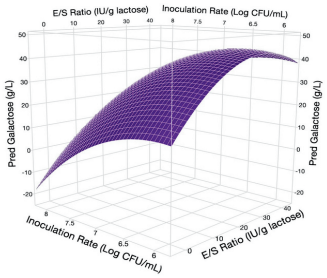


-$1 trillion: Estimated economic of global food waste

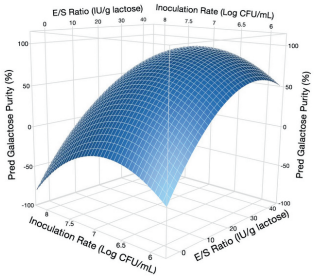
-Approximately 1.3 billion pounds of food waste per year

-85% of milk used for cheese production is discarded as cheese whey permeate





23.4% Increase in Galactose Recovery



22.6% Increase in Galactose Purity

Methodology









Create Synthetic Cheese Whey Permeate Solution → **Use Hot Water Bath to Crystallize and Extract Galactose From Solution**

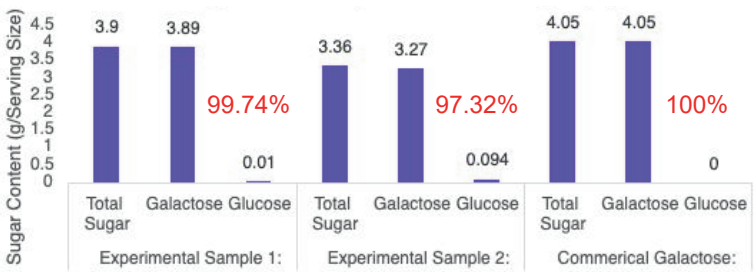
Results





Galactose Yield:
38.4 Grams
Or
68.52% of Available Galactose

Purity of Sample 1:
99.74%
Purity of Sample 2:
97.32%



Conclusion

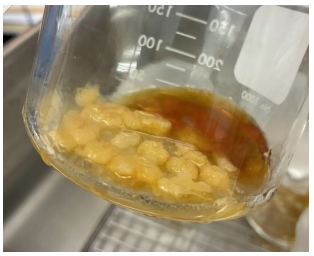
Problem
- Amethodologyto extractrecoveredgalactose from upcycled cheese whey permeate had been nonexistent

Goal
- Determine the efficacy of a hot water bath for crystallizing galactose for extraction

Novelty
- Galactose has yet to be the main focus for recovery despite the large amount consistently wasted around the world
- There has also been no previous methodology for the recovery or extraction of galactose

Future Research
- Investigate the efficiency of a batch process for implementing this methodology in both small dairy farms and large industrial factories
- Manufacture food products with upcycled galactose





Development and Field Deployment of a Low-Cost Passive Sampler for Nutrient Monitoring in River Water

Introduction

Nutrient Pollution

- **River ecosystems** are critical for thousands of organisms. Unhealthy or polluted eutrophic rivers can kill entire ecosystems

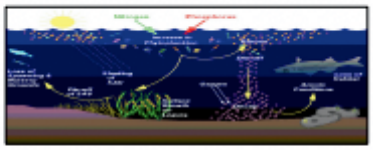


Figure 1: Image depicting eutrophication. Taken from mentor

- **Contaminate** our food & **degrade** water quality (Xie et al., 2021)

Gap in Research

Affordable & accessible passive nutrient sampler needed

Goals

To **evaluate** whether my sampler can accurately absorb and measure nitrate concentrations in Saugatuck River, CT, and to use those results to **analyze** concentrations over time.

Hypothesis

An accessible passive nutrient sampler can **effectively monitor** nutrient levels in aquatic ecosystems (Audet et al., 2014)

Methodology

Assembly

1. **15 cm** pieces of dialysis tubing cut
2. One end sealed with rubber band
3. Filled with **1 ½ tbsp** of activated charcoal



Figure 3: Right - Photos depicting steps of passive sampler assembly. Taken by student, 2025

Study Site



Figure 2: Study site of Saugatuck River, CT. Coordinates are 41.2945400252424, -73.39512029021 31. Location ID: USGS-01208990

- Study site chosen because of previous USGS nitrogen concentration data, also collected using passive samplers

Deployment

- Tied to overhead branch, left **in situ** for **3 days**



Figure 4: Photos depicting deployment. Taken by student, 2025

Results/Analysis

API Nitrate Test Kit



Figure 5: API Nitrate Test Kit. Photo taken by student, 2025

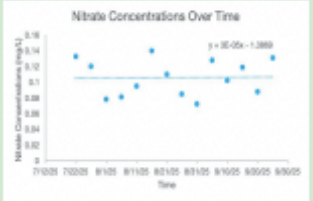
Cost Breakdown

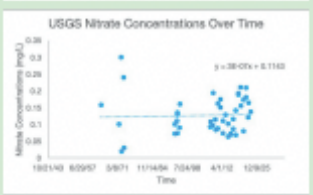
Table 1: Cost breakdown of materials used to construct the passive nitrate sampler. For each material, unit quantity, cost per unit (USD), amount used, and cost per sampler (USD) is displayed. Made by student using Excel, 2025.

Cost Breakdown of Materials Used to Construct the Passive Nitrate Sampler

Material	Unit Quantity	Cost per Unit (USD)	Amount Used	Cost per Sampler (USD)
API Nitrate Test Kit	90 tests	$0.12 per test	1 test	$0.12
Activated Charcoal	32 tbsp	$0.38 per tbsp	1.5 tbsp	$0.57
Dialysis Tubing	16 ft (305 cm)	$0.05 per cm	15 cm	$0.75
Test Tubes	50 tubes	$0.24 per tube	1 tube	$0.24
Total Cost per Sampler				**$1.68**

- Approximately **$1.68 per unit**
- Materials readily available online or in store, such as **Amazon**





Figures 6 & 7: Both graphs (left) display nitrate concentrations (mg/L) over time periods. Fig. 6 (top) measures nitrate concentrations through the months of July and September 2025 (p-value: 0.925500276) , while Fig. 7 (bottom) measures nitrate concentrations through the months of August and September over many years (p-value: 0.04602004). Trendline equations are displayed on each graph.Made by student in Excel, 2025.

Major Findings

- Nitrate concentrations between **0.07 - 0.14 mg/L**
- Overall nitrate levels low & stable
- Two-sample t-test conducted in Excel
  - **P-value: 4.81×10^{-10}**

Conclusion

Problem:

- Existing monitoring methods are often costly and/or inaccessible

Goals:

- To design a low-cost passive nitrate sampler
- To deploy in a natural river system
- To evaluate using time-integrated sampling

Hypothesis:

- An accessible passive sampler can **effectively monitor** nutrient levels in aquatic ecosystems

Findings:

- Measured nitrate levels were low + stable
- Trends were consistent with long-term USGS data despite methodological differences

Novelty:

- Demonstrates that a simple, low-cost, student-built passive sampler can generate nitrate data comparable to professional monitoring systems

→ expanding access to reliable nutrient monitoring

KATHLEEN PASKOWITZ

DEVELOPMENT AND FIELD DEPLOYMENT OF A LOW-COST PASSIVE SAMPLER FOR NUTRIENT MONITORING IN RIVER WATER



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of California, Santa Barbara
INTENDED MAJOR/CAREER PATH	Environmental Studies

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Seeing everyone proud of their research, finally getting a successful p-value, and getting an award at WESEF

FAVORITE MEMORY

WESEF! It is a nerve-wracking competition, but once I got past my initial anxiety and relax, I met so many fun people and had fun conversations with my judges.

WORDS OF WISDOM

Enjoy the research process! Talk to your peers, get close to your mentor, and do as much hands-on work as you can! WESEF, and the whole Science Research program, is what YOU make of it!!

PROJECT ABSTRACT

Eutrophication in aquatic ecosystems and a decline in water quality is a major threat caused by nutrient pollution, particularly from excess nitrates. Traditional nutrient monitoring methods present cost barriers, as they are often expensive and require specialized equipment, where access can only be obtained through laboratories, limiting their availability for community use. In this study, we designed and tested a passive nitrate sampler using affordable and accessible materials including dialysis tubing and activated charcoal. The device was deployed in the Saugatuck River in Connecticut, where we found publicly available, preexisting nitrate data collected by the United States Geological Survey (USGS). This data was compared to the data measured by the passive nitrate sampler in order to evaluate accuracy and effectivity. A two-sample t-test was conducted, yielding a statistically significant p-value of 4.81E-10 which indicates differences likely caused by variations in sampling techniques rather than actual measurement error. Trendline analyses of both datasets reflected stable concentrations over time, supporting the passive nitrate sampler's ability to capture reliable environmental data. Additionally, a cost breakdown of the nitrate sampler revealed that each sampler could be built for approximately $1.68. Compared to other standardized passive samplers, including the Chemcatcher which can cost around $1,000, the affordability of the passive nitrate sampler designed in this study is greatly highlighted. Our research can help expand accessibility to schools, communities, and other scientists through the passive nitrate sampler, promoting scientific inclusivity and a greater understanding of nutrient pollution through monitoring.

EVE RUTMAN



PATTERNS OF TUMOR MUTATION BURDEN ACROSS PEDIATRIC CANCERS: ASSOCIATIONS WITH CANCER TYPE, SEX, AND AGE

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Wesleyan University
INTENDED MAJOR/CAREER PATH	Chemistry and Biology

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Finishing 2 summers of 90 hours of work and then completing two 20 page papers to reflect my work.

FAVORITE MEMORY

Having pancake days after WESEF

WORDS OF WISDOM

"The only way you're going to grow is by pushing yourself beyond what you think is possible." - David Goggins

PROJECT ABSTRACT

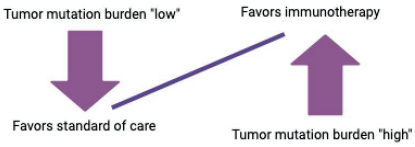
In the pediatric population, the percentage of kids who are diagnosed with cancers is much less than that of adults diagnosed with cancers; nevertheless, they still represent a major health and mortality burden in the pediatric population globally. Much of what we know about tumor mutational burden (TMB) and treatments comes from data extracted from adult studies. The pediatric population remains unexplored in this context, making gaps in understanding how mutation counts and types can vary by cancer types or demographic data. By identifying which mutations are most common across pediatric cancers and whether certain groups of patients are more likely to carry them, this study aimed to look at potential biological biomarkers between different cancer types. This study analyzed 1800 pediatric cancer samples and found, using chi-squared test and Fisher's exact test, bone cancer and lymphoid neoplasms showed much higher TMB values than the rest of the study. Gliomas and retinoblastomas showed lower TMB. Significant sex correlations were found in cancers like T-lymphoblastic leukemia and Wilms' tumor. The correlation shows that there are notable differences that could influence the diagnosis of a pediatric patient. Age was also associated with certain cancer types— younger children showed embryonal tumors, and older children had more mutation-driven cancers. Future research should expand datasets to include balanced sample sizes for all cancers to run and validate smoother analyses. By using datasets beyond cBioPortal, sampling bias can be lessened. Relating this to treatment outcomes will eventually give better survival chances to pediatric cancer patients.

Patterns of Tumor Mutation Burden Across Pediatric Cancers: Associations with Cancer Type, Sex, and Age

Introduction

Tumor Mutation burden

- Measures **total mutations** per million of bases
- Pediatric cancers usually have a **lower** TMB than adults



Demographics essential for looking at **potential trends** in genomic data

Pan-cancer studies

- Analyze **multiple cancer types** at the same time
- Increase statistical validity

Hypotheses

Neuroblastoma will show the highest number of mutations

Age will correlate with differences in mutation burden and mutation type

Results

Cancer Type	Avg TMB	Median TMB
Ependymoma Tumor	79.1	4.17
Lymphoid Neoplasm	12.6	1.43
Glioblastoma	2.37	2.37

Table 1: Cancers with highest/lowest TMB: Shows the top 2 high TMB and lowest TMB values by cancer type. Table made by student on Google Sheets.

Cancer Type	Female	Male	NA	p_value
T-Lymphoblastic Leukemia/Lymphoma	7	31	0	**0.0015**
Non-Hodgkin Lymphoma	2	15	0	**0.0114**
Wilms Tumor	45	34	0	**0.0142**
Glioma	198	215	3	**0.0257**

Table 2. Sex compared with cancer type: Significant P-values from the dataset.

Table made by student on Google Sheets

Methods

Data Collection

- Obtained from the cBioPortal for Cancer Genomics
- Found the "Pan-Cancer Studies" collection

Processing

- Most common cancer types in the combined dataset
- Grouped by cancer type

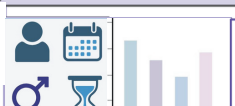
Data Analysis

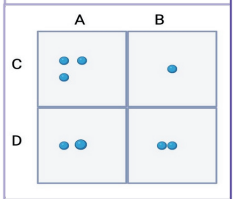
Step 1: Cleaning



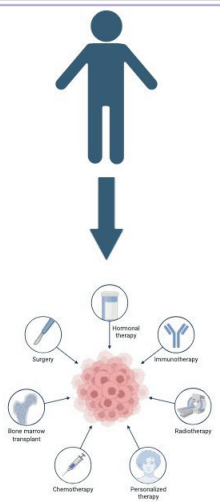
- Dataset was **imported into R**
- Categorical variables → **binary code**

Step 2: Chi Squared and Fishers





- Correlation between two variables
- More accurate for smaller sample sizes



Discussion

- Results **partially supported** the hypothesis
- High TMB cancers associated with greater therapy resistance
- Low TMB cancers suggest **inheritance found developmental abnormalities**
- **Significant sex distribution differences**

Applications and Future Work

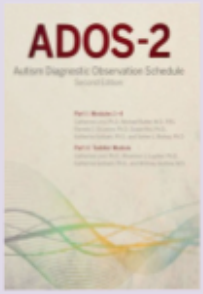
- Guide diagnostic approaches and advance age-specific clinical testing
- Immunotherapy benefits
- More analysis on gene-specific mutations
- Balanced sample size for all
- cancertypes

Age-Related Trends in Presentation of Camouflaging Behavior Among Females with Autism Spectrum Disorder

Background & Problem

- Current diagnosis of Autism Spectrum Disorder (ASD) assesses:
  - **Social interactions**
  - **Communication skills**
  - **Repetitive behaviors**

  (American Psychiatric Association)
- The Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) is historically **based on the white male phenotype**





- ASD **women scored significantly higher than men on camouflaging**
  (Cremone et al., 2023)
- Unclear how **camouflaging changes with age**

Hypotheses

- Camouflaging behaviors in females with ASD become **more frequent and sophisticated with age.**
- **As girls grow older, social pressures and increased self-awareness may lead to greater masking of symptoms,** which can complicate accurate diagnosis in adolescence and adulthood.

(Clarke et al., 2021; Rea et al., 2023; Young et al., 2018)

Results

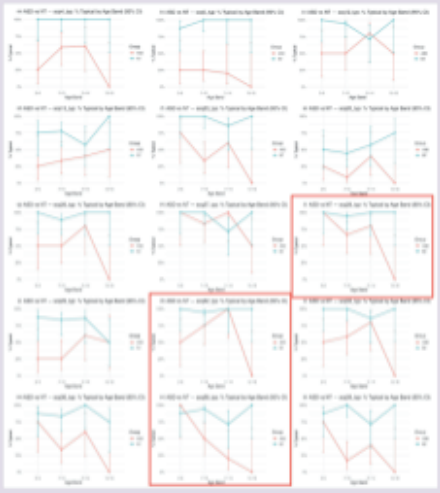


Figure 1. Percent Typicality by Age Band for ASD and NT Participants Across Fifteen SCQ Items. Figures were made by the student using RStudio, 2025.

Table 3. Kruskal-Wallis Test Results by Group. Table was made by the student using Google Docs, 2025.

SCQ Item Number	p-value		η^2	
	ASD	NT	ASD	NT
4	0.545	–	1.144	–
5	0.8882	0.2998	0.036	3.667
11	0.7124	0.2468	1.371	4.364
13	0.9551	0.5056	0.425	2.347
20	0.4851	0.8027	2.914	0.994
23	0.2182	0.2998	4.051	3.667
26	0.508	0.4546	3.6	2.733
27	0.2824	0.0371	3.728	7.317
28	0.0963	0.7312	6.338	1.333
29	0.5356	0.6681	2.182	1.562
32	0.0625	0.7312	7.317	1.333
33	0.5829	0.2998	1.641	3.667
34	0.2182	0.3403	4.051	3.333
35	0.0593	0.4562	7.433	3.607
36	0.1284	0.1189	5.66	4.938

- **NT group remained near ceiling** across ages
- ASD group showed **increasing outwardly typical behavior**
- Biggest gains in **eye contact, peer response, and social overtures**

Integration with Phase 1

- **Phase 2** identified specific behaviors where masking is likely to change over time
- Find areas of overlap between camouflage behaviors and ADOS-2 questions within each module
- Hypothesis partially supported



Figure 2. Log-transformed Kruskal-Wallis p-values for ASD and NT Participants Across SCQ Items. Figure was made by the student using RStudio, 2025.

Methodology

- ADOS-2 split into **4 modules that align with 4 different age groups**
- Data was from de-identified records from Harvard Dataverse
- Social Communication Questionnaire (SCQ) scores for 13/39 questions that aligned with camouflaging behavior

Table 2. Camouflaging-Aligned SCQ Items and Scoring. Table was made by the student using Google Docs, 2025.

SCQ Item Number	Behavior	Standard Scoring	Adjusted Scoring
4	Inappropriate questions / stereotyped language	0 = No 1 = Yes	1 = Typical 0 = Atypical
5	Repetitive or odd utterances / pronoun reversal	0 = No 1 = Yes	1 = Typical 0 = Atypical
11	Repetitive use of objects	0 = No 1 = Yes	1 = Typical 0 = Atypical
13	Circumscribed interests	0 = No 1 = Yes	1 = Typical 0 = Atypical
20	Social chat	0 = No 1 = Yes	1 = Typical 0 = Atypical
23	Gestures	0 = No 1 = Yes	1 = Typical 0 = Atypical
26	Eye gaze	0 = No 1 = Yes	1 = Typical 0 = Atypical
27	Social smiling	0 = No 1 = Yes	1 = Typical 0 = Atypical
28	Showing and directing attention	0 = No 1 = Yes	1 = Typical 0 = Atypical
29	Offering to share	0 = No 1 = Yes	1 = Typical 0 = Atypical
32	Quality of social overtures	0 = No 1 = Yes	1 = Typical 0 = Atypical
33	Range of facial expressions	0 = No 1 = Yes	1 = Typical 0 = Atypical
34	Mimic mannerisms / interest in children	0 = No 1 = Yes	1 = Typical 0 = Atypical
35	Response to peer social cues / attention to others	0 = No 1 = Yes	1 = Typical 0 = Atypical
36	Appropriateness of social responses / imaginative play with peers	0 = No 1 = Yes	1 = Typical 0 = Atypical

- Items were re-coded so that **higher values represent typical behavior**

Table 1. Participant Counts by Group and Age Band. Table was made by the student using Google Docs, 2025.

Age Band	ASD (n)	NT (n)
3-6	4	9
7-10	12	16
11-14	5	9
15-18	2	6
Total (n)	23	42

- **Filtered data to female participants** with autism (ASD) (n = 23) and without autism (NT/NND) (n = 42)
- Participants **grouped into four age bands**: 3 to 6 years, 7 to 10 years, 11 to 14 years, and 15 to 18 years
- Data analysis included **wilson confidence intervals and non-parametric Kruskal Wallis tests** to assess **whether outwardly typical social behavior varied significantly across age bands within each group**
  - Significance threshold **$p < 0.05$**
- **NT group used as a control**

Conclusions

- Developmental convergence between ASD and NT females on social communication items across age bands
- Strongest age-related increases in **eye contact, social overtures, and peer response**
- **Hypothesis partially supported**
- Trends interpreted as **exploratory** due to small sample size

Future Research

- The project initially aimed to **modify specific**
- **ADOS-2 questions** to better capture gender differences in ASD, particularly in females
  - The student was unable to do this due to limited access to detailed demographic data

Section	Original Description	Modified Description	Adjusted Scoring
A2. Speech Abnormalities Associated With Autism (Intonation/Volume/Rhythm/Rate)	Focus on speech abnormalities, including intonation, volume, rhythm, or rate characteristic of autism.	Assess whether speech abnormalities are present and whether they reflect efforts to conform to perceived norms (e.g., overly controlled or mechanical delivery).	0: Appropriately varying intonation, reasonable volume, and normal rhythm. 1: Slightly unusual intonation, mechanical rhythm, or exaggerated control. 2: Markedly abnormal speech patterns (e.g., flat, rapid, or unnatural rhythm).

- Questions from Modules 3 and 4 used on the scoring chart were adjusted
- Section A2 (left)

- Explore **additional behavioral and emotional domains**
- Incorporate these factors into **novel questions** to account for camouflaged symptoms and unique presentation of behaviors from female patients
- **Expand the understanding of gender research** in ASD
- **Pave the way for diagnostic criteria in other disorders**



UMA SHARMA

AGE-RELATED TRENDS IN PRESENTATION OF CAMOUFLAGING BEHAVIOR AMONG FEMALES WITH AUTISM SPECTRUM DISORDER



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Washington University in St. Louis (WashU)
INTENDED MAJOR/CAREER PATH	Cognitive Neuroscience

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- 1st Place, WESEF (BES) 2025
- Transforming Lives Award for Autism Research, WESEF 2025
- United States Air Force Award, WESEF 2026
- 2nd Place Somers Science Fair, 2024

FAVORITE MEMORY

My favorite memory was at the Somers Science Fair when a woman came up to my project during public viewing and almost started crying because her daughter with Autism went through the same experience.

WORDS OF WISDOM

There will be MANY times when you want to give up. No matter how hard or stressful it gets, keep your end goal in mind. The experience you will gain after three years of legitimate science research will help you for the rest of your life.

PROJECT ABSTRACT

Autism Spectrum Disorder (ASD) is historically diagnosed more often in males, contributing to under-recognition and delayed support for females. Many autistic girls camouflage, meaning they mask or compensate for social differences, which can obscure symptoms during evaluation. Understanding how camouflaging develops across age is essential for improving diagnostic accuracy. Current diagnostic tools, including the ADOS-2, rely heavily on observable behavior and may not fully detect subtle or effortful social adaptation in females. This study examines where existing assessments may overlook female presentations and how camouflaging changes across childhood and adolescence. Phase 1 compared male and female ADOS-2 scores and found minimal differences, suggesting clinician-observed tools may not capture female-specific behaviors. Phase 2 (current year's study) analyzed parent-reported SCQ data from autistic (n = 23) and neurotypical (n = 42) females ages 3 to 18 across four age bands. Fifteen SCQ items associated with camouflaging were recorded to reflect outwardly typical behavior. Descriptive plots and Kruskal-Wallis tests were used to explore developmental patterns. Autistic females showed gradual increases in outwardly typical social communication behaviors with age, including eye contact, gesture use, social smiling, and peer response. Neurotypical peers remained consistently high. While results were exploratory and not statistically significant, visual trends reflected developmental increases in camouflaging. Items related to restricted and repetitive behaviors did not converge, indicating surface-level adaptation rather than reduction in core traits. These findings emphasize the need for diagnostic approaches that separate effortful compensation from true social ability in order to better identify autistic girls.

SAM STRYKER



BAYESIAN-INFORMED PRIORS FOR ZERO-NOISE EXTRAPOLATION

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	The University of Chicago
INTENDED MAJOR/CAREER PATH	Physics and Quantum Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Getting the opportunity to speak to head IBM scientists, and having them ask for my feedback on their programs.

FAVORITE MEMORY

Laughing with my friends on the bus ride back from WESEF.

WORDS OF WISDOM

Know your subject WELL. Be able to answer any question they throw at you confidently.

PROJECT ABSTRACT

Quantum error mitigation techniques are essential for improving the performance of noisy intermediate-scale quantum (NISQ) devices. Zero-noise extrapolation (ZNE) is a widely used method that estimates noise-free expectation values by artificially amplifying circuit noise and extrapolating to zero noise. However, ZNE requires substantial measurement overhead that scales unfavorably with desired precision, and extrapolation uncertainty grows with circuit depth. Recent Bayesian approaches have demonstrated improved shot efficiency but are limited by the computational cost of classical simulation beyond ~50 qubits. We introduce Shadow-Informed Bayesian Zero-Noise Extrapolation (BZNE), which uses quantum shadow tomography to generate informative priors directly from quantum hardware measurements, eliminating the classical simulation bottleneck. Our dual-prior framework incorporates both shadow-derived priors for the zero-noise limit and witness-based priors for noise decay parameters, enabling improved shot efficiency through Bayesian inference. We demonstrate the method on IBM's 133-qubit Torino backend for H_2 and LiH ground-state energy calculations using four noise-scaling factors. While the approach did not improve absolute accuracy over standard ZNE due to biased shadow priors under weak noise amplification, it provided critical advantages: full uncertainty quantification, hardware-specific noise characterization, and transparent diagnostics of prior-likelihood mismatch. These results establish quantum shadows as a scalable primitive for error mitigation and demonstrate how Bayesian inference can transform mitigation from deterministic curve-fitting into interpretable statistical inference.

Shadow-Informed Priors for Bayesian Zero-Noise Extrapolation

Sam Stryker

Research Objectives

Intro

-Qubit state important to computation
-Degrades due to noise present in system

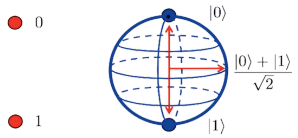


Figure 2: Bit v.s. Qubit
https://poetryinphysics.wordpress.com/2017/03/08/what-is-a-qubit/

Bayesian Regression
-Statistical regression tool makes predictions from prior information
-Gives probability band

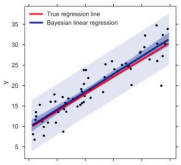


Figure 4: Bayesian Regression
https://www.dataminingapps.com/2017/09/simple-linear-regression-do-it-the-bayesian-way/

-H1: Greater accuracy
-H2: Greater uncertainty classification

-Zero-noise extrapolation (ZNE) mitigates these errors
-Extrapolates single line toward noise-free result

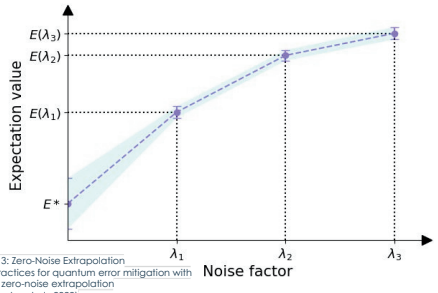


Figure 3: Zero-Noise Extrapolation
Best practices for quantum error mitigation with digital zero-noise extrapolation (Majumdar et al., 2023)

Methodology

Quantum Shadow Tomography

$$\langle O \rangle = \frac{1}{N} \sum_{j=1}^{n} \mathrm{Tr}(O \hat{\rho}_j)$$

Different observables can be tested on the same snapshot

Single shadow dataset used to construct snapshot

-Very efficient measurements through quantum shadows
-Used to build priors E*, a, b

$$\hat{\rho}_j = \mathcal{M}^{-1}(R_j^\dagger |b_j\rangle\langle b_j| R_j)$$

-a and b values for noise degradation quantification
-E* prior anchors function
-λ = 1,3,5,7 from standard shots

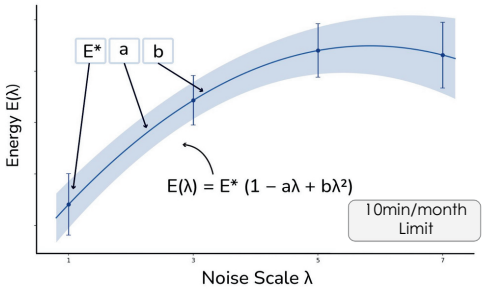
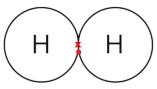


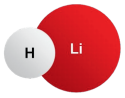
Fig. 7. BZNE visualization showing E* priors for the zero-noise value and a and b priors defining curve shape. Priors modifying likelihood data from standard shots. Figure made by student in Adobe Photoshop and Python, 2025.

Results

H_2 and LiH



Prior:
E* = -0.625476 ± 0.053852 Ha



Prior
E* = -5.082872 ± 0.111803 Ha

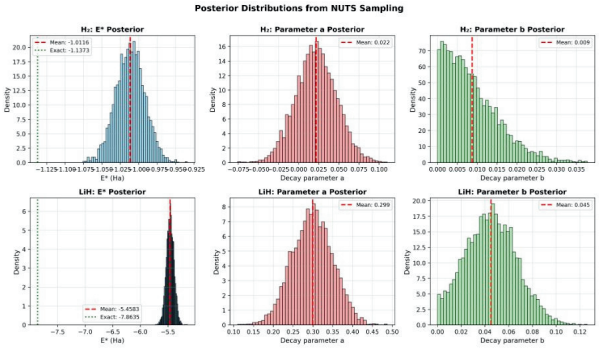


Fig. 9. Posterior distributions from NUTS. Top row: H2 posteriors for E*, a, and b showing tight credible intervals but a biased E* estimate. Bottom row: LiH posteriors showing broader uncertainty reflecting deeper circuits. Red dashed lines denote posterior means; green dotted lines show exact energies. Figure made by student in Python, 2025.

Conclusions

Debiasing

Hypothesis 1

-Shadow-derived E* priors substantially biased
-Bayesian update moved toward the true value but insufficient under weak noise amplification

-Not supported - requires adaptive priors

Hypothesis 2

-Full posterior distributions provide enhanced uncertainty information
-Calibrated credible intervals
-Hardware-specific noise parameters
-Heteroscedastic uncertainty propagation

-Standard ZNE provides only point estimates with no uncertainty quantification

- Supported

Evaluation of RPE Tortuosity as a Biomarker for Intermediate AMD Using New OCT Data from UK Biobank

Introduction and Background

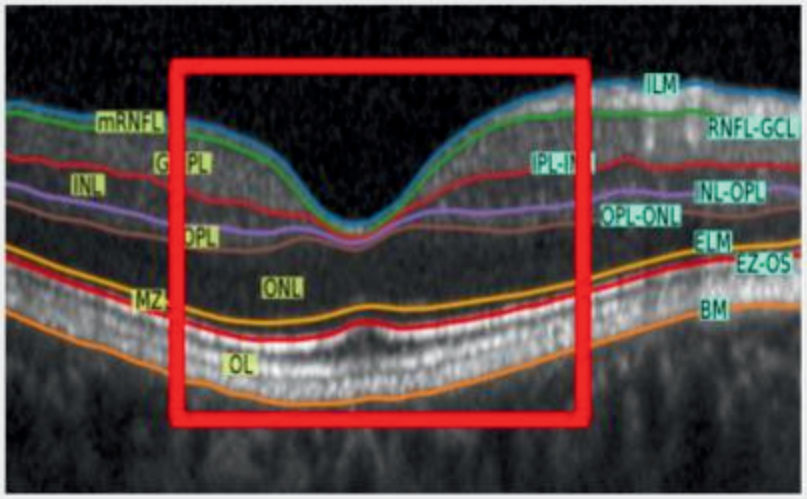
- AMD accounts for nearly 9% of all cases of blindness in the US, affects 200 million people worldwide (Paudel, 2024)
- AMD risk is associated with mutations in genes such as complement Factor H (CFH) and ARMS2 (Toomey, 2018), (Jong, 2021)

Gap in Research:
In order to identify genetic variants influencing drusen development, we need automated methods that can quantify drusen size rapidly and efficiently at scale.

Goal:
Develop a computational technique to quantify drusen from images in the UK Biobank and find genetic factors related to drusen formation and AMD.

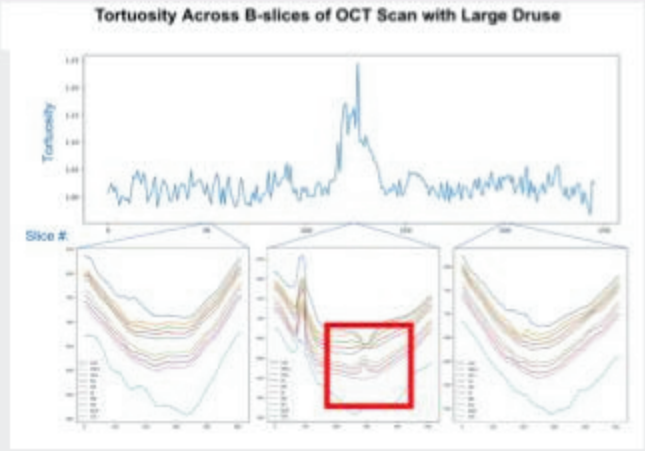
Hypothesis:
Retinal Pigment Epithelium tortuosity correlates to drusen presence and dry AMD diagnosis. (Cheung, 2024)

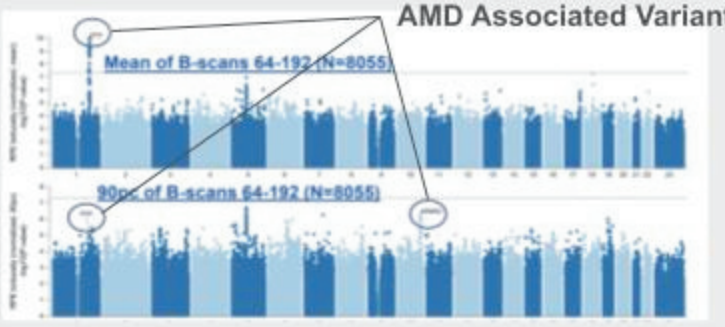
Methodology



- **Tortuosity:** *(RPE Length)/(length of Bruch's membrane)*
- Computed in foveal region of retina (red box)

Results



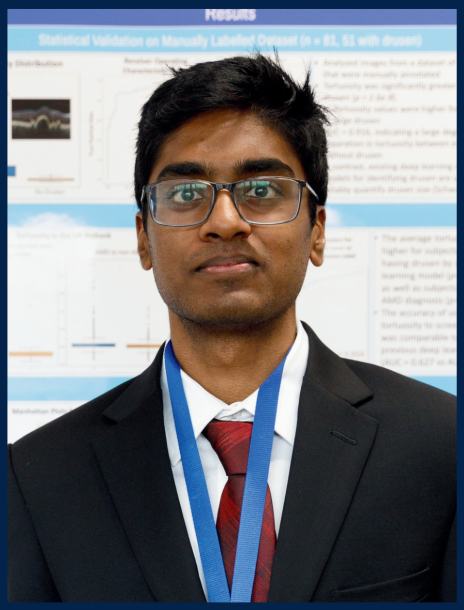


Conclusion

- **Hypothesis supported:**
  - Tortuosity was significantly higher in eyes with confirmed drusen presence
- Tortuosity based on multiple layer segmentations resulted in more accurate measurement of RPE curvature
- GWAS identified signals for genes associated with AMD, including CFH, ARMS2

NAVEEN TALLA

AUTOMATED QUANTIFICATION OF DRUSEN FROM RETINAL OCT SCANS



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Columbia University
INTENDED MAJOR/CAREER PATH	Medicine

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- Submitting my STS application
- Presenting my work to my mentors research group

FAVORITE MEMORY

Playing UNO at WESEF

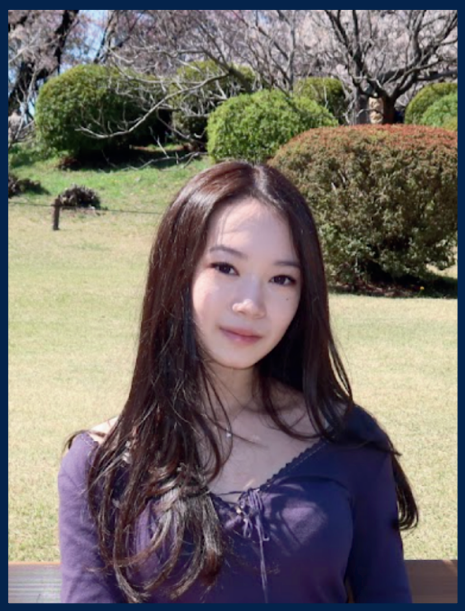
WORDS OF WISDOM

Don't procrastinate!

PROJECT ABSTRACT

Age-related macular degeneration (AMD) is one of the most common causes of irreversible vision loss, affecting 200 million people worldwide and accounting for nearly 9% of all cases of blindness. [1, 2] AMD typically presents itself in one of two forms, dry (atrophic) AMD, which is more common, and wet (neovascular) AMD, which is less common but more severe [3]. Dry AMD is characterized by the formation of deposits of proteins, lipids, and cellular debris between the retinal pigment epithelium (RPE) and Bruch's membrane, known as drusen. Late-stage disease results in progressive loss of retinal tissue, known as geographic atrophy (GA), which can lead to blindness. Wet AMD is caused by choroidal neovascularization in the macular region [4, 5, 6], and can be successfully treated with anti-VEGF drugs, such as Aflibercept (Eylea), or Ranibizumab (Lucentis), reversing effects of the disease and improving vision [7,8]. However, current treatments for dry AMD are limited [9], and once GA begins it may be irreversible; it is therefore of interest to study factors influencing progression of early-stage disease. This study addresses a key step in achieving this goal: developing an accurate and scalable technique to quantify the extent of drusen to enable inference of subjects' current disease stage using data from a common form of retinal imaging, optical coherence tomography (OCT).

EMMA TONG



THE EFFECT OF ALTERED C-10 STRUCTURE ON PODOCYTE ABUNDANCE IN DIABETIC KIDNEY DISEASE

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of North Carolina at Chapel Hill
INTENDED MAJOR/CAREER PATH	Interdisciplinary Studies

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Placing 3rd place at WESEF and Somers, having my abstract at the American Society of Nephrology National Kidney Conference in Houston, learning how to confidently present my work

FAVORITE MEMORY

Making friends at WESEF and making pancakes in class!!!

WORDS OF WISDOM

Don't stress too much about the future. Appreciate what's in front of you!

PROJECT ABSTRACT

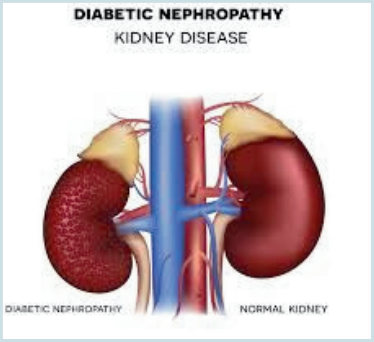
Diabetic kidney disease is the leading cause of kidney failure and can cause irreparable damage to the kidneys. This is often because DKD is associated with the loss of podocytes, which is a specialized kidney cell that helps prevent renal damage, therefore it is important to increase podocyte abundance to prevent detrimental effects. Previous treatments such as TYRO3 agonist C-10 have been shown to increase the abundance of podocytes, but such treatments were found to be cancer-causing in large quantities. As a result of this, this study sought to find a treatment similar to C-10 that could harness the benefits of reduced damage as seen through less inflammation without carrying the same potential downsides. We ordered variants of the C-10 compound with altered binding sites to see which compound would be the most efficient, identifying such compounds with a smaller fold increase of inflammatory markers HIL-6 and hCCL2. After testing this in both a 16hr and 24hr treatment exposure group for each of the six variants, we found that the BT1310, BT1313, BT1315, and BT1312 groups had the lowest significant fold changes compared to the regular C-10 compound. From these findings, we concluded that these four variants had the most potential to be further investigated because they are linked to greater podocyte populations. The results yielded from this study could support future endeavors for DKD treatment as current options can contribute to a decreased quality of life.

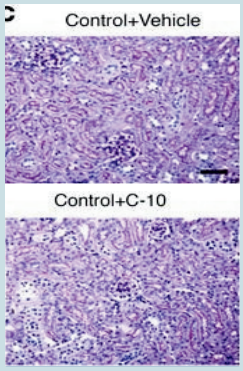
The Effect of Altered C-10 Structure on Podocyte Abundance in a Diabetic Model

Background and Objective

- Diabetic kidney disease is leading cause of renal failure and doesn't have adequate treatment options
  - Immune cells of the kidney **podocytes** isrenal protective factor
- TYRO3 found to upregulate podocytes, but don't know how to activate
  - C-10isTYRO3agonist, needto learnhowto maximize its efficiency for best results

Goal: Test out different C-10 variants to see which one has maximal efficiency in increasing podocyte population and therefore minimizing kidney damage





Results

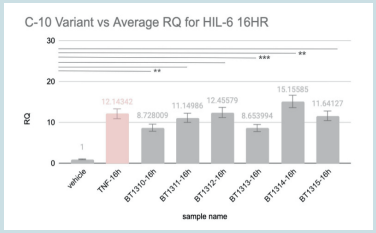


Figure 1a. Bar graph model of the average RQ values of the HIL-6 marker for the six different compounds. TheTNF-16h represents the C-10protein withoutanyalterations.***forp<.001;** forp<.01; * for p<.05.

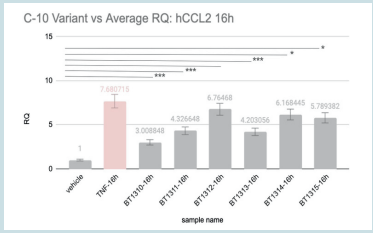


Figure 2a. Bar graph model of the average RQ values of the hCCL2 marker for the six different compounds. TheTNF-16h represents theC-10 proteinwithoutanyalterations.***forp<.001;**for p<.01;*for p<.05.

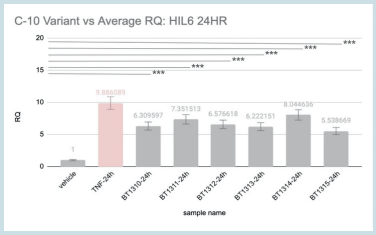


Figure 1b. Bar graph model of the average RQ values of the HIL-6 marker for the six different compounds. TheTNF-24h represents theC-10 proteinwithoutanyalterations.***forp<.001;**for p<.01;*for p<.05.

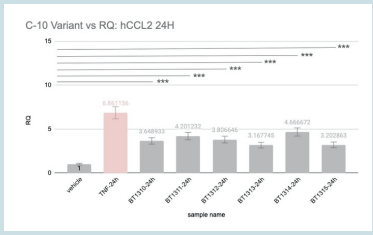


Figure 1b. Bar graph model of the average RQ values of the hCCL2 marker for the six different compounds. TheTNF-24h represents theC-10 proteinwithoutanyalterations.***forp<.001;**for p<.01;*for p<.05.

HIL-6 and hCCL2 are inflammatory markers, so looking for SMALLEST fold change to indicate more TYRO3

- For HIL-6 16hr, BT1310 & BT1313 had lowest RQ values
- For HIL-6 24hr, all groups significant but same trend as 16hr
- For hCCL2 16hr, BT1310 & BT1313 had lowest RQ values
- For hCCL2 24hr, BT1310 % BT1313 had some of the lowest RQ values

Methodology

Cell Cultures

- Humanpodocyte cell line
- Split cells when converting 70-80% of the plate



Nuclear Extraction

- Pellet cellswithlow-salt buffer
- Extract supernatant for further analysis



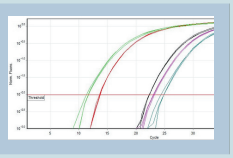
Protein Assay

- Measure concentrations of TYRO3 protein with color dilutions



qPCR

- Measure TYRO3 at RNA level using delta-delta CT values



Statistical Analysis

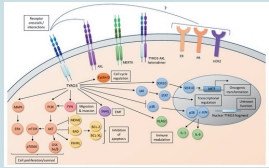
- Calculate RQ value, perform one-way ANOVA test on Sheets



Conclusions

- **Applications**
  - Create new treatment options with more efficient C-10 variants to effectively treat diabetic kidney disease
  - Help the **11% of the U.S. population** affected by diabetes
- **Future research**
  - Further experiments to quantify inflammation levels through additional perspectives
  - More time frames for exposure investigation
- **Conclusion**
  - Current methods of DKD treatment do not adequately support the patient
  - Goal is to test if new C-10 variants more effective than original model
  - BT1310 and BT1313 are most efficient versions and should be considered in future studies





Isorhapontigenin Induces Ferroptosis and Exhibits Synergistic Potential in Triple-Negative Breast Cancer

Sydney Tsao

INTRODUCTION

Triple-negative breast cancer (TNBC) is a particularly aggresisve subtype that is sensitive to ferroptosis, an iron-dependent cell death driven by lipid peroxidation and oxidative stress.



Cancer cells resist ferroptosis through antioxidant defense systems, mainly the GPX4 pathway and the FSP1 pathway, which neutralize lipid damage and allow tumor survival even under stress.



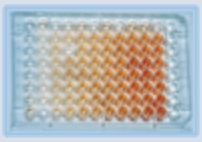
Isorhapontigenin (ISO), a Chinese herb, has known anticancer effects and can induce oxidative stress, but its role in regulating ferroptosis – and its interaction with FSP1 – remains unclear.

H_1: ISO alone will induce ferroptotic activity in TNBC cells by increasing oxidative stress and lipid peroxidation

H_2: ISO + iFSP1 will synergistically induce ferroptosis by blocking the FSP1/CoQ10 defense system, allowing ISO-induced lipid damage to accumulate unchecked

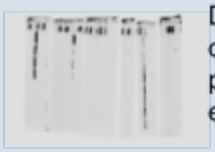
METHODS

CCK-8 ASSAY



Measure cell viability

WESTERN BLOT



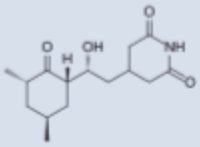
Detect changes in protein expression

qRT-PCR



Measure gene expression levels

CHX CHASE ASSAY



Assess protein stability over time

TNBC Cell Lines



MDA-MB-231 (human TNBC)

4T1 (murine TNBC)

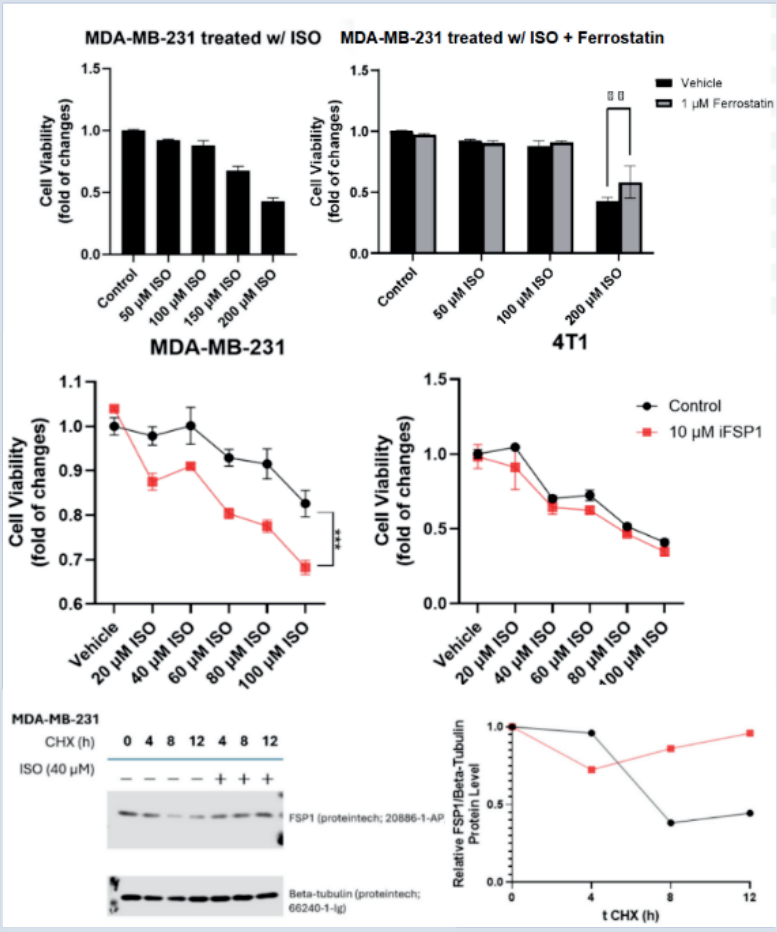
Data Analysis

ImageJ used to quantify WB bands

GraphPad Prism used to graph all data

Performed One/Two-way ANOVA, post-hoc Dunnett's test

RESULTS



CONCLUSION

Major Findings:

- ISO exhibits strong, dose-dependent ferroptotic effects in TNBC + increased oxidative stress
- TNBC cells treated with ISO respond by stabilizing FSP1, indicating compensatory defense response
- ISO + iFSP1 significantly enhances cell death

BOTH HYPOTHESES SUPPORTED ✔

Applications:

- Supports ISO + iFSP1 therapy for treating TNBC
- Provides a strategy to overcome tumor resistance by targeting antioxidant defense pathways

Future Research:

- Further investigate mechanism of stabilization vs expression in ISO-FSP1 axis
- Knockdown or inhibit GPX4 to determine relative contribution vs FSP1
- Evaluate effects of ISO in additional cancer types
- Test ISO efficacy and ferroptosis induction *in vivo*



SYDNEY TSAO

ISORHAPONTIGENIN INDUCES FERROPTOSIS AND EXHIBITS SYNERGISTIC POTENTIAL IN TRIPLE-NEGATIVE BREAST CANCER



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Cornell University
INTENDED MAJOR/CAREER PATH	Human Biology, Health, and Society

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Watching my friends walk the stage at Somers and WESEF!

FAVORITE MEMORY

The bus ride to Somers on set-up day and getting Chili's with my friends after the competition.

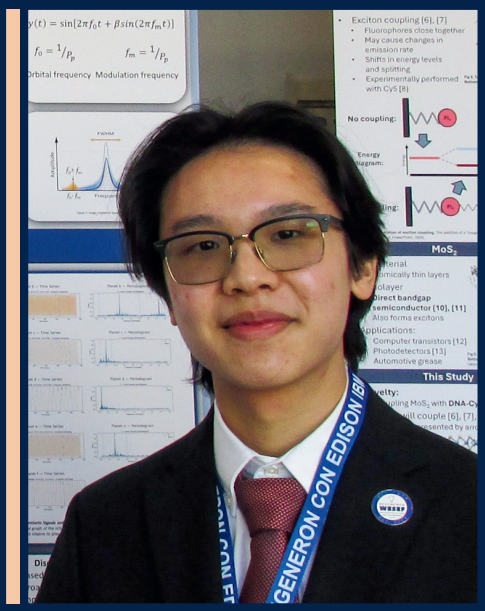
WORDS OF WISDOM

Don't be afraid to ask questions! Your mentor and peers are there to help you; take advantage of the resources at your disposal.

PROJECT ABSTRACT

Triple-negative breast cancer (TNBC) is an aggressive cancer subtype with limited targeted therapies, making ferroptosis a promising therapeutic vulnerability. This study investigates the anti-cancer mechanism of the natural stilbenoid isorhapontigenin (ISO) and its combination efficacy with the ferroptosis sensitizer iFSP1 in human (MDA-MB-231) and murine (4T1) TNBC cells. ISO alone demonstrated strong dose-dependent cytotoxicity in both TNBC lines. Combination treatment of ISO with a non-lethal (10 μM) dose of iFSP1 resulted in a significant synergistic reduction in cell viability ($p < 0.001$). Mechanistically, ISO acted as a ferroptosis inducer by dramatically upregulating the oxidative stress marker Heme Oxygenase-1 (HO-1). However, the CHX chase assay revealed a novel compensatory effect: ISO promotes FSP1 protein stability. This suggests the cells attempt to activate an anti-ferroptotic defense to counter the ISO-induced stress. The observed synergy thus results from ISO generating overwhelming damage while iFSP1 disables this FSP1-mediated cellular defense. These findings support using ISO and iFSP1 as a combination therapy to exploit the unique vulnerability of TNBC to ferroptotic cell death.

RUDOLF TSENG



VALIDATING KEPLER-20G USING TTVS AND ORBITAL RESONANCES:A COMPARATIVE STUDY WITH TESS FOR HIDDEN EXOPLANETS

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of Wisconsin-Madison
INTENDED MAJOR/CAREER PATH	Mechanical/Aerospace Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Qualifying and competing at NYSSEF/WESEF

FAVORITE MEMORY

Making too many science research memes for Mr. Zupan

WORDS OF WISDOM

Sleep is important

PROJECT ABSTRACT

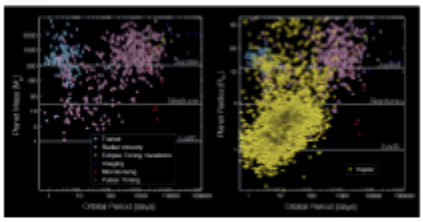
Validating non-transiting exoplanets remains a major challenge in astrophysics, as their signals are often obscured by stellar noise and limited observational coverage. This study combines Time-Averaged Force (TAF) with the Lomb-Scargle periodogram to investigate the debated existence of Kepler-20g. The methodology connects predicted gravitational influences within the Kepler-20 system to measurable changes in the shape of frequency spectra derived from radial velocity and transit timing data. Simulations show that larger TAF values correspond to greater phase modulation depth (β), leading to broadened peaks and enhanced sidebands in synthetic periodograms. When this is applied to the Kepler-20 system, planets with a higher predicted TAF (Kepler-20c and Kepler-20f) showed broader frequency peaks. These results show that TAF affects periodogram peak width and provides a framework for identifying and validating non-transiting exoplanets. Combining TAF and the periodogram is a tool for detecting hidden exoplanets in compact multi-planetary systems like Kepler-20.

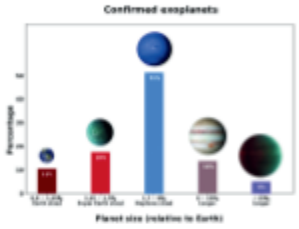
Integrating Time-Averaged Force and the Lomb-Scargle Periodogram for Non-Transiting Exoplanet Validation

Rudolf Tseng

Introduction

- Newly discovered exoplanets challenge traditional planetary evolution models (Mayor & Queloz, 1995) (Bean et al. 2020)
- **Kepler Mission**: Detected Earth-sized and Neptune-mass exoplanets, including debated Kepler-20g (Buchhave et al. 2016; Bonomo et al. 2023)
- **Kepler-20g:** Neptune-mass (21.0 ± 3.4 $M_\oplus$), 0.1387 ± 0.0027 AU orbital radius, crucial for planetary formation models if proven to exist
- The existence of Kepler-20g is still debated in literature (Buchhave et al. 2016; Bonomo et al. 2023; Weiss et al. 2023)





- Current exoplanet validation methods focus on **either:**
- **Radial velocity periodograms** to detect periodic stellar motion optimized for signal detection *not physical origin of signals*
- **Transit timing variations** (TTVs) to infer gravitational interactions (Nesvorný, 2009).
- **Orbital dynamics** to test long-term interactions

No standard methodology that directly connects predicted gravitational strength interactions to quantitative changes in RV periodogram features

Methodology

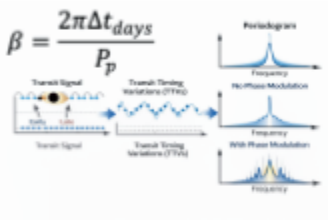
1 Calculating Time-Averaged Force (Tseng, 2025) **(Top)** Newton's Law of Gravitation and synodic period equation.
(Bottom) Novel equations developed by (Tseng, 2025)

$$F_g = \frac{m_1 m_2}{r^2} \quad \frac{1}{P} = \frac{1}{G} + \frac{1}{S}$$

$$\frac{\gamma}{S_d} = C_y \quad F_G \times C_y = T_{af}$$

2 **Mapping Time-Averaged Force to Phase Modulation Depth**

$$\beta = \frac{2\pi \Delta t_{days}}{P_p}$$



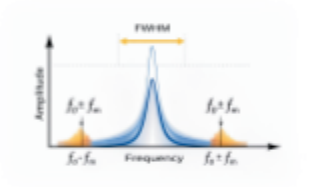
3 **Synthetic data set generation to analyze the effects of Phase Modulation Depth**

$$y(t) = \sin[2\pi f_0 t + \beta \sin(2\pi f_m t)]$$

$$f_0 = {}^1/_{P_p} \qquad f_m = {}^1/_{P_p}$$

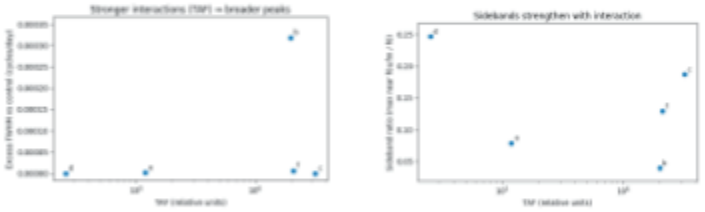
Orbital frequency Modulation frequency

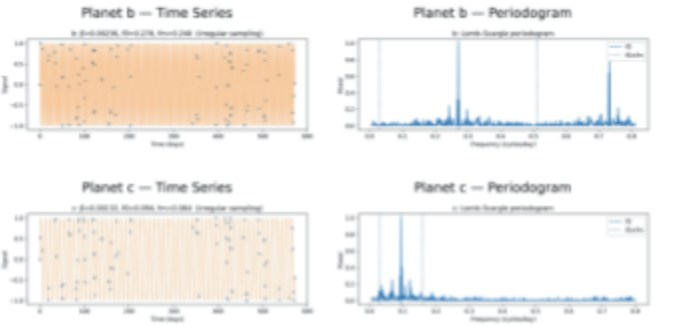
4 **Periodogram Analysis using the Lomb-Scargle Periodogram**



Results

planet	m_p (MΘ)	a_p (AU)	P_p (d)	Fg (rel.)	S (d)	Cy (/yr)	TAF (rel.)	Fg norm	TAF norm
c	13.6	0.093	10.60	136769.517594	15.676071	23.373356	3.196295e+06	0.492884	1.000000
f	1.0	0.193	19.60	277447.483155	48.268657	7.561843	2.098016e+06	1.000000	0.656389
b	9.5	0.045	3.70	22722.887961	4.167235	87.588043	1.990254e+06	0.081900	0.622675
e	0.7	0.061	6.10	2434.867300	7.483271	48.775460	1.187618e+05	0.008776	0.037156
d	10.1	0.210	34.94	41721.662808	594.340206	0.614126	2.562237e+04	0.150377	0.008016





- Planets close to Kepler-20g experience the largest TAF
- Higher TAF values translate to larger modulation depths (β)
- Increased β ⟶ broader periodogram peaks and stronger sidebands
- Kepler RV periodograms show peak broadening consistent with TAF

Conclusion

Applications:

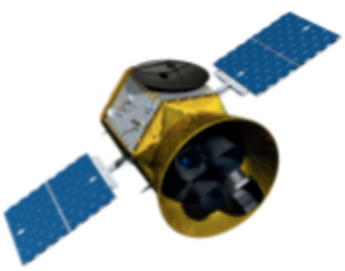
- Methodology can be used on other systems to predict TTVs and hidden exoplanets

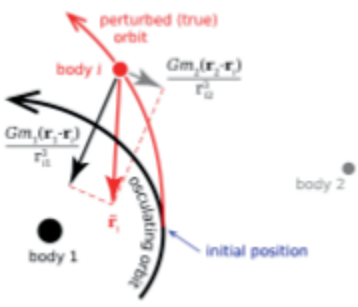
Conclusion:

- Many existing controversial exoplanets
- I extended the TAF methodology to work with new data variables
- My hypothesis was supported

Future Research

- Obtain transit data on the Kepler-20 system to confirm/disprove predicted TTVs
- Extend this methodology to work with non-circular orbits





Generation of Antibody Oligonucleotide Conjugates Using a Conjugation Chemistry with Multiple Linkers

Brady Wang, Horace Greeley HS, Chappaqua, NY, United States of America

BCHM #022

Research Question

Small Interfering RNA (siRNA)

- **Therapeutic Potential**: Has the potential to treat diseases that were previously considered "undruggable" through its specific gene silencing capabilities and durable mechanism of action
- **Challenges:** Unable to achieve cellular uptake due to size and charge

Antibody Oligonucleotide Conjugates (AOCs)

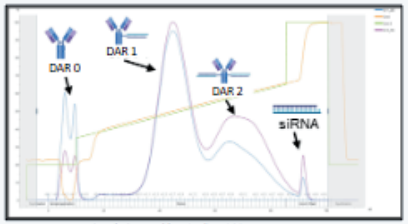
- Antibody conjugated (attached) to siRNA
- **Use:** Allows for specific delivery and specific cellular uptake of siRNA using antibody's properties
- **Previous Work:** Developed a new conjugation chemistry to generate AOCs using IEDDA click chemistry
- **Problem**: Developed chemistry was slow (8-12 hrs) and overall purification method was inefficient

Goal: Develop a different methodology using alternative chemical linkers in IEDDA to optimize and shorten reaction time

Methodology

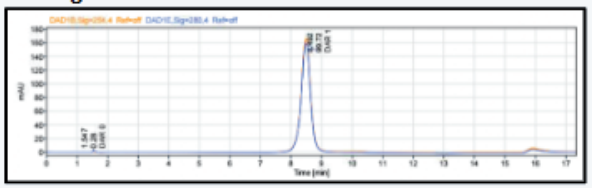
- **Step 1: Linker Installation**
  - Tetrazine linkers installed on bivalent mAb through a transglutaminase enzymatic reaction
  - Confirm linker installation using mass spectrometry to check the mass of the antibodies before and after installation
  - Purify antibody linker conjugate using Size Exclusion Chromatography (SEC)
- **Step 2: AOC Conjugation**
  - Conjugate antibody linker to siRNA (with TCO handle) through IEDDA Click Chemistry
  - Purify final AOC product with Anion Exchange Chromatography (AEX)
- **Step 3: Characterization and Quality Control**
  - Measure DAR through uv-vis Nanodrop technology and a derivation of the Beer-Lambert Law
  - Confirm DAR and protein aggregation using analytical AEX
  - Measure endotoxin levels using Endosafe
  - Suspend final AOC in Phosphate Buffered Saline (PBS) at 37 C
  - Monitored 14 days to check for degradation

Data Analysis and Results



Graph Created by Finalist, 2025.

Fig 1. AEX Profile of AOC Purification



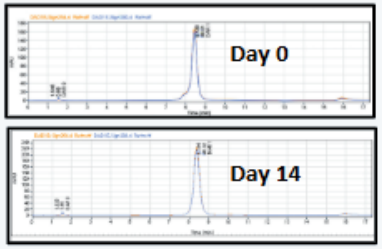
Graph Created by Finalist, 2025.

Fig 2. Analytical AEX Profile of Final AOC

RT [min]	Type	Width [min]	Area	Height	Area%	Name
1.547	BV	0.18	9.96	2.49	0.28	DAR 0
8.492	BBA	4.77	3586.98	159.53	99.72	DAR 1
		Sum	3596.94			

Graph Created by Finalist, 2025.

Fig 3. Analysis of Analytical AEX Profile



Graph Created by Finalist, 2025.

Fig 4. AEX Profile of AOC over 14 days

Interpretation and Conclusions

Figure 1: Four peaks from least negative charge to most negative charge representing DAR 0, DAR 1, DAR 2, and siRNA. Full conjugation achieved at hour 1.

Figure 2: One single AOC peak with species eluting out in order of increasing negative charge. The minor shoulder on the left is likely an injection artifact and not DAR 0.

Figure 2: Final AOC is extremely high purity: over 99% DAR 1.

Figure 3: Almost identical graphs from Day 0 and Day 14. Indicates little to no breakage of conjugate during this time.



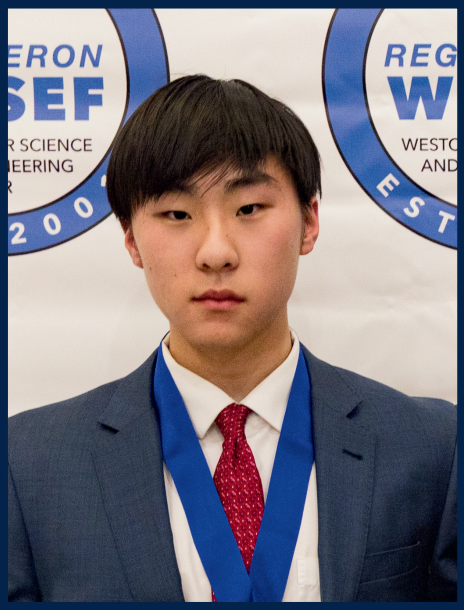
https://pubs.acs.org/toc/jmcmar/68/7

Conclusion: New optimized method, allows for stable high purity AOCs to be generated significantly faster. This chemistry and method can also be used to conjugate siRNA to **peptides,antibodies**, and **lipid nanoparticles** for targeted delivery of siRNA to extrahepatic tissues



BRADY WANG

GENERATION OF ANTIBODY OLIGONUCLEOTIDE CONJUGATES USING A CONJUGATION CHEMISTRY WITH MULTIPLE LINKERS



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Cornell University
INTENDED MAJOR/CAREER PATH	Biological Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Not eating, drinking, or sitting down during 8 hours of WESEF judging

FAVORITE MEMORY

Eating steak and truffle fries on WESEF's budget at ISEF

WORDS OF WISDOM

Always remember to relax and take it easy.

PROJECT ABSTRACT

Oligonucleotides, especially siRNAs, have been identified as a point of interest in recent research due to their capability for targeting of "undruggable" targets. siRNAs bind to and guide the RNA Induced Silencing Complex (RISC) in the cytoplasm, leading to degradation of specific targeted mRNAs. Despite advancements in the field, delivery to extrahepatic tissues remains a challenge. Current FDA-approved delivery systems such as lipid nanoparticles (LNPs) and trivalent N-Acetyl galactosamine (GalNAc), primarily target the liver. Antibodies, however, are emerging as a promising modality for targeted extrahepatic delivery of oligonucleotides. Antibody oligonucleotide conjugates (AOCs) leverage antibodies' receptor-based uptake for precise delivery of siRNA to targeted regions of the body. However, current chemistries for AOC generation are either inefficient or non-site specific. My research introduces a improvement on a previous method for generating AOCs. This method combines an enzymatic transglutaminase reaction with an Inverse Electron Demand Diels-Alder (IEDDA) reaction but uses a different linker. Specifically, a tetrazine linker is added to the antibody, followed by purification through size exclusion chromatography (SEC). The siRNA is conjugated to the antibody linker using IEDDA and purified through anion exchange chromatography (AEX), achieving a drug to antibody ratio (DAR) of ~1. The conjugate was characterized through multiple analytical methods. This new conjugation method successfully generates AOCs while significantly shortening conjugation time. Future applications include applying this method to significantly enhance the efficiency and scalability of AOC drug development as well as generate other modalities such as peptide siRNA conjugates.

RYAN ZHANG



SEED-CODE: DYNAMIC PROMPT COMPRESSION FOR LARGE LANGUAGE MODEL INFERENCE WITH SERVICE LEVEL GUARANTEES

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Princeton University
INTENDED MAJOR/CAREER PATH	Computer Science & Economics

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Presenting at NeurIPS 24', 25' and AAAI 26'.

FAVORITE MEMORY

When Sam, Tingray, and I went 3/3 1st Place Computer Science at Somers.

WORDS OF WISDOM

The Science Research Program builds a strong foundation. Beyond competitions, try to share your work at conferences and professional events. The more you put your research out into the world, the more you'll grow.

PROJECT ABSTRACT

As large language models become integrated into everyday tools, users expect fast, affordable, and reliable responses. However, as context increases, models process more tokens, driving up costs for both users and providers. For service providers, these operating costs must be managed without compromising the guarantees defined by Service Level Agreements (SLAs). SEED-CODE introduces a novel optimal control algorithm for prompt compression that minimizes token usage while satisfying SLAs over time. The Lyapunov Drift-Plus-Penalty framework is applied to balance cost and performance for each inference request using virtual queues and a pretrained linear regression model to estimate accuracy. Users define the priority of token efficiency and the required accuracy threshold. Experiments on the LongBench benchmark using Llama-3.3-70B-Instruct and Phi-4, show SEED-CODE adapts to each input's complexity, achieving a stable cost-accuracy trade-off. SEED-CODE reduces token usage by 2.1× compared to standard inference while meeting user-defined accuracy targets. On the Qasper task, SEED-CODE achieves equivalent F1 performance while using 42.8% fewer tokens than fixed compression. This adaptivity improves API billing efficiency by reducing redundant computation and aligning token usage with workload demands. SEED-CODE's efficiency and modularity make it suitable for real-world deployment in retrieval-augmented generation pipelines, conversational assistants, and enterprise-scale systems. Beyond performance and cost, SEED-CODE supports more sustainable model deployment by directly lowering the token consumption required for large-scale inference.

SEED-CODE: Dynamic Prompt Compression in Large Language Model Inference with Service Level Guarantees

Ryan Zhang

Introduction

- Token usage in large language models (LLMs) has become a growing concern for users

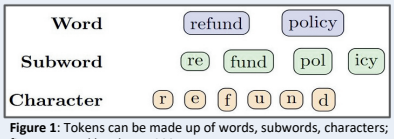


Figure 1: Tokens can be made up of words, subwords, characters; figure created by Zhang, 2025

- Prompt compression reduces the number of tokens in an LLM prompt while preserving key semantic information
- Methods are often model-agnostic, meaning they can improve efficiency without modifying the underlying LLM

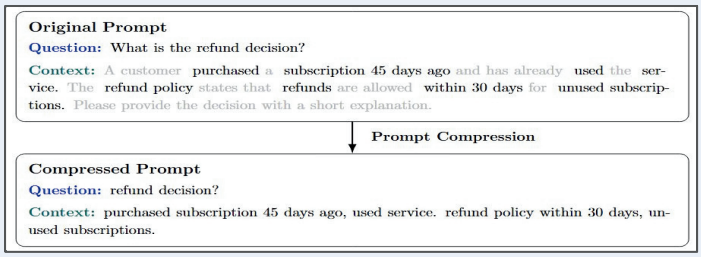
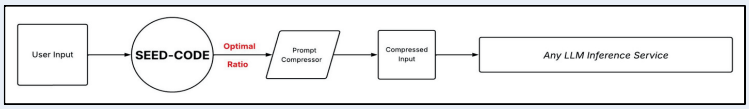


Figure 1: Prompt compression. Less informative tokens (gray) are removed while key information is retained; figure created by Zhang, 2025.

Engineering Goal

- My algorithm determines the optimal amount of context to compress for each inference request, while maintaining performance levels.

Methodology



Overall Control Problem:
E Energy consumption (joules) for a model.
A Accuracy of a model's response (requires feedback signal).
α SLA minimum accuracy requirement.

$$\min_{\{s_t\}} \frac{1}{T}\sum_{t=1}^{T} \mathbb{E}[E(t)s_t]^{1}$$

$$\text{s.t.} \quad \frac{1}{T}\sum_{t=1}^{T} \mathbb{E}[A(t)] \geq \alpha,$$

$$s_t \in [0,1], \quad \forall t \in \{1,\ldots,T\}.$$

Algorithm: SEED-CODE

Input: T, V, α, candidate rates $\mathcal{S}$, token cost $E_s(t)$, pretrained accuracy predictor $\hat{A}(\mathbf{a}_t, s)$
Output: Chosen retention rates and outputs for all t

Initialize $Q(1) \leftarrow 0$;
for $t \leftarrow 1$ **to** T **do**
  // Per-request optimization
  foreach $s \in \mathcal{S}$ **do**
    Compute $J_s(t) \leftarrow V \cdot E_s(t) + Q(t) \cdot (\alpha - \hat{A}(\mathbf{a}_t, s))$;
  $s^* \leftarrow \arg\min_{s\in\mathcal{S}} J_s(t)$;
  // Execute chosen retention rate
  Run PromptCompressor with target s^*;
  Obtain output and realized accuracy $A_{s^*}(t)$;
  // Virtual queue update
  $Q(t+1) \leftarrow \max\{0,\ Q(t) + \alpha - A_{s^*}(t)\}$;

Figure 2: Algorithm dynamically selects optimal retention rate for each request using predicted accuracy and token cost; figure created by Zhang, 2025

Results

Table 1: Performance comparison on the Phi-4 backend. Methods are evaluated under their respective target α values, with the average retention rate s shown per dataset. Created by Zhang, 2025.

Method (Phi-4)	Qasper					HotpotQA				
	Target α	Avg. compress $\bar{s}$	Accuracy (F1)	Avg. Tokens	Meets α?	Target α	Avg. compress $\bar{s}$	Accuracy (F1)	Avg. Tokens	Meets α?
No Compression (full context)	–	–	0.324	6853	–	–	–	0.354	6370	–
LongLLMLingua	0.20	0.55	0.191	3510	No	0.20	0.54	0.187	3395	No
Selective Context	0.25	0.50	0.234	3260	No	0.25	0.52	0.261	3721	Yes
SEED-CODE (LongLLMLingua)	0.20	0.55	0.210	3792	Yes	0.20	0.54	0.209	3632	Yes
SEED-CODE (Selective Context)	0.25	0.50	0.261	3482	Yes	0.25	0.52	0.256	3596	Yes

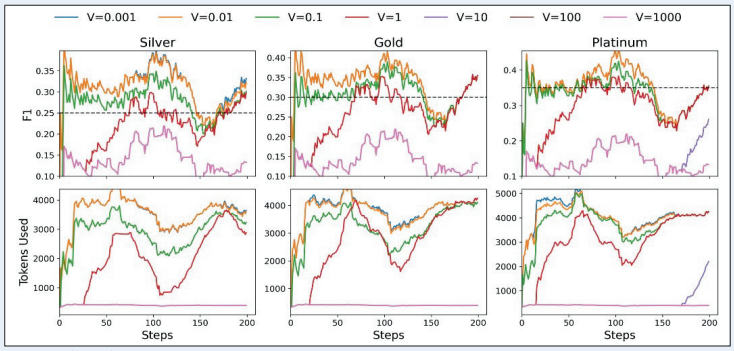


Figure 3: Effect of control parameter V on service-level performance. Sensitivity analysis of V under different service levels (α) for the Qasper dataset using the LongLLMLingua compressor with candidate rates S = [0.1, 0.9]. Higher V values prioritize cost savings by reducing tokens used, while smaller V values maintain higher F1 scores near the target service level. Created by Zhang, 2025.

Application

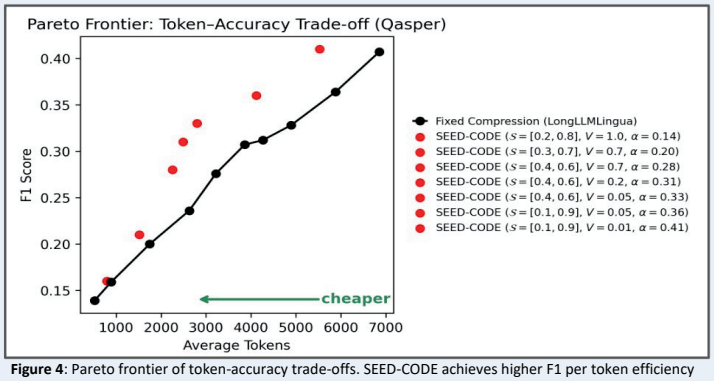


Figure 4: Pareto frontier of token-accuracy trade-offs. SEED-CODE achieves higher F1 per token efficiency through adaptive control. Created by Zhang, 2025.

Conclusion

Problem

- Long-context inputs lead to higher inference cost
- Prompt compression has no service guarantees

Goals

- Create a novel algorithm for selecting the most optimal compression ratio in language inference services on a per-request basis
  - Accurate, Efficient, Adaptable

Results

- My algorithm demonstrates to effectively allow the full benefits of prompt compression methods, while ensuring fulfilment of accuracy threshold α
  - Similar levels of compression compared with baselines
  - Useful for users with quality-sensitive workloads as it enables service level guarantees

RIYA ARON



ENGINEERING BIO-INSPIRED ABDOMINAL SUTURES: EXPLORING NOVEL FIBERS WITH HAGFISH PROTEINS AND SPIDER SILK

AWARDS	1st Place Engineering (Somers Science Fair), Citadel Securities Innovation Prize & The Holmes Family Engineering Innovation Award- 2nd Place (WESEF)
EXTRACURRICULARS	Competitive dancer, founder of Greeley Growers, Science Olympiad Event Supervisor, SAMES Exec, Theater

PROJECT ABSTRACT

Abdominal wound dehiscence is a serious complication of surgery that results in the re-opening of a closed abdominal incision due to suture failure. Dehiscence has up to a 45% risk of mortality in post-operative patients. Although many suture types are available, there is a need for fibers more capable of withstanding abdominal pressure. In this study, proteins from spiders and hagfish were combined to create a material mechanically stronger than traditional sutures. Spider silk was chosen for its high elasticity and hagfish proteins for its toughness and scalability. Two hypotheses were tested. First, it was hypothesized that inserting a GPGGX flagelliform spider silk motif into recombinant hagfish proteins would create a stronger fiber than regular hagfish fibers. Second, it was hypothesized that the novel fiber would exhibit superior performance compared to that reported for traditional sutures. The GP GGX fiber was synthesized and tested for mechanical qualities using an MTS machine. To evaluate the first hypothesis, data for toughness, stress, strain and Young's modulus were analyzed in Excel and compared to regular hagfish fibers. The novel fiber exhibited a higher slope and larger area under the stress/strain curve than hagfish fibers, revealing a superior resistance to failure under severe pressure. To evaluate the second hypothesis, properties of the new fiber were compared to those of traditional sutures tested in prior studies, revealing that the GPGGX-hagfish fiber exhibits superior toughness, strength and elasticity. In conclusion, the GPGGX-hagfish fiber has a strong potential as a new suture to reduce abdominal wound dehiscence.

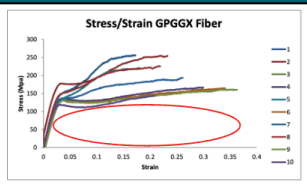
QUAD CHART

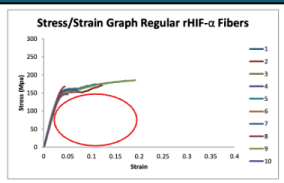
Introduction

- Some current sutures (stitches) aren't strong enough → abdominal wound dehiscence (reopening of abdominal incision).
  - Use hagfish proteins + flagelliform spider silk to make novel suture.
- **Hypothesis:** Novel hagfish-spider silk suture will have superior mechanical qualities when compared with regular hagfish fibers and Prolene sutures.
- **Goal:** determine whether novel fiber has potential as a suture to ↓ dehiscence rates.



Results





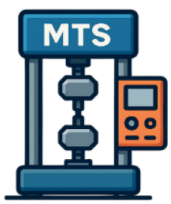
	Novel Fiber		Prolene
Tensile stress	195.31 ± 41.65 MPa	>	186.56 ± 0.3 MPa [5]
Strain	0.26 ± 0.07	>	0.1424 ± 0.006 [5]
Young's Modulus	5.79 GPa	>	< 5 GPa [11]
Toughness	40.36 ± 8.54 MJ/m³	⊘	125.2 ± 19.1 N*mm [7]

Novel fiber had greater stress, strain, toughness and Young's Modulus vs. regular hagfish fibers.

Novel = ↑ stress, strain, Young's Modulus. Unable to compare toughness

Methodology

1. **Fiber creation**
   - Synthetic gene made, inserted into plasmid + E. coli.
   - Protein production scaled → protein extracted to spin dry fibers.
2. **Mechanical testing**
   - Tested fibers in MTS Synergie 100 Machine to stretch until breaking point.
3. **Statistical analysis**
   - Raw mechanical data inserted into Excel to compare fibers.



Conclusions

Applications:
- Artificial ligament/tendon creations.
- Sutures in brain/abdomen.

Future:
- Create a suture prototype according to FDA guidelines, test it in an organism.

Overall:
- Suture shows strong potential to be used to ↓ dehiscence rates.

CHRIS CORREIA

NATURALISTIC EVENT BOUNDARIES ELICITED BY AUDITORY STIMULI AND THEIR EFFECTS ON TEMPORAL ORDER MEMORY



AWARDS	Somers 3rd Place, Excellence in Behavioral Science
EXTRACURRICULARS	Debate, newspaper, academic challenge, track, volunteering

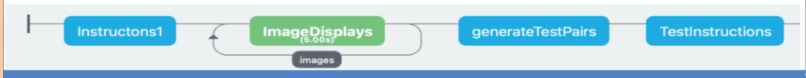
PROJECT ABSTRACT

Temporal order memory (TOM) is the cognitive ability to recall the order of events. Event boundaries, signaled by perceptual shifts, implicate the form in which content is organized, therefore affecting the accuracy of recall. However, the bright-line for what constitutes a shift in 'perception' is vague and unexplored. Artificial audio-physical boundaries have been utilized in prior research, yet the exportable utility of naturalistic, solely auditorily induced boundaries is unknown. This study utilizes a novel methodological paradigm of temporal coherence to test the effects of auditorily induced boundaries on temporal recall. It was hypothesized that auditory boundaries will near-replicate the temporal effects of other modalities by eliciting worse accuracy across boundary conditions than within them. A novel paradigm for boundary identification was applied to create the conditions for recall testing. This 'listening phase', in which participants place boundaries themselves maximizes subjective placement accuracy, reduces over-estimation of exportability and replicates real-life conditions. Participants viewed images and listened to music simultaneously, completed a TOM test, and then placed boundaries within the music. There was a similar accuracy for the within condition and the across condition, going against what previous research would suggest. This creates a double bind explanation, either temporal coherence intercepts boundary effectiveness, or different modalities have different effects on TOM. Future research should hyperspecify on intersectional boundaries and attempt to find the missing link in explanation. This is done to maximize exportability, reduce overgeneralization and homogenization of boundary effects, and reduce overestimation that previous research may have fallen victim to.

QUAD CHART

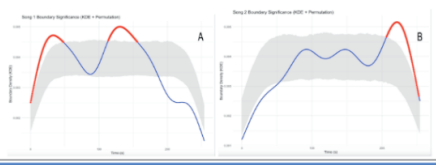
Objectives

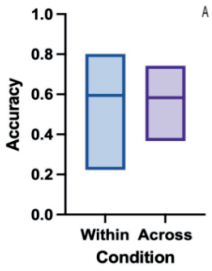
- Test how auditory event boundaries (a less-studied modality) organize memory, building on prior visual-based research
- Examine whether auditory boundaries produce temporal order memory (TOM) effects similar to established findings
- Address the gap in defining what counts as a perceptual shift and whether audio alone can signal meaningful boundaries



Results

- Hypothesis 1 not supported
  - Auditory boundaries didn't affect temporal order memory
- Hypothesis 2 supported
  - Auditory boundaries were produced



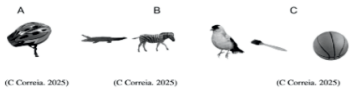


Methodology

26 participants completed a 3-block task (music + white noise)

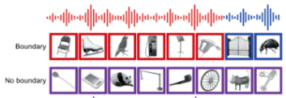
1. Study phase: viewed images while hearing classical music
2. Test phase: shown a pair of images from study phase → instructed to identify which appeared first
3. Listening phase: listened to music again, marked perceived boundaries in the music

Compared memory accuracy within vs. across boundaries using t-tests



Conclusion

- Auditory cues can reliably signal event boundaries, as participants showed consistent placement
- However, these boundaries did not significantly affect temporal order memory, unlike prior visual-based findings
- Suggests that modality (auditory vs. visual) or temporal coherence may limit boundary effects on memory



JASON DANG



DETECTING PARKINSON'S DISEASE USING VOICE SIGNALS AND DEEP LEARNING MODELS

AWARDS	1st Place Somers, 4th Place WESEF
EXTRACURRICULARS	Varsity Tennis, Science Greeley

PROJECT ABSTRACT

Parkinson's Disease (PD) is a progressive neurodegenerative disease that is often only detected with invasive methods after significant motor decline. Voice-based machine learning models may allow for simpler screening. However, our understanding of how deep learning models capture subtle vocal changes in PD remains incomplete. In this study, we address this by applying a CNN-LSTM hybrid architecture and comparing it against single-architecture approaches. It was hypothesized that the CNN-LSTM hybrid model would be able to distinguish between healthy controls and PD patients from voice signals and would outperform single-architecture baselines. We applied preprocessing steps to sustained vowel phonations and converted them into spectrograms. CNN-LSTM, CNN, and LSTM models were trained and evaluated using nested cross-validation, primarily assessing their accuracy and AUC. The CNN-LSTM model achieved the strongest overall performance, with a mean accuracy of 0.914 and a mean AUC of 0.928, among all architectures. The CNN model had a slightly lower AUC than the hybrid model and a substantially lower accuracy, indicating a weaker classification ability. The LSTM model captured temporal but had a slightly lower accuracy and AUC, showing that temporal features alone are insufficient for robust detection. We found that combining both spectral and temporal information in the hybrid model improved the overall detection performance compared to single-architecture baseline approaches, which may lead to the development of more reliable PD screening tools. Overall, this work demonstrates the potential for voice-based deep learning for detecting Parkinson's disease.

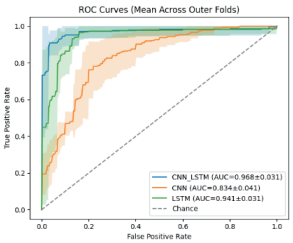
QUAD CHART

Research Question

- PD affects 10M+ people
- Current diagnosis is often late and invasive
- ~90% show speech impairments
- Can deep learning detect PD from voice signals with rigorous evaluation?

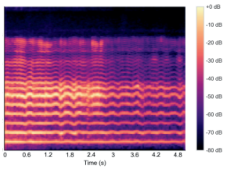
Findings

- CNN–LSTM best performance
  - ROC-AUC: ~0.96
  - Accuracy: ~0.89
  - Low variance



Methodology

- Dataset: PD vs HC voice recordings
- Preprocessed recordings into spectrograms
- Models: CNN, LSTM, **CNN–LSTM (proposed)**
- 5-Fold Nested-CV (speaker-independent)



Conclusions

- Hybrid model improves classification performance for voice-based PD detection
- Rigorous validation → reliable results
- Supports voice as non-invasive screening tool
- Applications: mobile health, early screening
- Future: larger datasets, earlier-stage PD

EMMA FEIG

THE IMPACT OF THE ONSET OF FEMALE PUBERTY ON THE LIKELIHOOD OF ADOLESCENT SPORTS RELATED INJURIES



AWARDS	3rd place at Somers Science Fair medicine and health
EXTRACURRICULARS	Chappaqua Volunteer Ambulance Corps, Soccer, Lacrosse, President of SCOPE club, Renaissance tutoring

PROJECT ABSTRACT

Females are a very under-represented area of research and with that, knowledge about their puberty is a large gray area, the full extent to which puberty, hormonal fluctuations and musculoskeletal implications are extremely unknown. In this study, we surveyed female athletes in high school asking about the onset of puberty in the form of their first menstrual cycle. Various questions based on injury patterns were also asked in hope to understand the relationship between the two. To determine statistical significance, Spearman's correlation tests were run and it was found that through this research, that there is no significant correlation between individuals who experience delayed/late puberty and a greater injury rate and risk.However, it is believed that this is due to the low response rate and uneven distribution of responses within the low amount of responses. It is concluded that there is no significant correlation between those who experience a delayed onset of puberty and a higher risk/rate of injury than those who have an early/normal onset of puberty. If there is a standardized survey that athletes (of all ages and levels) can take, the knowledge can help them prepare their bodies better for sports, lowering injury risk.

QUAD CHART

Problem

- **Prioritizes male development**
- Focus on **pubertal offset** and **isolated injuries**
- limited knowledge about **how delayed puberty influences overall injury risk**

Goal

- **Evaluate how pubertal onset influences injury risk**
- **Inform participants about their pubertal status**
- Helps athletes **better prepare for upcoming sports seasons**

Hypothesis

Female athletes with delayed pubertal onset will exhibit a **higher injury risk** due to **reduced estrogen levels**, leading to **lower bone density**, **decreased muscle strength**, and **altered ligament and tendon properties**.

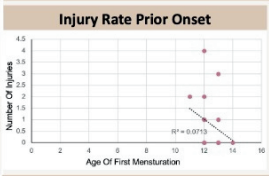
Methodology

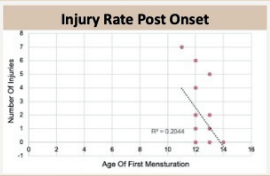
- Adapted questions from the LESADO and RAPILL II questionnaires
- Questionnaires were adapted to focus on the **onset of puberty**
- Female athletes ages 13-18 were studdied
- Collected information on demographics, sports participation, injury patterns and recovery tactics
- **Excel** was used for **analysis** and **graphs**
- **Spearman Correlation test**
- Allowed for the **determination** of a **relationship** between **pubertal onset and injury rate**

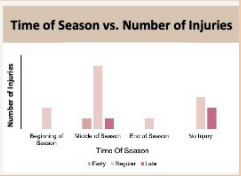
Survey Questions

- **Puberty Onset:** At which age did you start menstruation?
- **Compare Onset & Injury Levels**: About how many athletic injuries did you have prior to getting your period? And after your period?
- **Identify Injury Location & Severity:** Have you sustained an athletic injury requiring a doctor visit? If yes, which type of doctor did you see?
- **Impact of Injury:** How long were you out of sports due to this injury?
- **Identify the Treatment:** Did you need physical therapy?

Results







Limitations

- Self recorded recall bias
- Sociopolitical climate
- Response rate
- Data collection

Conclusion

- **Major findings:**
  - R^2 values were insignificant
  - Hypothesis was not supported
  - Pubertal timing alone is not a reliable predictor of injury risk in female athletes
- **Future Research:**
  - Expand sample size
  - More diverse population
  - Follow those who took the survey
- **Applications:**
  - Preseason assessment
  - In hospitals
  - In personalized training programs

CALEB FIJMAN



PROJECT TITLE: FUNCTIONAL ANALYSIS OF TIGR-TAS, A NOVEL RNA-GUIDED DNA-TARGETING SYSTEM, IN LIVE PHAGE INFECTION MODELS

AWARDS	1st place Microbiology Somers Science Fair, 2nd place Microbiology WESEF
EXTRACURRICULARS	The Highly Prestigious Horace Greeley High School Science Research Program, Track and Field (Spring), Speech & Debate Team Rising Captain, Phelps Memorial Hospital Volunteer, Piano

PROJECT ABSTRACT

TIGR-Tas is a recently identified RNA-guided DNA-targeting system, but its ability to function as an antiviral defense during live phage infection remains unclear. This study tested whether plasmid-expressed TIGR-Tas could reduce bacteriophage susceptibility in Shigella flexneri using plaque assays and efficiency-of-plating (EOP) analysis. Across all strains and phages tested, TIGR-Tas did not significantly reduce phage infectivity, with EOP values statistically indistinguishable from negative controls (one-way ANOVA, $p > 0.05$). Although minor differences in plaque morphology were observed, these qualitative changes did not correspond to measurable resistance. Growth curve analysis showed that TIGR-Tas imposed a lower metabolic burden than the CRISPR-Cas control, but this advantage did not translate into improved survival during infection. These findings suggest that TIGR-Tas does not function as an effective antiviral system under the conditions tested, likely due to the absence of phage-specific guide RNAs. Overall, this work highlights the importance of sequence-specific targeting in RNA-guided defense systems and establishes a foundation for future optimization of TIGR-Tas as a programmable tool.

QUAD CHART

Background/Research Question

Background

- Bacteria possess immune systems such as CRISPR-Cas, which use **RNA guides** to recognize and cleave invading viral DNA
- TIGR-Tas is a **newly identified RNA-guided system** with key differences (dual-guide RNAs and no strict targeting requirement), but its protective function in living cells remains unclear

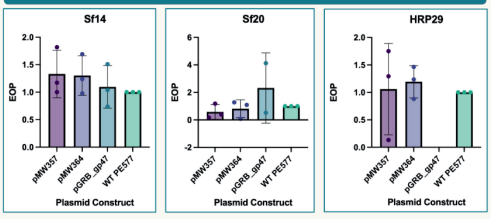
Research Question

- This study tests whether expressing TIGR-Tas in Shigella **reduces susceptibility to phage infection** compared to CRISPR-Cas

Results

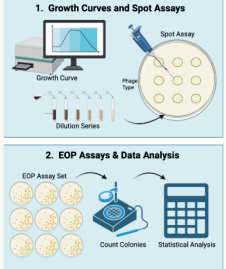
-TIGR-Tas strains showed similar EOP values to controls, indicating no significant reduction in phage infection
-TIGR-Tas strains grew better than CRISPR-Cas strains but slightly worse than unmodified bacteria.

Efficiency of Plaquing (EOP) Assays



Methodology

- It was hypothesized that TIGR-Tas would enhance bacterial survival during phage infection and provide strong antiviral defense.
- Introduced TIGR-Tas DNA **through plasmids into multiple *Shigella* strains** and exposed bacteria to bacteriophages (viruses) to test for potential resistance.
- **Monitored growth rates of transformed *Shigella*, and measured infection rates using plaque assays (EOP).** All results were compared to positive (CRISPR) and negative control conditions.



Discussion/Conclusions

Main Findings

- TIGR-Tas did not reduce phage infection (EOP unchanged), though it imposed a lower growth burden than CRISPR-Cas

Hypothesis

- The hypothesis was partially supported: TIGR-Tas improved bacterial growth relative to CRISPR-Cas, but did not enhance antiviral defense

Future Directions

- Future work should introduce phage-specific guide RNAs and test TIGR-Tas across different hosts and phages to evaluate its true defensive potential

PARVATHY GOPIKRISHNA

UNLOCKING OFFSHORE WIND POTENTIAL: A NOVEL MACHINE LEARNING APPROACH TO ENHANCED CLIMATE-RESILIENT TURBINE SITE VIABILITY ASSESSMENT



AWARDS	2nd Place in Environmental Sciences at WESEF, 1st Place Behavioral Sciences at Somers Science Fair
EXTRACURRICULARS	Sustainability Research Center (Co-President), Northern-Westchester President's Junior Leadership Council, Peer Leadership, Chamber Orchestra, Table Tennis

PROJECT ABSTRACT

Offshore wind has emerged as a significant renewable energy source in the U.S. However, as turbine projects require substantial long-term investments, site selection must account for all vital factors and future impacts from climate change. The goal of this study was to develop a climate-informed Geographical Information Systems-based (GIS-based) multi-criteria decision-making (MCDM) framework to identify offshore wind zones that remain viable under future climate scenarios. We compiled eight siting criteria: wind speed, bathymetry, distance to grid, distance to ports, hurricane risk, regulatory exclusions, marine mammal density, and vessel traffic, assigning Analytic Hierarchy Process weights with a consistency ratio of 0.018. We used climate change projections for 2050 under SSP2-4.5 and SSP5-8.5 scenarios, incorporating CMIP6 model increases of 5-9% for wind speed and 12-20% for hurricane intensity across 1.6 million km2 of offshore area. Results revealed adaptations in both scenarios, with mean suitability increasing from 5.09 to 5.17 under SSP2-4.5 and from 5.09 to 5.23 under SSP5-8.5. However, SSP2-4.5 improved only 18.6% of the area, while SSP5-8.5 improved 90.4%. High resilience zones maintaining suitability above 7.0 encompassed 138,625 km^2, mainly in Atlantic waters. Validation against BOEM lease areas showed leases scoring 2.1 points higher than non-lease areas. Neural network analysis confirmed wind speed as the dominant predictor, accounting for 52% of model capacity. We conclude that identified climate-resilient zones exceed current deployment targets, allowing for siting that accounts for extended climate stability.

QUAD CHART

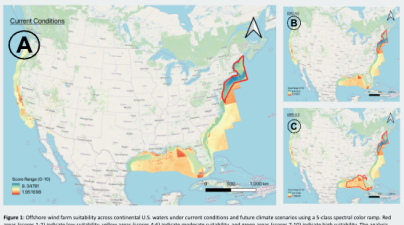
Background

- **40.8 billion tonnes** CO2 emissions emitted in 2024 (Rapier, 2025)
- U.S. wind energy has 4**.3 TW of offshore wind potential** (Fuchs et al., 2025)
- **Research Gap**
  - Low regard for **environmental & socio-technical** siting factors in models
  - Lack of **future climate considerations**

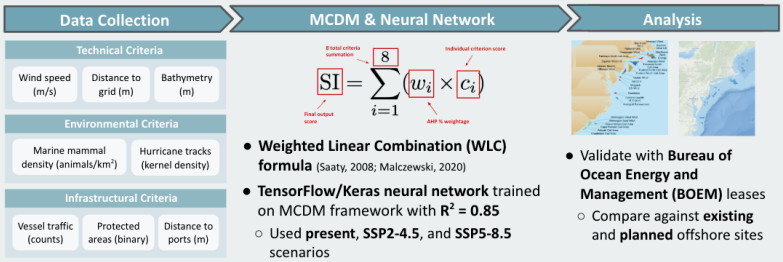


Key Findings

- **138,625 km^2** of high-resilience area identified
- **99.7% concentrated** in Atlantic
- BOEM-leased turbine areas show **91% matching accuracy**
  - **2.1 suitability pts** advantage for turbine over non-turbine areas



Framework



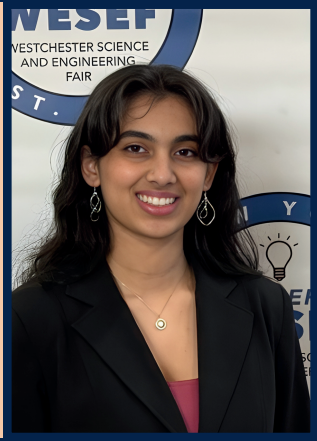
- **Weighted Linear Combination (WLC) formula** (Saaty, 2008; Malczewski, 2020)
- **TensorFlow/Keras neural network** trained on MCDM framework with **R^2 = 0.85**
  - Used **present**, **SSP2-4.5**, and **SSP5-8.5** scenarios
- Validate with **Bureau of Ocean Energy and Management (BOEM)** leases
  - Compare against **existing** and **planned** offshore sites

Conclusion

Novel Engineering Goal Achieved: Map climate-resilient offshore wind area across the U.S. with GIS multi-criteria decision making

- **138,625 km^2** identified resilient area → **583 million tons CO2** offset potential
- **Applications**: Companies can operate on sites with long-term viability, prevents thousands of air pollution deaths annually (Buonocore et al., 2016)
- **Future Research**: Varying turbine type conditions considered (Tanvir & Etminan, 2025)

LASYA HOTA



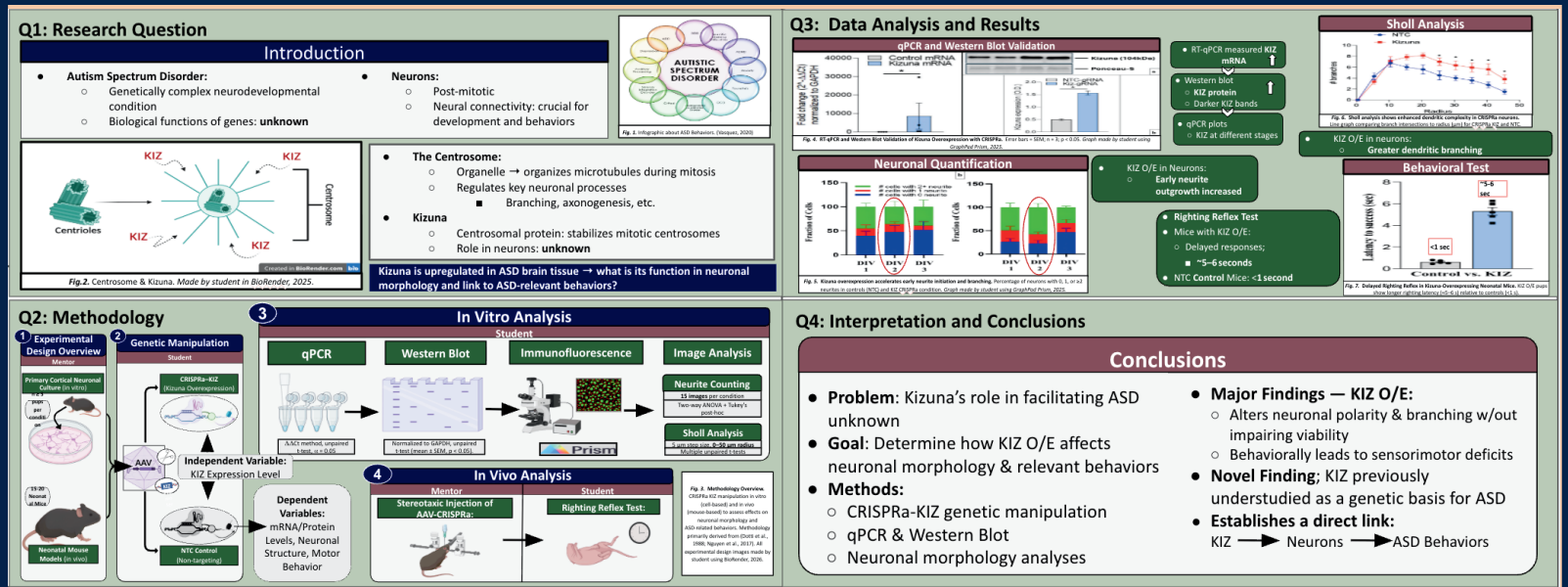
CRISPR ACTIVATION OF KIZUNA: INVESTIGATING A CENTROSOMAL GENE LINKING NEURONAL MORPHOLOGY TO AUTISM SPECTRUM DISORDER

AWARDS	2nd Place Cell & Molecular Biology (Somers), Society for In Vitro Biology Award (WESEF)
EXTRACURRICULARS	Arts & Culture Director for The Greeley Voice, volunteer for organizations against domestic violence, creative writing.

PROJECT ABSTRACT

Autism Spectrum Disorder (ASD) affects 1 in 31 children in the United States, and recent multi-omics studies have identified Kizuna (KIZ)—a centrosomal scaffolding protein crucial to polarity and axon initiation—as significantly upregulated in ASD brain tissue. However, the specific influence of KIZ on neuronal morphology and early developmental behaviors remains entirely unknown. It was hypothesized that experimentally increasing KIZ expression would modify neurite and dendritic structures, leading to measurable differences in early behavioral development. Using a CRISPR activation system delivered through Adeno-Associated viral vectors, KIZ was upregulated in vitro in primary cortical neurons and in vivo in neonatal mouse models. RT-qPCR and Western blotting confirmed significant mRNA and protein upregulation compared to controls. Immunofluorescence analysis revealed that CRISPRa-KIZ neurons produced longer primary neurites at early developmental stages, but they ultimately converged to similar final lengths as controls. Sholl analysis exhibited significantly increased branch density within the first 15-40 µm from the soma, producing compact, highly arborized dendritic trees; whereas the controls exhibited fewer, more sparsely distributed branches. In vivo, CRISPRa-KIZ mice demonstrated significantly reduced righting-reflex latency compared to untreated mice, indicating altered neuromotor maturation. The findings suggest that KIZ overexpression reshapes centrosomal stability by amplifying early neuronal growth patterns and influencing developmental milestones. These results may inform future diagnostic approaches based on cellular biomarkers, and support therapeutic strategies targeting centrosomal-associated pathways. By identifying a mechanistic link between a dysregulated structural gene and early developmental outcomes, this study contributes to a deeper understanding of neurodevelopmental disorders and their societal impact.

QUAD CHART



ASHNA KHANNA

EVALUATING THE IMPACT OF INFORMATION PROVISION ON CONSUMER PREFERENCES FOR PRODUCTS PRODUCED USING A SUSTAINABLE WEED SUPPRESSION PRACTICE



AWARDS	WESEF Ricoh Sustainable Development Award
EXTRACURRICULARS	Dance, Piano, MAANGO VP, SPCA Club President

PROJECT ABSTRACT

Unsustainable weed suppressors used by farmers have significant environmental impacts. Currently, there are no viable sustainable alternatives on the market. The objective of this study is to determine the economic viability of a new sustainable weed suppressor, BioWRAP, by determining consumer willingness to pay (WTP) for tomatoes produced using BioWRAP and how it is affected by information provision. This study hypothesizes that information provision will have a significant indirect impact on consumer preferences for BioWRAP produced products. The data used in this study originated from a survey previously conducted by the mentor. Three information provision treatments were used for the survey. The student analyzed 4083 responses from the survey through the use of a random utility model and regression analysis. It was found that consumer WTP for tomatoes produced using BioWRAP, compared to tomatoes produced using unsustainable weed suppressors, was significantly increased under all the information provision treatments. These results indicate that information provision impacts the focal points of the value norm belief theory, most notably awareness of consequences and ascription of responsibility, which impacts consumer perception and preference for sustainable products. We concluded that the use of information provision can be utilized in marketing for BioWRAP produced products to increase WTP and act as an incentive for farmers, and increase the economic viability of the use of BioWRAP. This study promotes the use of information provision to facilitate a more sustainable future for the agricultural industry, promoting an overall healthier planet and an improved quality of life for all.

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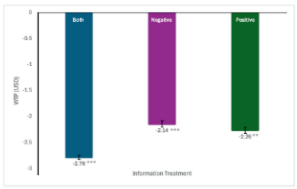
Question and Hypothesis

Question: How does information impact consumer preferences for products produced using BioWRAP?

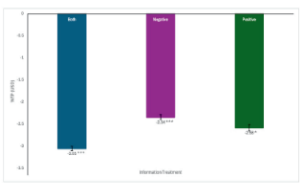
Hypothesis: Information provision will significantly impact the relative strength of consumer preferences for products produced using BioWRAP

Results

WTP of mulch film products compared to BioWRAP Products



WTP of pesticide products compared to BioWRAP Products



Methodology

Discrete Choice Evaluation Survey

	Weed Suppression	Certified Organic?	Source	Water Footprint (gallons)	Carbon Footprint (lbs. CO_2)	Price (per pound)
Option A	Chemical herbicides	No	Your state	25	1.2	$4.78
Option B	BioWRAP	Yes	USA	30	2.4	$1.98
Neither	None					

Information Treatments

- Positive information regarding BioWRAP
- Negative information about mulch film
- Both the positive and negative information

Random Utility Model

Analyzes the utility of the variables and the interactions between the information treatments and variables

Willingness to Pay

$$WTP = -\frac{\beta variable}{\beta price}$$

Discussion and Conclusion

Value Norm Belief Theory

- Awareness of consequences
- Ascription of responsibility
  - Directly impacted by information provision

Applications

- Policymaking - Informs about sustainable agriculture
- Marketing - Sustainable labels or packaging

Hypothesis Supported ✓

Ultimate Impact

- Promote sustainable agriculture
- Slow climate change
- Improve quality of life for all





ANYA KHURANA



UTILIZATION OF PUBLIC GENOMIC DATA TO PREDICT CROSS RESISTANCE PATTERNS OF MULTI-DRUG RESISTANT TUBERCULOSIS: A MACHINE LEARNING APPROACH

AWARDS	Presenter for New York Medical Graduate Conference
EXTRACURRICULARS	Hospital Volunteering, Track and Field

PROJECT ABSTRACT

Multidrug-resistant tuberculosis (MDR-TB) is a growing global health issue present predominantly in stage two developing countries such as Africa, India, South America and Eastern Europe. MDR-TB is caused by mutated Mycobacterium tuberculosis strains that are resistant to the most commonly used first-line antibiotics. Currently doctors may prescribe multiple medications that still have no effect on the MDR-TB. Current diagnostic tools, including culture-based drug susceptibility testing and rapid molecular assays, cannot reliably detect rare or novel mutations, contributing to treatment delays and ongoing transmission. In this study, we benchmarked four machine learning models, Logistic Regression, Random Forest, Support Vector Machine (SVM), and XGBoost, using whole-genome sequencing significant data from 22,990 isolates and 59,049 nucleotides from CRyPTIC consortium to predict resistance across 19 antibiotics. Our findings show that SVM and Logistic Regression achieved the highest overall accuracies (up to 95%), while XGBoost excelled for drugs with complex, multi-gene resistance patterns such as rifampicin and pyrazinamide. The novelty of this study lies in the discovery of 570 uncharacterized nucleotide mutations across 18 genomic regions associated with resistance. We developed a clinician-focused, novel pairwise cross-resistance matrix heatmap using predictions for 22,990 M. tuberculosis isolates across 19 antibiotics. This tool visualizes resistance co-occurrence, identifies drug combinations least likely to share resistance, and eliminates the guesswork in low resource setting TB treatment. Additionally, web app development is implemented that helps clinicians identify the most effective drug combinations to combat the disease and deliver personalized treatment for the 1.25 million people affected worldwide.

QUAD CHART

Introduction

Tuberculosis (TB) is world's **leading** infectious disease caused by *Mycobacterium tuberculosis*; Targets lungs [1]

In 2025, **10.7 million** diagnosed with TB; **1.25 million** deaths [2]



400k with **Multidrug Resistant Tuberculosis** (MDR-TB) [3]

MDR-TB is resistant to multiple combinations of antibiotics to treat TB (eg.Rifampicin and Isoniazid) [4]

Antibiotic resistance develops through genetic mutations that occur in the presence of overused drugs [5]

Methodology

DATA SOURCE	MACHINE LEARNING	CROSS RESISTANCE HEATMAP	WEB APP
Large Open - Source Dataset 23,000+ TB patient samples 59,000 + corresponding genes	Implemented 4 ML Models Random Forest XG-Boost Logistic Regression SVM	Calculated pairwise resistance percentages for each pair of 19 antibiotics	Developed Web App Prototype to select optimal drug combinations

Results

Goal 1 Achieved:
- Successfully implemented 4 ML Models for each of the 19 antibiotics

Goal 2 Achieved:
- Novel Pairwise Cross-Resistance Matrix Heatmap

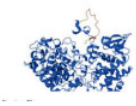
Goal 3 Achieved:
- Developed prototype for optional drug combinations

Goal 4 Achieved:
- Modeled 3D Protein Structure for potential drug/vaccine development



Conclusion and Future Research

- Utilize protein structures to enhance TB vaccine development.
- Expand novel ML methodology to other drug-resistant bacteria (eg. *A. baumannii*).
- Connect with clinics to link genomic predictions with patient outcomes.





EMMA KNAPP

BIOLOGICAL SEX-BASED DIFFERENCES IN GUT VIRAL MICROBIOME IN PEOPLE LIVING WITH HIV



EXTRACURRICULARS

Varsity tennis (4 years), State champion (2024), artist in fine arts, piano, Greeley Voice

PROJECT ABSTRACT

In order to comprehensively characterize the gut viral microbiome (virome) of those living with HIV of differing biological sexes, we must examine viral diversity and abundance to understand whether differing HIV therapies will help improve quality of life. Globally, the prevalence of HIV is higher among women, who have been underrepresented in study cohorts. Sex-based differences include HIV acquisition, viral load set point, immune activation, and how HIV persists and hides in the body, which raises the concern of whether women have adequate accessibility to effective therapies. Bacteria present in the gut differ by biological sex, predominantly due to sex hormones, and have been shown to influence immunity, drug metabolism and disease risk. Our group previously found differences in gut bacteria in people living with HIV (PLWH). Samples were collected, extracted, and sequenced, and the resulting resequencing data was analyzed in R. We found that gut viral alpha diversity did not significantly differ between sexes in either all participants or only those on antiretroviral therapy (ART) (p-value >0.05). Gut Viral beta diversity analysis revealed significant differences between biological sexes for all participants (p-value = 0.0043) and ART participants (p-value = 0.0197), significantly supporting the hypothesis. We found no differentially abundant viral species between men and women in this study cohort. These findings suggest that biological sex may influence viral diversity in PLWH. This highlights the importance of continued research on how the gut virome may influence the efficacy of HIV medicine, in pursuit of improved patient outcomes.

QUAD CHART

Research Question

Problem

Men and women have **different responses** to HIV medications and therapies

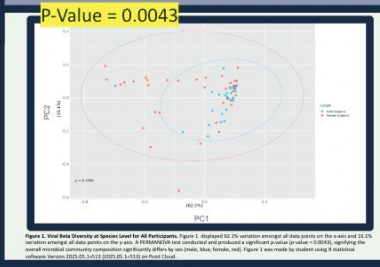
- This is due to biological sex hormones that directly modulate gut microbial diversity and composition
- Women living in Sub-Saharan Africa may not have access to adequate therapies

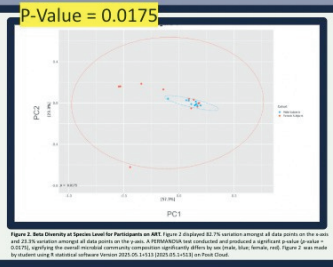
Goals

Characterize the **gut virome** present in samples

- Examine gut viral correlation to biological sex to further understand viral diversity and abundance
- Contribute research surrounding biological sex-based therapies to improve quality of life for PLWH

Results





Methodology

Matched, de-identified stool samples were collected from subjects registered from the Mbarara Regional Referral Hospital located in Uganda → Participant **demographics, medication** history, clinical **symptoms, HIV RNA levels, and CD4+ T cell counts** were collected → **VLPS** were prepared to **enrich viral particles** and **reduce** host bacterial contamination. Viral sequences were identified using Kraken2. → **R statistical software** (version 2025.05.1+513) was utilized for all analyses and visualizations. → **Alpha diversity** was compared using the **Mann–Whitney U** test. **Beta diversity** was analyzed using **PERMANOVA**. Heatmaps were generated on normalized reads.

Hypothesis: Viruses present in the gut differ by biological sex in PLWH (Monaco et al., 2016)

Conclusions

Hypothesis Supported

New understandings of gut virome of PLWH in Uganda, an understudied region

- **Novel** research to the understudied field of gut virome
- Need for **equitable sex representation** due to biological hormonal differences

MADELINE LAMB



PHTHALATE LEVELS AND HEALTHY EATING INDEX SCORES: DIETARY QUALITY AS AN INDICATOR OF AN ENDOCRINE DISRUPTING CHEMICAL

AWARDS	2ND Place Somers Science Fair, Tricounty Award
EXTRACURRICULARS	Biotech Vice President, Care facility Volunteer, LIFT Tutor, Student Ambassador, Cross Country,

PROJECT ABSTRACT

Phthalates are endocrine disrupting chemicals that are known for their widespread presence across plastic products. Phthalates are commonly found throughout dietary sources, often being found in food packaging. As plastics become more common, it is essential to understand how they get into our bodies and how to reduce their presence. Our understanding of how dietary quality and dietary changes impact phthalate levels remains incomplete. In this study we used the NHANES database to determine the relationship between urinary phthalate levels and diet quality measured using the Healthy Eating Index. We created a linear regression comparing urinary phthalate levels and HEI scores using the 2017-2018 NHANES dietary and lab data. We also assessed several confounders such as age, income, and gender to determine the strength of the relationship. We found that there was a statistically significant inverse relationship between HEI scores and phthalate levels. We found the diets with higher HEI scores had significantly lower urinary phthalate levels overall, therefore we also confirmed that diets with lower HEI scores had higher urinary phthalate levels. However, we also found that when age, income, and gender were held constant, this relationship was far less strong for some phthalates. We concluded that dietary quality has a significant impact on urinary phthalate levels, but there are still many other aspects that influence urinary phthalates. This indicates that large food production companies need to work on decreasing the amount of phthalates used in heavily packaged less nutritionally dense products. Future research could examine how these confounding factors work together to influence phthalate levels rather than looking at them separately.

QUAD CHART

Research Project

How do individuals Healthy Eating Index Scores influence their levels of urinary phthalate metabolites?

- Phthalates are endocrine disrupting chemicals
- Almost all adults and children in the United States have measurable levels of circulating phthalates due to exposures in their environment.

Results

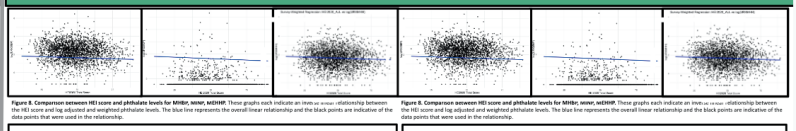


Figure 8. Comparison between HEI score and phthalate levels for MHBP, MiNP, MEHHP. These graphs each indicate an inverse relationship between the HEI score and log adjusted and weighted phthalate levels. The blue line represents the overall linear relationship and the black points are indicative of the data points that were used in the relationship.

Figure 8. Comparison between HEI score and phthalate levels for MHBP, MiNP, MEHHP. These graphs each indicate an inverse relationship between the HEI score and log adjusted and weighted phthalate levels. The blue line represents the overall linear relationship and the black points are indicative of the data points that were used in the relationship.

a) Without the confounders, all three phthalates showed a **strong** statistical relationship [14][13]

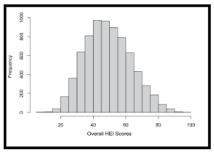
d) Adjusted for sex, age, and income the relationship persisted, though it was less strong[22]

Statistical Analysis

- **Paired T-test** between HEI scores less than 50 and greater than 50[19]
- Reject the null hypothesis if p-value less than or equal to **0.05**
- Linear regression will evaluate confounding factors including sex, income, age[17][18]

Methodology

- Calculated HEI scores using HEI-package from GitHub
- Created Linear regression Including Confounders of **Sex, Income, and Age**



Discussion/Confusion

The hypothesis was supported by the data, consistent with prior research

Higher HEI scores lead to lower levels of Urinary Phthalate levels

Lower HEI scores lead to higher levels of Urinary Phthalates

Age, gender, and income did not diminish the strength of this relationship

Applications:

Not-for-profits can use research to provide more education to the public.

Individuals can make healthier choices to reduce their phthalate exposure and prevent hormonal disruption[23]

Future Research:

Creation of more recent data set, NHANES scheduled for 2028[25]

ISABELLA LIU

THE IMPACT OF ORPHANHOOD ON DEVELOPMENTAL MILESTONES OF KITTENS (FELIS CATUS)



EXTRACURRICULARS

Irish step dancing, writing, volunteering at animal shelters

PROJECT ABSTRACT

The premature separation of the kitten from its mother, or orphanhood, has many impacts on the development of kittens. However, our understanding of orphanhood's full effects on kittens is still incomplete, seeing as there is no research on how it affects the achievement of developmental milestones, to the author's knowledge. This study aimed to find out how orphanhood affects the temperament, behavior, weight, health, and completion rate of developmental milestones in kittens from ages of 0 days to 8 weeks. A survey addressing the topics above was written and sent to kitten fosterers to obtain relevant study data. We found that the temperament of orphaned (OR) kittens did not differ from mothered (MR) kittens, similarly to health problems. MR kittens had more weight compared to OR kittens at all ages, and OR kittens displayed the eating of unsuitable materials more often compared to MR kittens. OR and MR kittens completed developmental milestones at a similar rate, but OR kittens completed more milestones at earlier ages. We conclude that OR and MR kittens have similar personalities and health, MR kittens weigh more than OR kittens, and OR kittens eat unsuitable materials more often and complete developmental milestones earlier due to the need for independence. Future research should follow kittens into adulthood to see if these effects persist.

QUAD CHART

Introduction

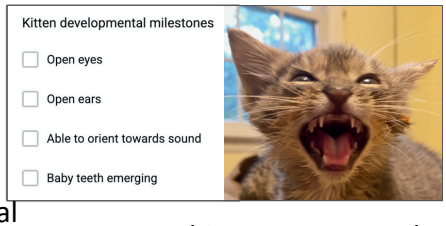
- Orphaned (OR) kittens act differently from mothered (MR) kittens
- OR kittens more stressed, more aggressive, have differences in weight gain

Research question: How does orphanhood affect the growth and development of kittens?



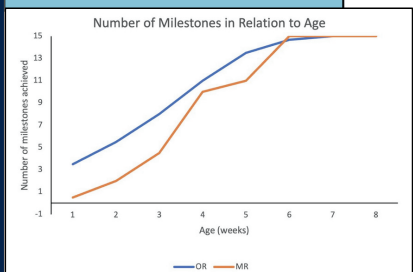
Methods

- Sent surveys to foster families
- Asked about behavior, temperament, weight, health, and developmental milestones



- Mann Whitney U test used for data analysis

Results



- OR kittens weigh less during weaning period
- OR kittens more prone to eating unsuitable objects
- OR kittens gain more developmental milestones compared to MR kittens

Discussion

- Orphanhood significantly affects a kitten's weight when weaning
- OR kittens needs to develop faster to make up for the loss of the queen



All figures made by student

SHAHAK LIVNE-TARANDACH



SEX DIFFERENCES IN AFFECTIVE BEHAVIOR AND THE AUGMENTATION OF ENKEPHALIN EXPRESSION IN THE VENTRAL PALLIDUM

AWARDS	2nd in Neuroscience (WESEF), 2nd in Behavioral Science (NYSSEF), 1st in Cellular and Molecular Biology (Somers)
EXTRACURRICULARS	Research (Karkhanis Lab), Intern @ The Harris Project, SADD (CODA Director), DECA (Vice President), HereNow Teen Advisory Board Sage (Founder)

PROJECT ABSTRACT

Substance use disorder (SUD) is a rapidly escalating public health crisis in men and women, resulting in fatal overdose, cardiovascular disease, and increased vulnerability to infectious illnesses, with a particularly steep rise in women. Yet, addiction research has historically centered on males, revealing critical gaps remain in understanding the neurobiological mechanisms underlying sex differences in addiction behavior. The gaps are especially evident within the enkephalin (ENK)/μ-opioid receptor (MOR) system, which regulates both positive and negative reinforcement. Prior studies have examined receptors mediating only one dimension of reinforcement in other brain regions, while the ventral pallidum (VP), a hub for motivation and drug seeking, remains unexplored. This study addresses these gaps by jointly examining sex differences in anxiety-like behavior, oxycodone consumption, and ENK expression in the VP. It was hypothesized that female (vs. male) Long-Evans rats would exhibit greater anxiety-like behavior (H1), higher oxycodone intake (H2), and express greater ENK in the VP (H3). Male and female Long-Evans rats (N = 62) were evaluated using the Successive Alleys Test for anxiety-like behavior, weekly oral oxycodone self-administration, and an ELISA to quantify ENK expression in the VP. Sex differences in anxiety-like behavior were not significant (H1 not supported). However, Female rats consumed greater amounts of oxycodone and expressed higher ENK compared to males, supporting H2 and H3. These findings highlight pronounced sex-specific vulnerabilities for females. Such insights can inform the development of sex-specific relapse prevention and early-detection strategies, including biomarker-based screening to identify individuals at high risk before SUD emerges.

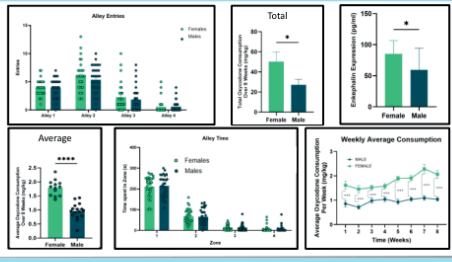
QUAD CHART

Research Question

- **48.4 million** Americans struggled with **SUD** in 2025
  - **Female overdose deaths increased ~480%** since 1999
- Addiction research **male focused**
- **ENK/MOR system in VP** remains **unexplored** despite relevance in addiction
- **Goal:** Examine behavioral and neurobiological sex differences within addiction

Results

- **No sex differences** in **Anxiety-Like Behaviors**
- **Females consume more oxycodone** than males
- **Females express more ENK** in the VP compared to males

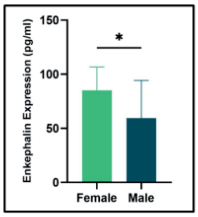


Methodology

- Successive Alleys Test
  - Measured time spent in each zone
  - Measured entries into each zone
- Oxycodone Self Administration Paradigm
  - 0.06mg/ml, 3h/d, 5d/wk, 8wk
- Competitive Enkephalin ELISA
  - VP Tissue

Conclusion

- Females showed **elevated opioid consumption + elevated ENK expression** in the VP
- **Hyperactive ENK/MOR** system in females
  - Can be targeted during treatment



LIVIA LOW

THE IMPACT OF SCREEN MEDIA ACTIVITY ON ADOLESCENT COGNITION AND BRAIN DEVELOPMENT: AN ABCD STUDY



AWARDS	Somers 3rd place, WESEF 4th place
EXTRACURRICULARS	Figure Skating Instructor, Mathnasium Instructor, Hospital Volunteer, SADD Junior, Media Club President, Debate Leader, Chinese School TA

PROJECT ABSTRACT

Today, more than 50% of adolescents report more than 4.5 hours of their daily time on screens, far exceeding any other activity since 2020. However, our understanding of whether screen media activity (SMA) during early adolescence is associated with white matter integrity growth and cognitive skills remains incomplete due to inconsistent results. In this study, we analyzed whether SMA is associated with growth in the Middle Frontal Gyrus and various cognitive abilities. We hypothesized that higher levels of SMA in adolescents aged 9-12 would be associated with lower white matter integrity and poorer performance across all cognitive domains. We used data from the Adolescent Brain and Cognitive Development Study and utilized linear regression models for analyses. We found that playing video games during the weekday at follow-up year 1 significantly decreases white matter volume in the right middle frontal gyrus at follow-up year 2. No other SMA were significantly related to white matter development in the prefrontal cortex. Watching videos, texting or video chatting, and social media during the weekdays and weekends was related to poorer performance in executive functioning, processing speed, and reading recognition tasks cross-sectionally and longitudinally. Moreover, playing video games during the weekdays and weekends was mostly related to increased performance in executive functioning, processing speed, and reading recognition tasks cross-sectionally and longitudinally. These findings suggest that moderating SMA use can lead to healthier cognitive development in ages 9-12. This also helps guide parents and policymakers about screen time guidelines.

QUAD CHART

Introduction

- Today, adolescents report more than 4 hours of **SMA (Screen Media Activity)** a day (Madigan, 2022)
  - SMA has significantly increased by 50% among adolescents over in past decade
  - SMA: Watching videos, texting/calling, social media video games
- Cognitive tests measure skills potentially affected by SMA in this brain region

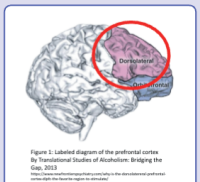


Figure 1: Labeled diagram of the prefrontal cortex
By Translational Studies of Alcoholism: Bridging the Gap, 2013

Results

Table 7
Longitudinal Weekday & Weekend Screen Media Activity & Brain Development
Table 7 shows brain development in the left and right middle frontal gyrus with its results with several activities of SMA at follow-up year 1 and 2. Figure made by student using Excel.

	Weekday SMA				Weekend SMA			
	L MFG T2		R MFG T2		L MFG T2		R MFG T2	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Watching Videos T1	-0.01	[-0.03, 0.02]	0.01	[-0.01, 0.03]	-0.02	[-0.04, 0.01]	-0.01	[-0.03, 0.01]
Text/Call T1	0.01	[-0.01, 0.03]	0.01	[-0.01, 0.04]	0.00	[-0.02, 0.02]	0.01	[-0.01, 0.03]
Social Media T1	-0.01	[-0.03, 0.02]	0.00	[-0.02, 0.02]	0.00	[-0.02, 0.02]	0.00	[-0.02, 0.02]
Video Games T1	-0.01	[-0.03, 0.01]	-0.02*	[-0.04, 0.00]	-0.01	[-0.03, 0.01]	-0.02	[-0.04, 0.00]
Age T1	0.06***	[0.04, 0.08]	0.05***	[0.04, 0.07]	0.06***	[0.04, 0.08]	0.05***	[0.04, 0.07]
Income T1	0.01	[-0.01, 0.03]	0.01	[-0.02, 0.03]	0.01	[-0.01, 0.03]	0.01	[-0.02, 0.03]
Parent Education T1	0.02	[0.00, 0.04]	0.00	[-0.02, 0.03]	0.02	[0.00, 0.04]	0.00	[-0.02, 0.02]
Race T1	0.00	[-0.02, 0.02]	0.02	[0.00, 0.03]	0.00	[-0.02, 0.02]	0.01	[0.00, 0.03]
Sex T1	-0.01	[-0.02, 0.01]	-0.01	[-0.03, 0.01]	-0.01	[-0.02, 0.01]	-0.01	[-0.03, 0.01]

Note: ***$p < .001$, **$p < .01$, *$p < .05$; SMA = Screen Media Activity; L = Left; R = Right; MFG = Middle Frontal Gyrus; T1 = Follow-up Year 1; T2 = Follow-up Year 2; CI = Confidence Interval; Analyses = Multiple regression

- Weekday video gaming at Year 1 → Reduced white matter volume in the right middle frontal gyrus at Year 2
- Increased use of watching videos and texting/calling → poorer performance in executive functioning, processing speed, and reading

Methodology

Independent Variable

- Type and amount of SMA: Watching videos, texting/calling, social media, video games
  - Measured separately for weekdays and weekends

Dependent Variable

- Cognitive performance (executive function, processing speed, reading recognition)
- White matter development in the dlPFC

- Data obtained from the Adolescent Brain and Cognitive Development (ABCD) Study (A large U.S. longitudinal neuroimaging study)
- Cognitive processes: NIH Toolbox Tests
- Dorsolateral Prefrontal Cortex (dlPFC): Diffusion Tensor Imaging

Conclusion

- Findings partially supported the hypotheses ✓ ✗
- Effects may be functional rather than structural

Applications

Families and Policymakers: Use findings to limit some types of passive screen use (e.g., videos, social media)



ANDY MARCHESANO



IMPACTS OF BEECH LEAF DISEASE ON BUD QUALITY IN AMERICAN BEECH (FAGUS GRANDIFOLIA)

EXTRACURRICULARS

Academic challenge, Varsity winter and spring track and field, Geogessr club, Origami club, FED challenge, Pep band, Guitar, and Saxophone.

PROJECT ABSTRACT

Beech Leaf Disease (BLD) is a disease that compromises the health of beech trees (Fagus grandifolia), which are highly valued for their nuts. The disease is associated with the invasive nematode Litylenchus crenatae mccannii. Though studies have examined the effects of BLD on buds at the cellular level, there is currently no knowledge of whether this disease affects the physical appearance and external properties of buds. This study aimed to test the quality (length, width, mass, and volume) of beech buds that are affected by BLD, compared to buds from trees that were not affected by BLD. This study was completed by removing twigs with buds on them from each infected and uninfected tree. They were then measured for quality and compared using four unpaired Welch's t-tests. We found that beech buds from trees infected with BLD, on average, had smaller masses, lengths, widths, and volumes, although the change in mass was the only one that was statistically significant (p-value = 0.003). This most likely occurred due to BLD's effects on each tree's leaves, reducing their ability to photosynthesize, generate energy, and use that energy to produce larger, higher-quality buds. We conclude that beech trees infected with BLD produce partially lower quality buds. In the future, more direct applications and findings can be observed if the rate and quality of beechnuts were studied, as that is more directly applicable to the environment of beech, and helps to show the longer-term implications.

QUAD CHART

Research Question

How does the presence of beech leaf disease effect bud quality?

- Beech leaf disease is largely under researched due to its recent discovery
- Reduces photosynthesis and overall tree functioning

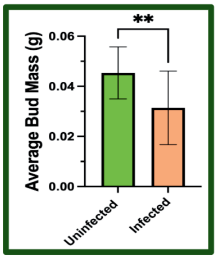


Methodology

- Collected over 400 buds from 30 different trees
  - varying disease status
- Measured mass, length width, and volume using standard methods.
- completed statistical analysis



Results



- Mass was significantly lower in infected trees
- Measures of length, width, and volume were consistently lower, though insignificant
- ¼ of hypothesis supported
- Failed to reject null hypothesis

Conclusions

- Addressed the gap in research that no one has studied the effects of beech leaf disease on buds from a quantitative macroscopic scale
- Applied standard methodology for novel research
- Bud mass significantly decreased, though all other measures of quality did not
- Did not support entire hypothesis

CHANAKYA NAYUDU

MULTIDOMAIN PATIENT-REPORTED OUTCOME IMPAIRMENT IN ADULTS WITH ANTIPHOSPHOLIPID SYNDROME USING PROMIS-29+2: AN INTERNATIONAL CROSS-SECTIONAL STUDY



AWARDS	Fourth @ WESEF; 3x Scholastic; 2x PVSA Gold; 2x publications; ISTH 202
EXTRACURRICULARS	Science research, president and founder of FAM Club, President of SAC Mount Kisco Food Pantry, firefighter, JLC @ Phelps Hospital

PROJECT ABSTRACT

Antiphospholipid syndrome (APS) Is a chronic autoimmune disorder that triggers the immune system to produce three main antibodies (lupus anticoagulant, anticardiolipin antibodies, and anti-beta-2 glycoprotein I antibodies) that attack blood cells, leading to a heightened risk of developing blood clots. Due to these burdens, patients face multiple long-term quality of life detriments often studied in isolation across prior studies. To address this gap, we used the Patient-Reported Outcomes Measurement Information System (PROMIS®) 29+2 Profile alongside APS-specific questions to evaluate nine patient-reported outcomes (PROS) simultaneously: physical function, anxiety, depression, fatigue, sleep disturbance, ability to participate in social roles and activities, pain interference, cognitive function, and illness burden. We hypothesized that APS patients will have significantly worse PROMIS scores across several domains than U.S. population standards, and that patients with a past thrombosis or pregnancy will also have greater impairments. 697 adults with self-reported APS were eligible for this study. Compared with U.S. population standards, participants demonstrated significant impairment across all domains ($p < 0.0001$), with the biggest deficits in cognitive function (mean T score of 38.2) and fatigue (mean T score of 62.3) Subgroup analyses revealed that a history of thrombosis was associated with significantly worse physical function, social participation, pain interference, and illness burden ($p < 0.05$), while pregnancy history was associated with greater fatigue, sleep disturbance, pain interference, reduced social participation, and cognitive impairment ($p < 0.05$). Overall, our results support the two hypotheses. This represents the largest APS-specific PRO cohort, and one of the first domain-level correlational analyses.

QUAD CHART

Problem & Goals

Problem: Lack of literature properly measuring quality of life in patients with Antiphospholipid syndrome (APS)

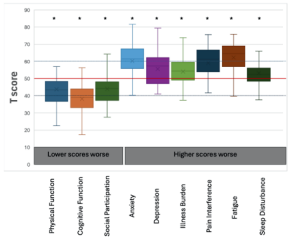
Goal: Assess psychosocial and quality-of-life burden in APS using PROMIS-29, comparing subgroups (thrombosis + pregnancy history, secondary APS)



Findings

1. Patients with APS have significantly ($p < 0.0001$) worse quality of life than the standard population.

2. Patients in certain subgroups have worse quality-of-life than their counterparts.

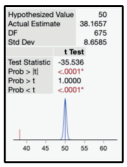


Methods

Recruitment → Administration → Analysis



PROMIS



Novelty:

First study using PROMIS-29 and largest study.

Conclusion

- Patients with APS have significantly impaired quality-of-life and patients in certain subgroups are more affected
- Supports routine PROMIS-29 screening and risk-stratified monitoring in APS care, which could save lives



ALEXIS OH



EXPLORING HOW VARIOUS HYDRAULIC RETENTION TIMES AFFECT DRIP HYDROPONICS SYSTEM'S PERFORMANCES

AWARDS	1st place in Environmental Science (Somers), NOAA Taking the Pulse of the Planet (WESEF)
EXTRACURRICULARS	YWEW, Field Hockey, Beach and Ocean Protection Club, AAPIA Club, Greenburgh Nature Center Volunteer

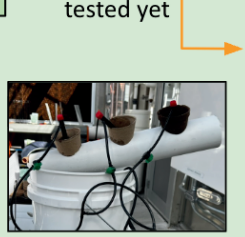
PROJECT ABSTRACT

Hydraulic retention times (HRTs) have a significant influence on hydroponics systems, but its specific impact varies depending on the length of the HRT and type of system. Thus, the conditions to optimize hydroponics systems' performances, particularly regarding HRTs, must be identified before applying it in the real-world. This study aimed to better understand this relationship and conditions to optimize a novel, smaller hydroponics system. It was hypothesized that an HRT of 9 hours and a 3 hour gap between 15-minute intervals of water pump activation are ideal for the system. To test this, a small drip-hydroponics system was built and utilized synthetic wastewater. Four of these systems were built, each testing different HRTs (1, 3, 6, and 9 hours). Electricity optimization was tested by setting the water pumps on timers (ran every 3, 6, and 12 hours). It was found that the system with an HRT of 6 hours removed the most amount of phosphate and nitrate at the fastest rate, and it led to the most plant growth. Although, the system with an HRT of 1 hour had the largest change in plant biomass. The systems with a 12, 6, and 3 hour gap led to the greatest nutrient removal, plant growth, and changes in biomass respectively. A larger variety of HRTs and gaps between pump usage intervals should be tested in the future. Although, this system has potential to be used domestically in areas where there are few adequate wastewater treatment facilities.

QUAD CHART

Research Objectives

- Poor understanding of effect of HRT and minimizing electricity on hydroponics in general
- Identify ideal conditions for system
- Novel drip-hydroponics system not tested yet





Methodology

1. Grow plants
2. Build systems (4)
3. Synthetic wastewater
4. Adjust drip emitters/timers
5. Data collection and analysis









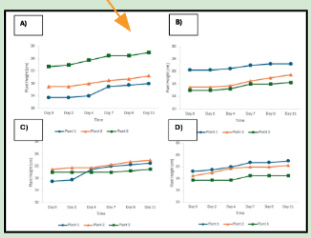


Results

Nitrate and Phosphate (Timer) | Plant Height (HRT)

	Day 2	Day 4	Day 7	Day 9	Day 11
No Timer	50	25	10	5	5
3 Hour Gap	50	50	25	10	5
6 Hour Gap	50	50	25	10	10
12 Hour Gap	50	25	25	10	5

	Day 2	Day 4	Day 7	Day 9	Day 11
No Timer	25	25	10	10	5
3 Hour Gap	25	25	25	10	10
6 Hour Gap	25	25	25	25	10
12 Hour Gap	25	25	10	10	10



Conclusions

- Initial goals/gaps addressed although ideal conditions not completely identified
- Stronger understanding of system's performance, HRT, and minimizing electricity
- System has strong potential to be applied outside of the laboratory



ADDISON PINNOW

THE HISTORICAL BASELINE AND MODERN FUNCTIONAL DIVERSITY OF BENTHIC MOLLUSKS IN PANAMA'S SEAGRASS MEADOWS



AWARDS	Teatown Young Environmentalist (WESEF), 2nd place Environmental Science (Sommers Science Fair)
EXTRACURRICULARS	Girls Varsity Ice Hockey, Greeley Growers, ASE Founder and Communication Director, CIT Save The Bay

PROJECT ABSTRACT

Seagrass environments contain high amounts of diversity. While these environments have been studied often using species-based approaches, investigating functional diversity can provide important insight into these systems' changes in trait occupation. Seagrass meadows in Panama have degraded in recent years, and have only been researched in regards to structural habitat comparison. Live-dead analysis allows comparison of living assemblages (LA) and death assemblages (DA) of communities to gain insight into how functional diversity has changed in seagrass meadows over time. From this comparison, it is expected that functional and taxonomic diversity in the LA of seagrass will be higher in comparison to the LA of sand habitats; and, the DA in seagrass most accurately represents the LA of seagrass due to higher fidelity. In contrast, the LA in sand will be different when compared to the DA, with lower fidelity present. Samples were collected by the mentor in the Caribbean along Panama's coast across six different sites. The mollusks were identified to the lowest level of identification possible before traits (substrate, feeding and fixation) were assigned to each taxon. Our studies confirmed that seagrass meadows are similar taxonomically and functionally diverse in comparison to sand. We determined that both sand and seagrass have low fidelity between the DA and LA with respect to functional diversity. Monitoring the functional diversity of benthic mollusks continues to leave a lasting impact on seagrass and sand environments because of observed changes in the LA and DA, which may have been affected by recent human activity.

QUAD CHART

INTRODUCTION

- Productive biodiverse ecosystem (Wolfenbarger et al., 2004)
  - Contains benthic mollusks

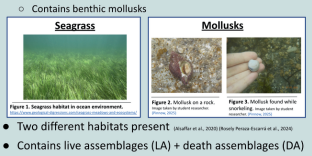


Figure 1. Seagrass habitat in ocean environment. Image taken by student researcher. (Pinnow, 2025)

Figure 2. Mollusk on a rock. Image taken by student researcher. (Pinnow, 2025)

Figure 3. Mollusk found while snorkeling. Image taken by student researcher. (Pinnow, 2025)

- Two different habitats present (Mcaffer et al., 2020) (Rosely Peroza Escarsi et al., 2024)
- Contains live assemblages (LA) + death assemblages (DA)
  - → preserves functional traits (Tyler & Kowalewski, 2025)



Figure 4. LA and DA cartoon images of benthic mollusks. Image generated by student researcher. (Pinnow, 2025)

Figure 5. Photo contains gastropods unattached and mobile. Image taken by student researcher. (Pinnow, 2025)

Figure 6. Cartoon displaying infaunal and epifaunal mollusks with different trophic guilds. https://www.researchgate.net/figure/Trophic-guilds-of-benthic-macrofauna_fig1_267944240

- Previous research monitored either seagrass or sand
- FD or species based approach
- Seagrass (Rosely Peroza Escarsi et al., 2024; Hauser et al., 2007; Bostrom et al., 2006)
- Seagrass + sand (Gaspie & Seitz., 2017; Hyman et al., 2019)

Lack of research on benthic mollusks in Panama's seagrass meadows



Figure 9. Map of world cropped to visualize where FD and species diversity has been analyzed among either seagrass meadows and/or sand habitats. Image generated by student researcher using canva. (Pinnow, 2025) https://www.freepnglogos.com/pngs/globe/

1) Compare the LA of seagrass and sand habitats
2) Evaluate fidelity in seagrass and sand habitats by comparing the LA and DA
   a) Comparing fidelity in both habitats + analyzing how well the DA represents the LA

→

1) The functional and taxonomic diversity in the LA of seagrass would be higher in comparison to the LA of sand habitats. (Hyman et al., 2019; Tyler & Kowalewski, 2025)
2) The functional diversity of the DA in seagrass would most accurately represent the LA of seagrass due to higher fidelity. On the contrary, the LA in sand would be different when compared to the DA, with a lower fidelity present. (Hyman et al., 2019; Costello et al., 2011; Tyler & Kowalewski, 2025; Gaspie & Seitz, 2017).

RESULTS

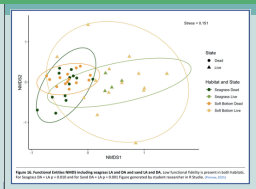


Figure 16. Functional Entities (FEs) metric including seagrass LA and DA and sand LA and DA. Low functional fidelity is present in both habitats. For Seagrass DA + LA: $t = 0.616$ and for Sand DA + LA: $p < 0.001$. Figure generated by student researcher in R Studio. (Pinnow, 2025)

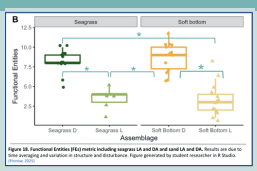


Figure 18. Functional Entities (FEs) metric including seagrass LA and DA and sand LA and DA. Results are due to time averaging and variation in structure and disturbance. Figure generated by student researcher in R Studio. (Pinnow, 2025)

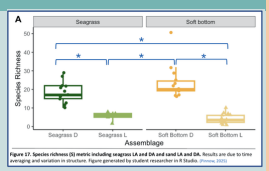


Figure 17. Species richness (S) metric including seagrass LA and DA and sand LA and DA. Results are due to time averaging and variation in structure. Figure generated by student researcher in R Studio. (Pinnow, 2025)

- Seagrass → low functional fidelity → **Hypothesis #2 refuted**
  - Different results observed by (Tyler & Kowalewski, 2025)
- Sand → low functional fidelity → **Hypothesis #2 supported**

Hypothesis #2 is refuted → low fidelity present in both → higher fidelity was anticipated in seagrass in comparison to sand

- **Similar functional richness** among Seagrass LA + Sand LA → **Hypothesis #1 partially refuted**
- **Seagrass LA S > Sand LA S** (Hyman et al., 2019) → **Hypothesis #1 partially supported**

Similar functional richness in seagrass + sand and Seagrass has greater species diversity than sand → Hypothesis #1 is partially supported

METHODS

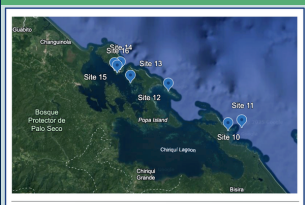


Figure 10. Map showing sites 10-16 for data collection in Panama. Map generated in Google Earth by student researcher. (Pinnow, 2025)

- Samples collected by mentor → Panamanian coast
- 27 samples collected across 6 sites in Caribbean Sea
- Collected LA or DA in sand or seagrass habitats

- Online databases primarily used →
  - No information literature used
- 461 taxa identified + assigned
  - Greater than family level not used during analysis
  - Some traits inferred based upon family or genus level
  - Fixation not available → MO species classified as UN

Table 3. List of different trophic guilds occupied by mollusks. Abbreviation, trait, and description provided from left to right. Table generated by student researcher in Google Slides. (Pinnow, 2025)

Abbreviation	Trait	Description
IN	Infaunal/Semi-Infaunal	Benthic species that live below sediment.
EP	Epifaunal	Benthic species living above/on top of sediment.
MO	Motile	Species that are able to move around.
IM	Immobile	Species that are not able to move.
UN	Unattached	Free moving species that are not attached to anything.
AT	Attached	Species attached either byssally or cemented.
SU	Suspension Feeder	A way of feeding in which the animal filters through water.
DE	Deposit Feeder	A variation of filter feeding through sediment.
HE	Herbivore	An animal that consumes plants for energy.
CAR	Carnivore	Consuming other living specimens for energy.
OM	Omnivore	Consumption of other living species and plants (this includes mollusks that feed both as a HE and a CAR).
PAR	Parasitic	A parasite attaches onto its host and feeds upon it or its resources.
SU DE	Suspension Deposit Feeder	An animal that filters feeds through water and sediment in order to get energy.
HE-DE	Herbivore Deposit Feeder	Filtering through sediment for food and an animal that is also capable of eating plants.

Esu, Madeline P., et al. (2026). The Effects of the Richmondian Invasion on Benthic Invertebrate Functional Diversity during the Late Ordovician." *Frontiers in Ecology and Evolution*, vol. 13, 29. https://doi.org/10.3389/fevo.2025.1706877.

CONCLUSION

Applications

- **Updated timeline** of functional diversity analysis in seagrass
- Insights into functional traits + ecosystem functioning
- Monitor **influence of stressors** on benthic ecosystems
  - **Changes in niche occupation** from stressors

Future Research

- **Date taxa** + have accurate **timeline for stressors**
  - **Pinpoint** places + specific stressors
- Continue to **monitor FD of benthic mollusks** in seagrass meadows + other **structured** habitats
  - Kelp forests + eel grass in New England

Major Findings

- Similar functional richness in sand + seagrass
- Seagrass has greater species richness than sand
  - Partially supports hypothesis #1
- Seagrass + sand both contain low fidelity
  - Refutes hypothesis #2



Figure 17. Image of different mollusks with different traits and roles in an ecosystem. https://mayanhbino.jimdofree.com/biology-and-geology-1st-eso/a-8-los-animales-invertebrados/b-moluscos/



Figure 7. Mass mortalities of benthic organisms due to hypoxic conditions worldwide. https://www.researchgate.net/publication/280139688_Soft-sediment_communities

RYAN RAMIREZ



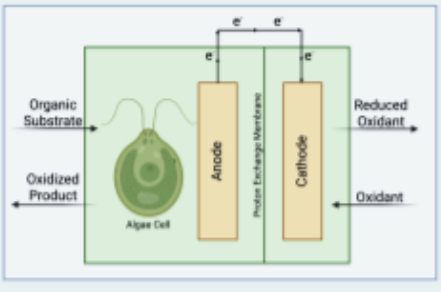
OBSERVING DIFFERENTIALLY EXPRESSED GENES OF FUEL CELL RELEVANT PATHWAYS IN ALGAE TO IDENTIFY THE OPTIMAL STRAIN FOR MICROBIAL FUEL CELL PRODUCTION

AWARDS	1st in Bioinformatics at Somers, 4th in Bioinformatics at WESEF
EXTRACURRICULARS	Varsity Track, president of OLAS club

PROJECT ABSTRACT

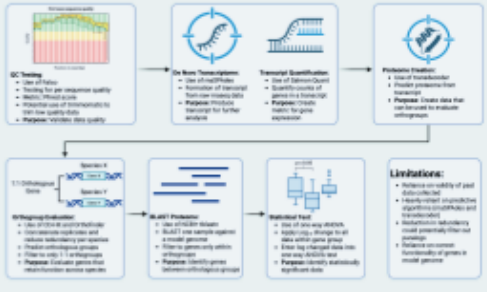
Algae can be used to produce alternative fuel, particularly in the form of microbial fuel cells, also known as MFC's, a sort of biological battery. Bioinformatics has been readily used to study biological processes of plants, like algae. Using bioinformatics to study algae as it pertains to MFC's grows ever more important as society requires more renewable fuel. Our understanding of genes in how they relate to algae MFC production remains limited. This study aims to fill this gap and learn more through transcriptomic analysis. We applied a de novo transcriptomic analysis of previously sequenced transcripts of various algae strains along with orthologous gene groups to evaluate differentiation in gene expression between strains. Overall, 5 genes that were expressed in all strains were examined based on TPM calculated. These genes code for proteins directly involved in processes of electron transport. The one-way ANOVA revealed that 4 of the 5 genes had statistically significant differences between groups due to the fact their p-values were less than the threshold $p<0.05$. Out of the 4 statistically significant genes, 2 were most highly expressed by Chlorella Sorkiniana, more than any of the other strains tested. We conclude that Chlorella Sorkiniana should be the most effective in transferring electricity. This can be used to create more effective MFCs which provide sustainable energy for a growing society.

QUAD CHART

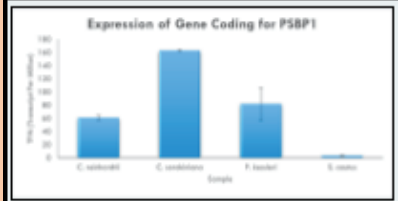


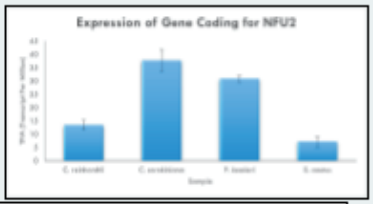
Microbial Fuel Cells (MFCs): Cells of bacteria or algae that degrade waste through metabolic processes

Bioinformatics = New way to study genetic data [9] Involves genes, transcripts and proteins



Criteria For Selection:
- 4 articles collected
- Similar growth conditions
- Algae strain tested is the independent variable
- Compare control groups
- 2 replicates needed per species





The hypothesis was supported since one strain, Chlorella sorokiniana, can be posed as the most effective MFC producer due to difference in gene expression observed between a group of algae strains.



- Alternative fuel (microbial fuel cell) energy is incredibly necessary for maintaining the environment
- Differential gene expression offers insight into different characteristics of algae strains
- Limited to specific genes rather than whole genome
- Chlorella Sorokiniana is the best candidate for MFC production
- Further research needed to validate claims regarding gene expression

SAKET REDDYJARUGU

IMMUNOHISTOCHEMISTRY ASSAY DEVELOPMENT AND DEPLOYMENT: PROTEIN X REAGENT ANALYSIS AND VALIDATION



AWARDS

3rd Place Cell and Molecular Biology at WESEF, 2nd Place in Medience and Health Somers

EXTRACURRICULARS

Chappaqua EMS Youth Corp EMT (NYS and Nationally Certifed EMT), Debate Captain (NYPDL), Student Researcher (Regeneron), Science Olympiad, LD Debater (2x Qualifed to NSDA Nats)

PROJECT ABSTRACT

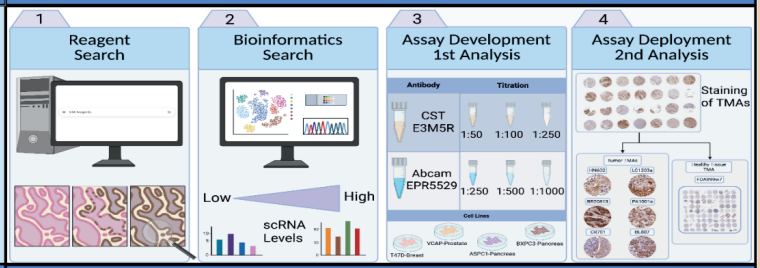
5T4, or Trophoblast Glycoprotein, is a transmembrane oncofetal antigen associated with epithelial-to-mesenchymal transition and cancer metastasis. It represents an important prognostic marker and therapeutic target. Since 2014, the research which uses IHC for detecting 5T4, uses the industry standard Abcam EPR5529 antibody clone. Since this clone is very prevalent in this field, different reagents are not tested, thus better reagents could slip through the cracks because scientists do not want to validate a new reagent. This study described the lack of characterization of the Cell Signaling Technologies (CST) E3M5R antibody clone and determined its efficacy relative to the standard Abcam Antibody. By producing IHC assays, the two antibodies can be compared, and the best one can be validated over a variety of tissues on a tissue microarray. For the results, the CST E3M5R clone showed more intense staining as well as more specificity compared to the Abcam EPR5529 clone, which exhibited off-tumor staining as well as less intense staining. The E3M5R assay was able to easily detect 5T4 expression over a variety of tumor cells; notably, it was able to detect 5T4 on Triple Negative Breast Cancer (TNBC) tumors with high specificity. However, contrary to expectations, 5T4 had an unexpectedly high expression level in normal tissue. Regardless, the study validated the CST E3M5R clone as a more robust and accurate tool for 5T4 IHC analysis than the current industry standard. While the high staining in normal tissue may require future research, the increased sensitivity of the assay suggests significant potential to improve the diagnostic accuracy of clinical tests as well as a way to focus on certain clinical trials for 5T4 targeted treatments, especially in TNBC patients.

QUAD CHART

Intro

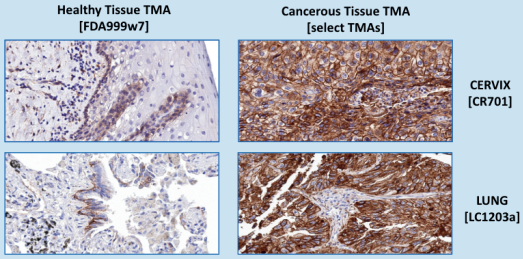
- **Rationale**: Cancer is a **globally leading** cause of death, just behind cardiovascular disease, with **18.5 million** deaths globally
  - 5T4 is expressed on lots of cancers, which makes it a good antigen to target for diagnostic purposes or for immunotherapy
- **Research Question:** Is there a way to improve cancer detection tools to **improve** diagnosis and clinical trials selection?
  - Trying to improve IHC reagents for 5T4 by choosing the one the reagent best expresses specific and intense staining on the tumors

Methodology



Results

- CST (E3M5R) proved most effective out of all reagents
- CST stained cancerous tissues with strong specificity and intensity
- Off tumor staining was faintly present



Conclusion

Application:

- This **CST antibody** can be used for **detecting cancers** in people with IHC better than current practices, **improving patient outcomes and treatment.**
- 5T4 staining could help **identify a subgroup** of patients who test positive for 5T4 in TNBC, for future clinical trials involving 5T4-based therapeutics.

Future Research:

- A **long term goal** would be using the reagent on archived patient samples with known outcomes to determine whether a **trend** is present with the E3M5R antibody.

OLIVIA REGAN



IMPROVING VEGETATIVE BUFFERS WITH COMFREY: INTRODUCING SYMPHYTUM × UPLANDICUM ‘BOCKING 14’ INTO A CONTROLLED MEADOW BUFFER SYSTEM FOR NUTRIENT RUNOFF MITIGATION

AWARDS	Rising Scholars Award (WESEF), 2nd place (Somers)
EXTRACURRICULARS	Science Olympiad, Horace Greeley Invitational, Sustainability Club, Greeley Quill, Tutoring

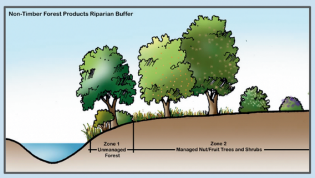
PROJECT ABSTRACT

Vegetative buffers are an effective and sustainable avenue to reducing the harmful effects of soil pollution. However, important factors like plant community composition remain unemphasized and underresearched. *Symphytum* × *uplandicum* ‘Bocking 14’ (comfrey) is a strong accumulator, possessing unique absorptive properties, and its introduction could improve vegetative buffers. It was hypothesized that due to comfrey’s unique nutrient absorptive properties, the introduction of comfrey into a native plant plot would improve the buffer’s absorption, diversity, and biomass. To test this, plants and soil were collected from a local meadow vegetative buffer, and separated into three plots: a soil plot, a native plant plot, and a native plant plot with introduced comfrey. An automatic watering system was constructed to recycle the infiltrated water, and data on the nutrient content, biomass, and plant community of the plots were collected. No significant differences were observed between the plots for the hardness levels, phosphate, or pH, but the comfrey showed the greatest decrease in conductivity and nitrate levels, partially supporting the hypothesis. The comfrey plot absorbed more water, had the greatest species richness, and had the significantly greater total biomass (p-value of 0.002), supporting the hypothesis around water, species diversity, and plant growth. This research could help improve New York vegetative meadow buffers by utilizing the introduction of comfrey to reduce nutrient runoff and nonpoint source pollution easily and effectively.

QUAD CHART

Introduction

- Vegetative buffers could absorb excess nutrients in water runoff

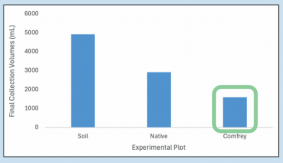


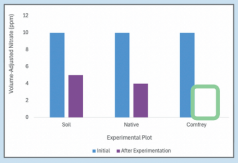
- *Symphytum* × *uplandicum* ‘Bocking 14’ plant
  - Also known as comfrey
  - Strong accumulator of nutrients with an extensive root system
- Analyzed whether comfrey could improve naturally occurring vegetative buffers

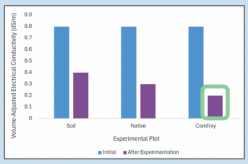


Results

- Comfrey plot absorbed significantly more water, nitrate, and overall nutrients
- Significantly more overall biomass (p-value of 0.002)
- No significant change in native plant biomass



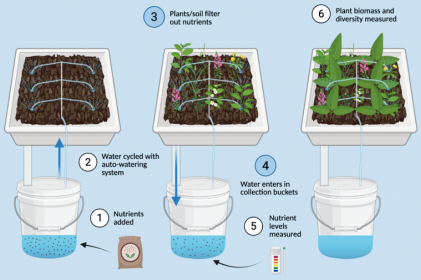




Methodology

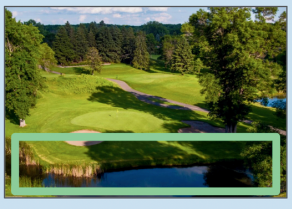
- Novel closed-loop hydroponics-like system to recycle nutrient-rich water and quantify nutrient absorption





Conclusion

- Comfrey is an effective, easy to introduce, and low-maintenance strategy to reduce nutrient runoff and pollution
- Particularly for preventing major ecosystem disasters (ex. eutrophication in aquatic environments) due to runoff



Nutrient runoff & eutrophication



GEORGE ROJEK

IN SILICO OPTIMIZATION OF POSTBIOTIC-LOADED NANOPARTICLE DELIVERY SYSTEMS FOR INFLAMMATORY BOWEL DISEASE THERAPY



AWARDS	NYSSEF 3rd Place, Somer's 1st place, Tricounty 2nd place
EXTRACURRICULARS	Swimming, Lifeguarding, Phelps Hospital Volunteering, Science Olympiad, Geoguessr Club Founder

PROJECT ABSTRACT

Inflammatory Bowel Disease (IBD) is a group of chronic gastrointestinal tract conditions with no effective cure. Current treatments struggle with bioavailability, toxicity, and a lack of targeted delivery. Currently, nanotechnology-assisted microbiotic-derived therapeutic formulations for oral delivery remain largely unresolved. A Solid Lipid Nanoparticle (SLN) system, optimized in silico with docking study and molecular dynamics (MD) simulations to pair the payload with lipid matrices, can overcome limitations in probiotic-derived agent delivery for IBD treatment. A docking study was used to screen solid lipids for binding affinity with the postbiotic IPA. A novel hybrid vacuum/water MD simulations workflow in GROMACS was developed to model hot lipid mixing, emulsification, and cooling/solidification and to assess stability, drug localization, and drug loading. In the docking study, indole-3-propionic acid (IPA) showed the strongest interactions with trimyristin (solid lipid), forming stable lipid-payload associations. MD simulations showed stable droplets with low drug expulsion and sustained molecular mixing during cooling. Different loading proportions were analyzed, and a limit on drug loading was suggested based on radial distribution function calculations and on molecule counts. The simulations suggest that the drug loading ratio for the selected combination of a postbiotic and a solid lipid can reach up to 14%. This compares favorably with 10% w/w drug loading reported in literature for similar SLN formulations and opens a promising path for nanomedicine development, future in vitro and in vivo validation, and potentially IBD treatment.

QUAD CHART

In Silico Optimization of Postbiotic-Loaded Nanoparticle Delivery Systems for Inflammatory Bowel Disease Therapy

Problem

1. Microbial agents are hindered by **low bioavailability**
2. Lipid–payload pairing in nanosystems is currently through **iterative experimental testing** → lengthy and costly

Goals

1. Identify a postbiotic payload and compatible solid lipid for SLN delivery
2. Use docking and molecular dynamics to model production-relevant formulation steps, guiding nanosystem design

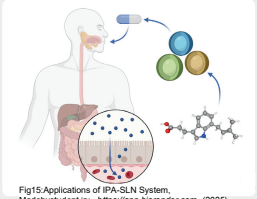


Fig15:Applications of IPA-SLN System, Madebystudent in: https://app.biorender.com (2025)

Postbiotic Decision

Indole-3-propionic acid

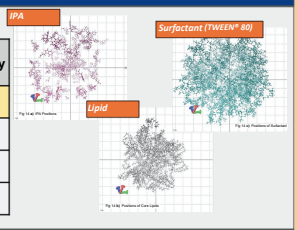
$C_{11}H_{11}NO_2$

- Chemically well-defined
- **Anti-inflammatory and barrier-protective** effects
- Postbiotic of **≥ 4 probiotics**

BindingAffinity

Lipid	CID	Binding energy
Trimyristin	11148	-4.76
Tripalmitin	11147	-4.71
Compritol	536258	-3.71
Stearic	5	-3.57

5281



1. **Payload** — Probiotics → Postbiotics
2. **Lipid Selection** — Data Preparation Steps
3. **Docking Studies** — Technical Steps
4. **Molecular Dynamics** — Simulation Steps
5. **Data Analysis** — Qualities of Interest

Checked:

- Structural stability
- Molecular mobility
- Spatial distribution

Predicted:

- Loading estimation
- Bounding estimation
- Structure prediction

GROMACS, visualized

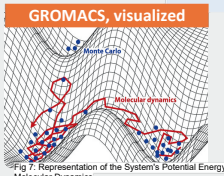


Fig 7: Representation of the System's Potential Energy Surface with Molecular Dynamics

Main Findings

- Predicted ≈14% loading is promising
- **First** in silico-driven postbiotic SLN MD simulation
- Major formulation decisions made **before laboratory work**

Applications

- **Expandable** to different APIs
- Novel workflow applicable to therapeutic areas **beyond IBD**
- **Accelerates** nanocarrier formulation decision-making → reducing cost and time

Future Research

- Expand simulation: include ionization energies
- Validate via **in-vitro** fabrication: system size, entrapment efficiency, particle decay

Long-Term Vision:

*Establish in silico modeling as a **standard pre-formulation step** in all nanomedicine development.*

CLARA SAMUELSON



PREDICTING AD CONVERSION OF MCI APOE4+ SUBJECTS THROUGH LONGITUDINAL ANALYSIS OF BRAIN VOLUME LEVELS OVER TIME

EXTRACURRICULARS Violin/chamber orchestra, art, skiing, camp counseling

PROJECT ABSTRACT

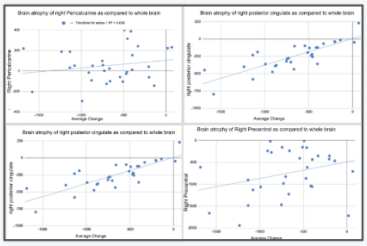
Alzheimer's disease (AD) is a common neurodegenerative disorder that affects millions of people worldwide. In the preclinical stage of AD, or the stage of disease development leading up to symptoms, the rate of brain atrophy and amyloid plaque levels are higher than cognitively normal (CN) patients. The APOE4 allele is strongly associated with AD risk, and despite recognizing APOE4+ as a risk factor, it is difficult to assess whether or not an APOE4 carrier will go on to develop AD. We aim to identify early signs of AD development within four years from baseline in the form of biological markers- plaque burden and brain atrophy- by comparing MCI (Mild Cognitive Impairment) APOE4+ subjects who stay at a diagnosis of MCI and AD converters. All data was obtained from Alzheimer's Disease Neuroimaging Initiative (ADNI). Brain volume was measured with Longitudinal FreeSurfer 5.1 by ADNI. A mixed-linear effects model was used to measure the rate of atrophy in one year from baseline to compare both the rates of atrophy between the two groups and plaque burden at baseline. We found

QUAD CHART

Background, Goal and Hypothesis

- **Alzheimer's disease (AD)**- most **common neurodegenerative disorder**
- It develops over **1-2 decades before symptoms** emerge →**genetics can increase risk** and rate of development during this time→ **APOE4** gene one such factor
- **Goal:** determining if **brain atrophy rates** are an **indicator** that someone with APOE4 is developing **AD**
- **Hypothesis: AD converters** will have higher rates of brain atrophy in years leading up to conversion than non converters

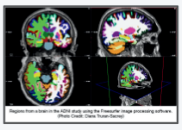
Results



- Correlation of Average Change to diagnostic group **p<.0001**
- **Correlation of different brain area brain atrophy rates to Average Change**

Methodology

- All data obtained from the **Alzheimer's Disease Neuroimaging Initiative (ADNI)**
- Two groups: **AD converters** and **MCI stable** patients
- **Brain volume measured annually for each patient over four years**

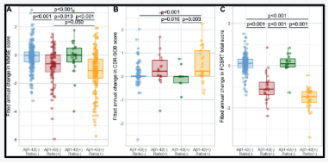


- MRIs analyzed with **FreeSurfer**
- Code sourced from **Stackshare**
- Analyzed using Mixed Linear Effects Model

```
md = smf.mixedlm("AVERAGE_CHANGE/(SPECIFICAREA) ~
DIAGNOSIS/AVERAGE_CHANGE", df2, groups=df2["RID"])
mdf = md.fit(method=["lbfgs"])
print(mdf.summary())
```

Discussion/Conclusion

- **Hypothesis supported**
- **Future studies** ---> Limited data on preclinical phase, conduct with more data in future
  - larger sample size with a higher power study
  - Data gathered over longer period of time to predict even further in advance



SRIHAAN SEELAM

CORAI: GLOBAL CORAL BLEACHING PREDICTION USING REGION-SPECIFIC ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING MODELS

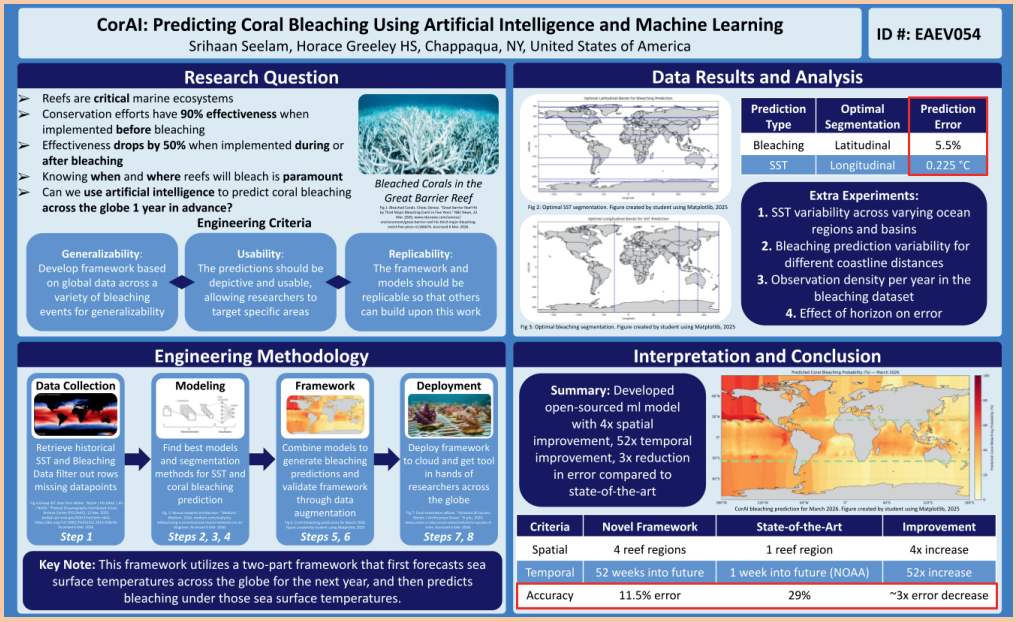


AWARDS	WESEF 1st place, 2nd place, Best in Fair (1/800), NYSSEF 1st, NASA Earth Science Award, 2x ISEF, ISEF 3rd in catagory
EXTRACURRICULARS	Research, Teach CS classes to students in India (over 3000 taught)

PROJECT ABSTRACT

Coral reefs are the world's most vital marine ecosystems, producing 50% of the world's oxygen and sustaining the livelihoods of 1 billion people globally. However, coral bleaching, a phenomenon stemming from global warming, has killed 50% of the world's reefs, with an estimated 90% to be dead by 2050, threatening the lives of billions globally. Advancing the forecasting capabilities of bleaching predictors is crucial for providing researchers with early warning systems to assemble necessary resources, plan field logistics, design sample protocols, and develop adaptive conservation plans. Moreover, applying for and receiving permits to implement conservation efforts often takes over six months. However, early warning models only predict bleaching events under current conditions and in a small region, severely limiting their utility. This study experimented with three neural networks for 12-month sea surface temperature forecasting and tested 14 regression models for predicting bleaching under sea surface temperature. Future predictions are generated by predicting the conditions in the coral reef (SST error of 0.14 degrees Celsius) for the next 12 months and subsequently predicting the percentage of the reef that will bleach under those conditions (error of 6%). When validated using data augmentation, the tool forecasted bleaching 1 year in advance (52x temporal improvement over existing models) across the globe (4x spatial improvement) with an absolute error of just 11%, a 3x improvement over the current state-of-the-art. Thus, this study developed a novel coral bleaching prediction mechanism that can predict reef-scale coral bleaching globally up to a year in advance, enabling proactive, targeted conservation efforts and enhancing reef survival rates. In the future, the study aims to validate the framework on bleaching data from the Australian Institute of Marine Science (AIMS) and aims to integrate the framework as a part of AIMS's coral conservation framework in the coming years.

QUAD CHART







NICHOLAS SERINI



STUDENT PERCEPTIONS OF THE NEW YORK STATE CELLPHONE BAN: IMPACTS ON PROCRASTINATION, SOCIAL MEDIA, AND ACADEMIC BEHAVIOR

EXTRACURRICULARS

Varsity Track and Field Indoor and Outdoor, Peer to Peer Tutor, Mathnasium tutoring, Science Greeley

PROJECT ABSTRACT

Procrastination affects areas such as mental health and social media use. In 2025, New York State introduced a cellphone ban in K-12 schools to reduce procrastination and excessive social media use. However, no research has examined the effectiveness of this ban, students' perceptions, or how these perceptions relate to procrastination. This study used established psychological surveys to measure procrastination and social media use, also using a newly developed questionnaire assessing perceptions of the New York State ban. This allowed us to measure levels of procrastination, social media usage, and policy perception, which could then be correlated. We found that daily social media use was positively correlated with procrastination ($r = 0.3846$, $p < 0.0001$) and problematic social media use ($r = 0.2763$, $p < 0.01$). Mean procrastination scores differed significantly across perception groups (one-way ANOVA, $p<0.0001$), with students who viewed the ban negatively scoring on average 0.7 points higher on the Pure Procrastinations Scale than those with positive perceptions. Problematic social media use was also associated with a more negative perception of the ban ($r = -0.3223$, $p < 0.01$). Additionally, high phone pickup and notification frequencies were linked to significantly higher procrastination scores (ANOVAs, $p < 0.0001$ and $p < 0.001$, respectively). These results suggest that policy perception influences self-regulation in academic settings. The findings suggest associations consistent with the ban's effectiveness in the participating high school and may help schools across New York reconsider its implementation.

QUAD CHART

Research Question

- How do high school students perceive the New York State cell phone ban, and how are these perceptions related to self-reported levels of procrastination and social media use?



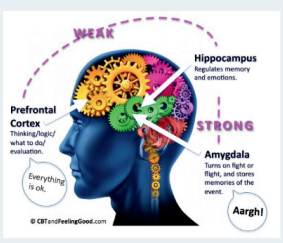
Methodology



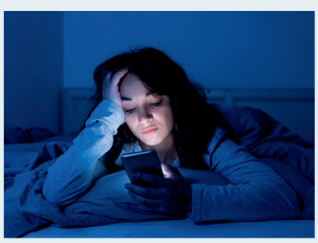
- Created a novel survey, assessing perceptions of the ban, social media use, procrastination levels, and amount of pickups, and notifications.

Results

- Strong correlations between negative perceptions and more procrastination, more social media usage, and more pickup and notifications. All hypotheses were supported.



Conclusions



- Ban is ineffective because it is shifting social media usage to outside of school. More research is needed on the ban before and after it's put in place.

PRIYANKA TALLA

DEFINING THE ROLE OF HORIZONTAL INTRACORTICAL NEURONS IN FUNCTIONAL RECOVERY AFTER SPINAL CORD INJURY USING A NOVEL KINEMATIC DEVIATION INDEX



AWARDS	WESEF: 2nd Place in Neuroscience Category. Somers: 1st Place in Medicine & Health Category. Tricounty Science Congress alternate
EXTRACURRICULARS	Varsity Tennis, Chamber Orchestra, Biology Club, Science Greeley

PROJECT ABSTRACT

Spinal cord injury (SCI) is a form of acute neurological damage affecting over 15 million people worldwide. Restoring fine motor skills of the arm and hand is a top priority for individuals living with tetraplegia from SCI. Limited clinical interventions currently exist for restoring hand and arm function, thereby necessitating research into the mechanisms that can support functional recovery and improve clinical outcomes. Studies in animal models have demonstrated that rehabilitation on skilled forelimb behavioral tasks results in plastic changes within the motor cortex, as areas originally devoted to hindlimb movements play new roles aiding in forelimb control. However, the mechanism of this intracortical reorganization is unclear. We propose that intracortical neurons spanning between the forelimb and hindlimb motor cortices facilitate this process, hypothesizing that optogenetically silencing them would impair the performance of motor skills regained during rehabilitation. To assess qualitative movement changes, we applied a novel Kinematic Deviation Index (KDI) approach that uses AI-marked spatiotemporal coordinates in forelimb movement recordings during the single-pellet reaching task, in order to comprehensively analyze trajectory deviations from healthy movement patterns. We found that silencing the existing intracortical circuits disrupted movements in intact animals, but that the original intracortical circuits played a less prominent role in forelimb movements after rehabilitation. This indicates that neuroplastic mechanisms may be re-shaping the intracortical circuits required for coordinating skilled movement. Our findings on intracortical circuit plasticity and establishment of the KDI as a reliable analytic tool are important steps towards more robust SCI research and optimized rehabilitation therapies.

QUAD CHART

Background, Research Gaps, and Goals

Background:

- Spinal Cord Injury (SCI) affects >15 million people
- Top patient priority: recovery of skilled hand, arm function
- Re-purposing of neurons facilitates forelimb functional recovery
  - **Gap:** Mechanism of re-assignment is unknown.
  - Horizontal Projection Neurons (HPNs) are a potential mechanism
- **Gap:** Standard techniques for movement assessment capture insufficient data

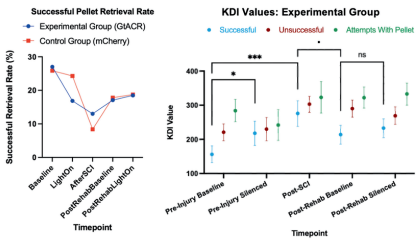


Goals:

→ **Determine role of HPNs in functional recovery by silencing their activity and assessing changes in movement quality.**

→ **Apply and refine a novel method to assess detailed movement trajectory.**

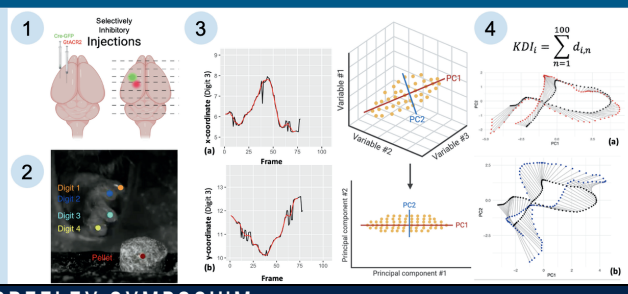
Results



- Success rate declined after injury, improved after rehabilitation
- KDI values varied significantly across timepoints
- Timepoint effect was dependent on reach type
- **Silencing HPNs significantly impaired pre-injury performance, had more limited effects post-rehabilitation**

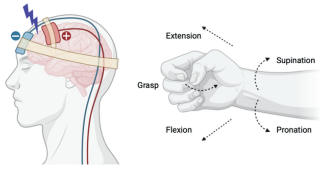
Methodology

1. Silence HPN activity
2. Extract coordinates
3. Clean, process data
4. Compute trajectory deviation value (KDI)



Interpretation and Conclusions

- Role of **existing HPNs became less prominent** following rehabilitation, suggesting **rehabilitation-mediated shift in the intracortical circuitry** controlling skilled forelimb function
- Null hypothesis was not rejected
- KDI captured subject-specific changes in movement quality, was receptive to treatment/modulation



Applications and future research:

- Neuromodulation to enhance rehabilitation
- Further analysis of trajectory

CONNIE TAO



EVALUATING THE PEDAGOGICAL EFFICACY OF AI TUTORING CHATBOTS: A STUDY ON HIGH SCHOOL STUDENT LEARNING AND ENGAGEMENT

AWARDS	Somers Science Fair 1st Place (Behavioral Science), WESEF 3rd Place (Behavioral Science), Dr. Sun Student Science Award 2nd Prize
EXTRACURRICULARS	Volleyball, Chinese Club, GNT - Media, interview video platform, web-app development, Chappaqua Library media designer

PROJECT ABSTRACT

Artificial intelligence unlocks new opportunities to provide low-cost and scalable tutoring that can dynamically adapt guidance based on individual needs and learning gaps. Previous studies on AI tutors are mostly conducted in higher education settings. This study evaluated the impact of a personalized AI tutoring tool on high-school students' learning, using a custom-designed AI tutoring tool featuring targeted practice questions, step-by-step guidance, real-time feedback, constant encouragement, and avoidance of direct answers. Eighty high school students interacted with this AI tool in 15-minute to 1-hour tutoring sessions on their selected subject areas, and completed pre- and post-surveys. Their interactions with the AI tutor, as well as their self-reported knowledge and interest gain after the tutoring session were collected and analyzed. Sizable learning benefits were reported by student participants: 75% of students reported improved understanding, 34% reported increased interest, and 71% expressed interest in using similar tools in the future. Students attributed the tool's effectiveness to detailed explanations, adaptive guidance, and targeted practice, suggesting that intentional design choices can enhance AI tutoring effectiveness. Overall, this study suggests that accessible, low-cost, and adaptive AI tutors have the potential to boost high-school students' self learning, provide personalized guidance, hence reducing educational resource imbalances amongst students.

QUAD CHART

Research Goal

Evaluate the learning impact and perceived effectiveness of a purposefully designed AI tutoring chatbot for high school students



- Limited access to affordable, personalized tutoring
- Potential of well-designed AI tutors to reduce resource gaps
- Identification of effective design features for AI learning tools
- Support for responsible AI adoption in secondary education

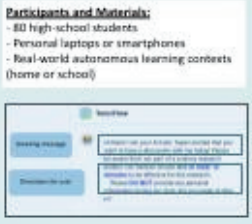
Data Analysis/Results

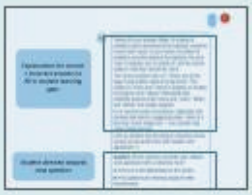


Methodology

TutorFlow:
- Self-designed AI tutoring chatbot using Google Gemini (2.5 Flash)
- **Pre-Assessment:** 5-question knowledge baseline in selected subject
- **Chatbot Tutor:** One-on-one adaptive chatbot tutoring, personalized questioning and feedback
- **Post-Assessment:** 5-question learning check

Participants and Materials:
- 80 high-school students
- Personal laptops or smartphones
- Real-world autonomous learning contexts (home or school)





Discussion/Conclusion

- Positive perceived learning gains from GenAI tutors
  - Strong role of engagement-focused, personalized design
- Support across grade levels and initial interest levels
- Maintenance or growth of student interest
- AI as learning enhancer, not teacher replacement
- Importance of intentional, ethical tutor design



AADHYA VIJIL

MOL-DETOX: REDUCING ANIMAL TESTING THROUGH AI-POWERED TOXICITY PREDICTION AND MOLECULE OPTIMIZATION



AWARDS	3rd place at NYSSEF, 2nd place at WESEF, Genius Olympiad, 1st place at Somers
EXTRACURRICULARS	MKVAC, WiSTEM, Chemistry Club, Biotech Club, GWYOA

PROJECT ABSTRACT

Each year, more than 110 million animals are killed in the U.S. for experimental purposes. Though animal testing has historically been a crucial tool for evaluating drug safety, it is often a poor predictor of human toxicity, allowing harmful drugs to advance, while rejecting some safe ones. Currently, toxicity prediction models are limited due to their inability to suggest alternative non-toxic molecules. This research proposes Mol-Detox, a novel framework to redesign toxic molecules into non-toxic alternatives, while still maintaining structural similarity and biological function. Random forest models were trained to predict the toxicity of compounds across 17 endpoints. Fifty known toxic molecules from the Therapeutic Data Commons were chosen for detoxification, with an additional condition of preserving similarity to the original molecules. The geometric mean of predicted non-toxic probability and similarity between the optimized and original molecules was used as a fitness function, with a query budget of 10000 calls. Across 17 endpoints, the majority of molecules were detoxified with a success rate of >70% where toxicity probability was reduced by 0.5-0.7 and average similarity was around 0.6. Then 27 active molecules for GSK3β and JNK3, with predicted liver toxicity, were selected for detoxification. Mol-Detox successfully detoxified 9 out of 27 molecules for GSK3β and 7 out of 27 molecules for JNK3, while still maintaining activity to the targets and a Tanimoto similarity of 0.6. Mol-Detox can significantly reduce the need for animal testing, while improving efficiency and lowering drug development costs.

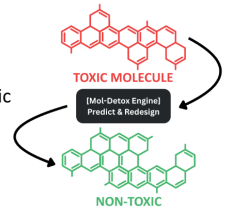
QUAD CHART

Research Gap & Goal

- **110 million animals** killed in U.S. laboratories for animal testing **yearly** (Diaz and Dunn, 2024)
- Many effective drugs cannot be used because of molecule toxicity (Lesuisse et al., 2010)



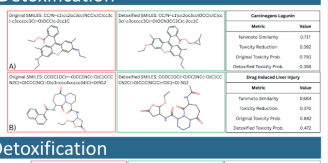
- No guidance on how to modify the molecule if found to be toxic
  → **limited** practical **applicability** & **increased costs**
- Goal: Use toxicity-guided optimization to **redesign harmful molecules** into safer compounds while maintaining **function**



Results

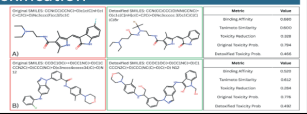
Task 1: Similarity Constrained Detoxification

- **>70% success rate:** detoxifications across most endpoints
- **0.5-0.7 toxicity reduction:** Created non-toxic molecules
- **Final toxicity <0.3:** Less than 30% probability of being toxic
- **~0.6 similarity conserved:** function & structure maintained
- Hypothesis & research goal supported



Task 2: Binding Constrained Detoxification

- JNK3: **7 out of 27** toxic molecules successfully detoxified
- GSK3β: **9 out of 27** toxic molecules successfully detoxified
- Retained **high binding affinity** (Li et al., 2018) & low toxicity
- Candidates for **bipolar disorder** & **neurodegenerative disease**



Methodology

Task 1: Similarity Constrained Detoxification

- Dataset: **≤50 toxic molecules** for each endpoint

Algorithm	Toxicity Goal	Similarity Goal
Genetic Algorithm (GA) with 10,000 query budget (Tripp et al., 2023)	Predict **non-toxic probability ≥ 0.5**.	Tanimoto **similarity** to original molecule **≥ 0.6** (Bajusz et al., 2015)

Optimization Function: $F(M) = \sqrt{P_{non\text{-}tox}(M) \times Sim(M, M_o)}$ (Probability non-toxic; Tanimoto similarity)

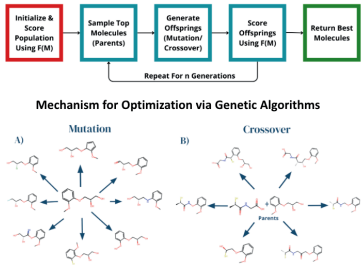
Task 2: Binding Constrained Detoxification

- Dataset: **27 toxic binding** molecules for each target (Jin et al., 2020)

Optimization Function: $F(M) = \sqrt[3]{P_{non\text{-}tox}(M) \times Sim(M, M_o) \times B_s(M)}$ (Probability non-toxic; Tanimoto similarity; Binding score)

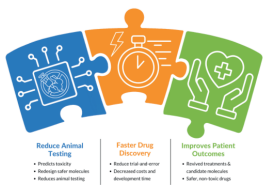
GSK3β	JNK3
Linked to higher risk of **bipolar** disorder. (Luykx et al., 2010)	Target for **neurodegenerative** diseases. (Musi et al., 2020)





Conclusion

- **Drug candidates** for diseases like Alzheimer's, Parkinsons, Bipolar disorder (Lesuisse et al., 2010)
- Future Work: Apply model and methodology to **chemicals, cosmetics, pesticides** (Bilal et al., 2020)
- First computational framework to **reduce toxicity & preserve target activity**
  - Goal achieved and hypothesis supported
  - Reduce **phase 1** drug failures (Waring et al., 2015)
  - Reduces trial-and-error experimentation & **improves efficiency**
  - Applicable for any target or disease
- **Human-relevant data** improves quality of toxicity assessment (Seed et al., 2005)
- **Reduces animal testing** & eliminates unnecessary trials



ADITI VIJIL



DARWIN: ACCELERATING DRUG DISCOVERY LEVERAGING NATURAL PRODUCTS FOR TREATING INCURABLE DISEASES

AWARDS	WESEF 1st place, NYSEF 3rd place, Somers 2nd place
EXTRACURRICULARS	MKVAC, Science Greeley, Chemistry Club, Biotech Club, GWYOA

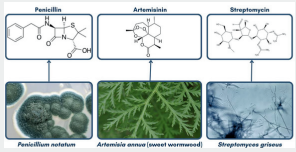
PROJECT ABSTRACT

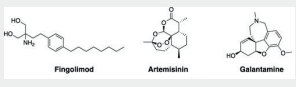
The rising global incidence of incurable diseases underscores the persistent gaps in drug discovery and development, largely rooted in the limited chemical diversity of modern drug compounds. Natural products (NP)—chemical metabolites produced by living organisms—offer a rich reservoir of diversity to address this limitation, yet require costly years of evolution and expensive retraining in a computational setting. Therefore, this study develops a novel framework, "DARWIN", that leverages the diversity of NPs and the scalability of computational techniques to propose novel drug candidates. The framework is generalizable and supports fine-grained control over molecular diversity by incorporating intermolecular similarity directly within the generation process. When applied to IGF1R (implicated in Ewing Sarcoma) and LCK (implicated in chronic lymphocytic leukemia), the generated molecules demonstrated improved properties relative to the DOCKSTRING baseline. For IGF1R, the average binding free energy was -10.28 kcal/mol compared to -7.95 kcal/mol in the DOCKSTRING dataset, and for LCK, DARWIN achieved an average of -11.13 kcal/mol relative to -7.97 kcal/mol. Likewise, the average NP likeness score for the generated molecules attained values of 1.15 for IGF1R and 1.25 for LCK, in contrast to the DOCKSTRING mean of -1.2. Notably, all proposed candidates achieved synthetic accessibility scores of less than 5, indicating that the molecules are easy to synthesize. Overall, DARWIN provides a novel, controllable framework for expanding the search for drug candidates beyond synthetic libraries, offering an effective method for accelerating drug discovery for currently incurable diseases.

QUAD CHART

Introduction

- **95%** of identified rare diseases lack treatment
- Drug discovery lacks diversity crucial for treating incurable diseases (Boström et al., 2018)
- **70% of FDA approved drugs** are based on known **scaffolds** (Taylor, Macchiarini, & Jonsson, 2020)
- **Natural products:** made by living organisms, diverse, improved binding
- Computaional models trained on synthetic libraries without NPs, GPUs



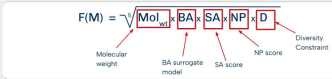


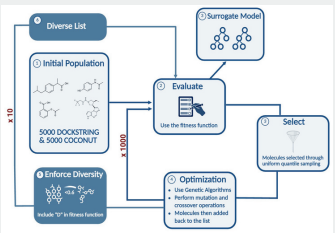
Framework

Surrogate Model

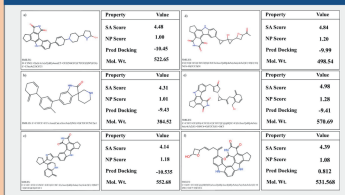
- Docking:~15 sec, DARWIN: milliseconds
- Random Forest Model, 2048 features
- Trained on DOCKSTRING: 260,000 molecules, 58 targets

Fitness Function

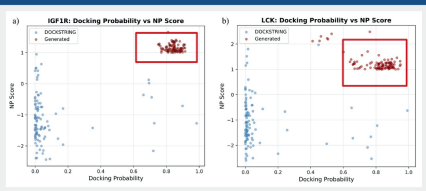




Key Findings



98% of molecules are nontoxic
All molecules had SA score<5



Does not require GPUs and expensive pretraining, unlike Reinvent 4 and Saturn

Conclusions

- **DARWIN:** Flexible framework to generate
- novel NP-like molecules for any target
- Hypothesis supported
- **Aid medicinal chemists for incurable diseases** and major global health threats
  Accelerates early-stage discovery **time and cost** by reducing hit identification from **1 yr to few days**
- Reshape early lead identification



EMILY VU

CP-ALS: A NOVEL CROSS-POPULATION FRAMEWORK FOR AMYOTROPHIC LATERAL SCLEROSIS GENOMIC ANALYSIS AND MODELING



AWARDS	3rd place (Somers), presented at NYMC HeLa conference, Scholastic Gold National Medal (2025)
EXTRACURRICULARS	Greeley Voice, Science Greeley, Fun & Arts Club

PROJECT ABSTRACT

Amyotrophic lateral sclerosis (ALS) is an incurable neurodegenerative disease. Although its genetic causes are complex, most genetic research has focused on North American and European populations, highlighting the need for further investigation in underrepresented groups. Thus, this study developed the first cross-population framework integrating data from the 1000 Genomes Project and NCBI, encompassing 25 populations, over 3,000 genomes, and 34 genes. While geographically proximal populations were expected to be genetically similar, those from different continents were anticipated to show significant genetic differences.This pipeline performs data preprocessing, population clustering, comparative analysis, and predictive modeling. Population clusters were identified through t-distributed stochastic neighbor embedding (t-SNE). Inter- and intra-cluster analyses using statistical heatmaps, t-tests, and principal component analysis (PCA) revealed distinct variant profiles across clusters and genetic similarities within clusters. Non-European populations—particularly those from East and South Asia and the Americas—also exhibited lower variant counts, underscoring the need for inclusion of these groups in future research. Machine learning models were trained to predict variant counts of ALS genes in an underrepresented population within a cluster using data from other populations in the same cluster. Recognizing the genetic overlap between ALS and frontotemporal dementia (FTD), ALS-derived clusters were also used to develop predictive models for FTD based on shared ALS-FTD genes. These models achieved comparable accuracy and consistent performance across clusters, demonstrating transferability across diseases. Thus, this study establishes a scalable framework for investigating genetic disorders in diverse populations with limited genetic data and supports the development of diagnostic strategies.

QUAD CHART

Background

ALS - most common MND, **incurable**

1) Strong genetic link to **FTD**
2) Majority of ALS/FTD studies **focus on European popul**

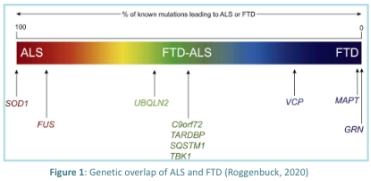


Figure 1: Genetic overlap of ALS and FTD (Roggenbuck, 2020)

Hypothesis - By leveraging genetic similarities of geographically proximal populations, the **variant profiles for ALS and FTD in underrepresented populations** can be determined.

Results

1. CP-ALS **outperforms other baselines**
2. ALS population clusters **transfer to FTD ML modeling** with robust performance

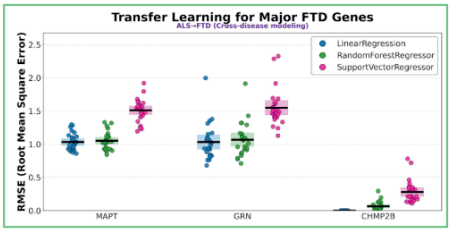
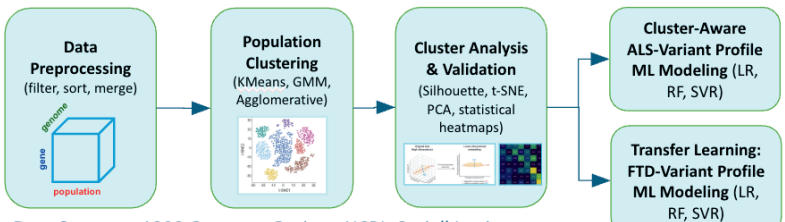


Figure 2: ML Model Performance for Predicting FTD Variant Profiles Across Genes.

Methodology



Data Sources - 1000 Genomes Project, NCBI, Coriell Institute

Conclusions

Hypothesis supported

1. CP-ALS establishes a novel framework, allows **analysis for underrepresented populations**
2. CP-ALS can be **easily extended for new diseases, populations, and genes.** Code **released as open source**

HENRY XUE



CELL IDENTIFICATION FROM PARTIAL OBSERVATION USING SPATIOTEMPORAL ATTENTION IN C. ELEGANS EMBRYOGENESIS

AWARDS	HiMCM Outstanding (top 8 global, #1 US, 1st Author), 3rd NYS indiv Tennis Doubles (All-State), USACO Plat, 4x AIME, 2nd CBIO WESEF, NYSSEF, 17th BrUMO, 47th MMATHS, 1st CBIO Somers
EXTRACURRICULARS	The Highly Prestigious Horace Greeley High School Science Research Program (ORNL, UTK, ICCS), CCE, WAMC, AAPIA, tennis, Math Club, and National Science Bowl

PROJECT ABSTRACT

Automated cell identification enables systematic phenotyping in developing embryos. Existing methods typically require nearly complete cellular configurations, but experimental constraints including phototoxicity and tissue-specific labeling often limit observation to cell subsets. We present a method that identifies *Caenorhabditis elegans* embryonic cells from partial observations containing 5-20 nuclei. Each cell is represented by geometric features computed from its local neighborhood, including pairwise relational statistics derived from a distance matrix. A joint attention encoder learns context-dependent embeddings, and cells are identified by nearest-neighbor lookup in a manifold built from training data. The model is trained on simulated embryos and fine-tuned on real data following the Twin Attention transfer learning approach. The method achieves 88.4% top-1 accuracy on held-out simulated embyros and 80.9% on real embryos after fine-tuning, with top-5 accuracy reaching 99.0% and 98.1% respectively. When predictions are filtered by confidence margin, accuracy reaches 95.8% for the top half of predictions. Most errors occur among spatially adjacent sister cells, consistent with biological expectations. These results demonstrate that partial cellular neighborhoods contain sufficient positional information for reliable identity assignment, enabling rapid cell identification in biomarker experiments and live imaging scenrios where complete observation is impractical.

QUAD CHART

Introduction

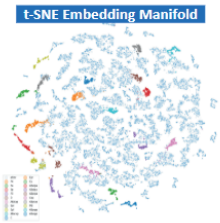
- Tracking and identifying individual cells during embryonic dev essential for understanding disease and genetic dynamics
- In real experiment, only 5-20 of ~200 cells are visible due to photobleaching, segmentation errors, selective fluorescent labeling
- Manual annotation takes hours per embryo, blocking large-scale



Goal: Develop joint-attention architectures for partial (5-20) cell observations achieving >85% accuracy for real-time workflows

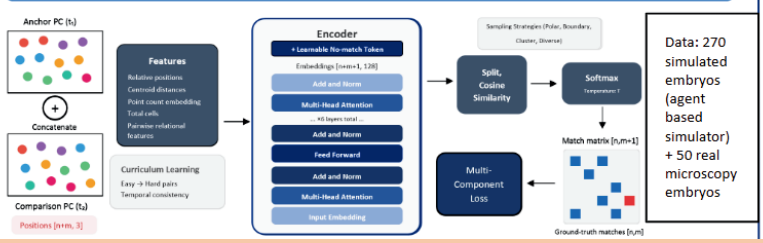
Results

Dataset	Top-1 (%)	Top-5 (%)
Simulated held-out	88.4	99.0
Real (after fine-tuning)	80.9	98.1



Methodology

Deployment: KNN search (k=30) across 10 matched references, <2 sec per subset on CPU



Data: 270 simulated embryos (agent based simulator) + 50 real microscopy embryos

Conclusion

- First automated method to identify cells from partial (5-20) cell observations in any developing embryo in real time
- Local cellular subsets encode sufficient positional information for ID without complete embryo observation
- Replace hundreds of hour of manual labor only needing a single frame of 5-20 cells in less than 2 second inference time.

Applications: Mutant embryo genetic screens | Drug discovery | Real-time microscopy module | organism-agnostic architecture applicable to zebrafish, drosophila embryos

KEVIN YAN

NEXT-GENERATION LITHIUM RECOVERY FROM BATTERY WASTE USING COVALENT ORGANIC FRAMEWORK COMPOSITE MEMBRANES: A SUSTAINABLE AND SCALABLE APPROACH



AWARDS	Finalist Genius Olympiad, WESEF 4th Place and David M. Holmes Engineering Innovation Award, National Gold Medal Scholastic Art & Writing Awards, First Place National Fish Art Contest by Art of Conservation, Second Place (New York State), National Songbird Art Contest by Art of Conservation
EXTRACURRICULARS	The Greeley Voice Print Media Director, ENOUGH Club Graphic Designer

PROJECT ABSTRACT

The growing demand for lithium-ion batteries (LIB) has escalated the need for effective lithium recovery from spent battery leachates. However, conventional hydrometallurgical and pyrometallurgical processes are energy-intensive and show poor lithium selectivity. We developed an acid-resistant covalent organic framework (COF) composite membrane, representing one of the first applications of COF-based separation to lithium recovery from battery waste. The membrane was synthesized via polymerization of tris(4-aminophenyl)benzene and divinyladipate on a polyacrylonitrile substrate under $Sc(OTf)_3$ catalysis, followed by thiol-ene click functionalization. Separation performance was evaluated using synthetic LIB leachates (pH ≈ 2.0) containing lithium, cobalt, nickel, copper, manganese, and representative impurity ions. The membrane delivered a water flux of 114 LMH, a water permeance of 7.7 LMH/bar, and lithium-over-competing-ion selectivity ratios as high as 250, substantially outperforming a state-of-the-art commercial nanofiltration membrane. Morphological, structural and chemical characterizations (SEM, AFM, TEM, XRD, GIWAXS and XPS) confirmed the formation of a uniform, smooth and defect-free ~150 nm COF selective layer with high crystallinity and chemical stability before and after acid exposure. Molecular dynamics simulations were performed to study the molecular basis of the membrane's lithium selectivity. Complementary techno-economic analysis demonstrated superior lithium enrichment, low energy consumption and strong cost competitiveness, underscoring the technology's scalability and practical viability. Overall, this work establishes the COF composite membrane as an efficient, sustainable and scalable pathway for lithium recovery in closed-loop battery recycling.

QUAD CHART

Objectives

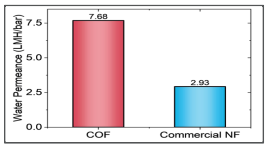
Develop COF (Covalent Organic Framework) composite membrane for selective, sustainable & scalable lithium recovery from end-of-life LIBs

Conventional Membrane:
- Energy efficient
- Environmentally benign

COF selective layer:
- Crystalline, porous materials made of organic units linked by covalent
- bonds
- Selective ion transport—Ordered nanochannels & tunable pore size
  Commercial polymer support: Scalable—Widely available at low cost

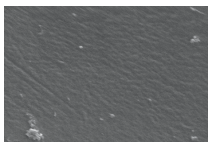
Results

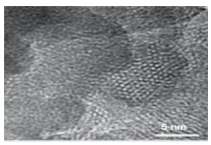
SUPERIOR PERFORMANCE:



COF > 2x NF90. Lower resistance/higher efficiency

Structural Basis for Strong Performance

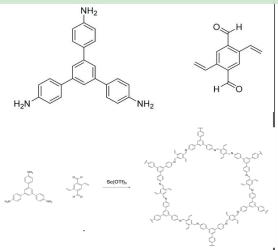




Well-aligned crystalline nanochannels
150 nm smooth COF, tight adhesion to substrate

Methodology

Monomers: TAPB and DVA form acid stable COF
Substrate:PAN—Conformal, Robust, and Low-cost
Catalysis: $Sc(OTf)_3$ Faster & smoother polymerization
Polymerization: Directly on substrate over 96 hours
Thiol-ene functionalization: Boosts Li^+ selectivity through fine tuning and affinity.
Performance evaluation, COF characterization, molecular dynamic simulations, and techno-economic assessment.



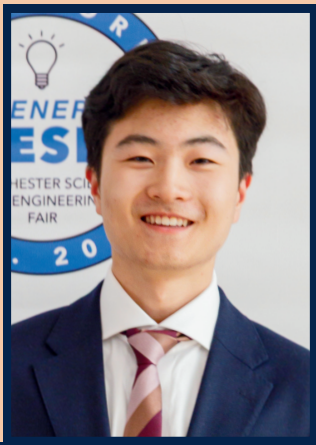
Conclusion

Engineering GoalsAchieved:
- Selective, sustainable and scalable Li^+ recovery from LIB leachates
- Acid-resistant and robust

FutureResearch:
- Use statistical tools to systematically find optimal parameters that maximize Li^+ selectivity

Application:
Broadly applicable to resource recoveries under harsh operating conditions, including: recovery of other metals in spent LIBs and extraction from industrial brines, geothermal fluids, and electronic waste

EDWARD YANG



BIOMIMICRY OF ALBATROSS WING MORPHING DURING DYNAMIC SOARING TO ENHANCE THE FLIGHT EFFICIENCY OF UAVS

AWARDS	HiMCM Outstanding Winner (Top 1 US), 2nd GS Skiing, 2x AIME, 3x State SCIO Medalist, USACO Gold, WESEF Ingenuity in Research
EXTRACURRICULARS	The Highly Prestigious Horace Greeley High School Science Research Program, Ski Team (V), Track Team (V), Math Club, Science Olympiad, Robotics,

PROJECT ABSTRACT

Unmanned Aerial Vehicles (UAVs) such as drones are becoming increasingly important in surveillance, disaster response, and environmental monitoring. Despite their applications, the flight efficiency of UAVs is limited by the need for onboard energy storage. To combat this, focus has shifted to studying the biological masters of long range flight: the wandering albatross. However, previous studies have mostly failed at acknowledging morphing wings, a major part of albatross flight. Those that did didn't test a wide range of morphs or flight conditions. In this study, we created a wing model and tested various wing morphs across a sweep of flight conditions along with calculating phase-specific energy gains and performance to quantify the energy efficiency of each wing morph. We constructed a wing model in XFLR5, a simulation software, and applied 8 different morphologies to the base wing. These wings were then simulated in XFLR5 to obtain aerodynamic and stability coefficients, from which we calculated the energy efficiency and performance of each wing. We found that the normal, unmorphed wing performed the best during aerodynamic testing, being 5 percent more efficient than mildly extreme morphs and 15 percent more efficient than extreme morphs. Stability testing showed that the extreme morphs exhibited a turn-in time over 2 times faster than the normal wing, with mildly extreme morphs exhibiting a 1.5 times faster turn in time compared to the normal wing. This led to the mildly extreme morphs being 11 percent more efficient and the extreme morphs being 4 percent more efficient over the turn compared to the normal wing. We successfully quantified the energy efficiency of each wing morph, concluding that mild morphing is the most optimal. This has many applications, including the use of morphing wings to increase energy generation from airborne wind energy generation systems. This work advances the development of UAVs and provides quantifiable data on the effectiveness of morphing wings.

QUAD CHART

Problem & Goals

UAVs are really useful, but they are limited by energy storage

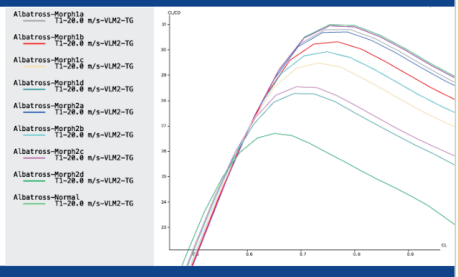
Goal: Mimic the albatross' ability to change its wing shape to optimize flight performance



Findings

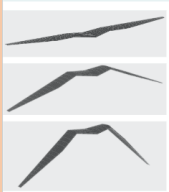
1. Morphing wings hinder aerodynamic performance
2. Instability caused by morphing wings decreases turn-in time

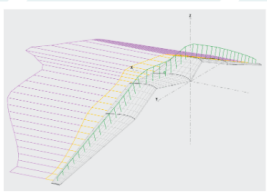
Morphing wings are beneficial to **turn performance**



Methods

Wing Model Creation → **Numerical Simulation** → **Turn Analysis**





$$t_{in} = \frac{\phi_{cmd}}{p_\infty} + \frac{1}{2}\tau_\phi \quad (4)$$

$$T_{core} = \frac{\Delta\psi}{\dot{\psi}} = \frac{V_{turn}\,\Delta\psi}{g\tan\phi} \quad (8)$$

$$E_{roll,j} = -P_{D,turn,j}(2t_{in,j}) \quad (16)$$

$$f_{dyn,j} = \frac{T_{core}}{T_{core} + 2t_{in,j}} \quad (10)$$

$$Q_{turn} = f_{dyn} * (CL/CD)_{turn} \quad (11)$$

Novelty:

First study testing **morphing wings** using stability and aerodynamic properties

Conclusion

	Morph2d	Morph2c	Morph1d	Morph1c	Morph2b	Morph1b	Morph2a	Morph1a	Normal
$(C_L/C_D)_{turn}$	24.16	26.54	25.98	27.87	28.28	28.95	29.48	29.58	29.82
f_{dyn}	0.766	0.742	0.734	0.711	0.704	0.676	0.651	0.633	0.600
Q_{turn}	18.51	19.70	19.07	19.82	19.91	19.57	19.19	18.72	17.89
E_{turn} (J)	174.0	163.7	169.0	162.6	161.9	164.6	168.0	172.2	180.2

Quantified the effect of morphing wings on flight performance

- Created a **novel** metric to compare turn efficiency
- Increased **energy efficiency** of UAVs (unmanned-aerial vehicles) by **11%**

SOPHOMORE CLASS OF 2028

INTRODUCTION TO RESEARCH

"YOU CANNOT HOPE TO BUILD A BETTER WORLD WITHOUT IMPROVING THE INDIVIDUALS. TO THAT END, EACH OF US MUST WORK FOR OUR OWN IMPROVEMENT."

-MARIE CURIE

KIRAN AGARWALA

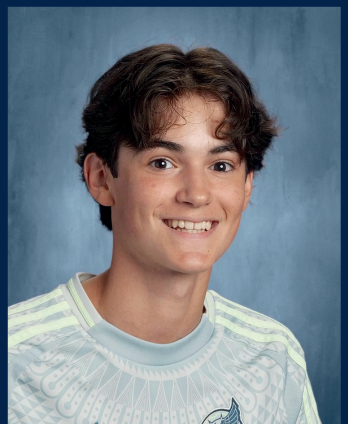
THE EFFECT OF DNASE1-FC ON NET-ASSOCIATED CISPLATIN-INDUCED KIDNEY DAMAGE IN TISSUE FROM LLC MOUSE MODELS



EXTRACURRICULARS

JV Tennis Team, Model UN Executive, Math Tutor, Speaker and member of Ok To Delay, a group that advocates for delaying smartphones for kids

FEDERICO ALARCON ZAMBRANO



DECODING THE PITCHING SHOULDER: IDENTIFYING PREDICTORS OF GLENOHUMERAL INTERNAL ROTATION LOSS AND INJURY IN MAJOR LEAGUE BASEBALL (MLB) PITCHERS OVER TIME

EXTRACURRICULARS

Greeley and Club Baseball, NCBSA Baseball Volunteer Coach, Junior Coach at ProSwing Baseball & Softball Facility, Rock Band Drummer, LIFT Tutoring Exec

FIONA ALLENDORF

IMPACT OF LONG DISTANCE RUNNING ON MEDIAL LONGITUDINAL ARCH DEFORMATION AS A FUNCTION OF SHOE TYPE



EXTRACURRICULARS Outside of Science Research I participate in: Track and Field, Soccer, Model UN, and I write for the literary magazine: The Greeley Quill.

DEVEN AMRUTE



EFFECT OF THE PERINATAL WESTERN DIET ON GLP-1 SIGNALING IN THE VENTRAL HIPPOCAMPAL FORMATION (HPFV)

EXTRACURRICULARS Piano, Horace Greeley Tennis, Volunteer at MKCCC

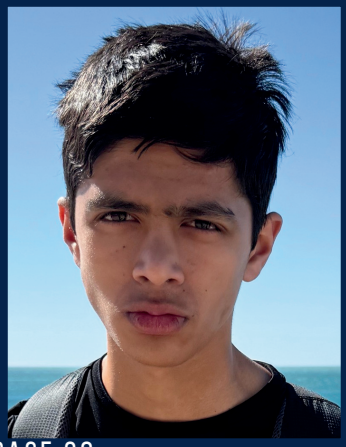
STELLA BEATON

FROM CUT-AND-COUNT MODELS TO AI-DRIVEN METHODS: ENHANCING GPU EFFICIENCY FOR PRECISE AND SCALABLE PARTICLE DISCOVERY



EXTRACURRICULARS Theatre, Student Council, GNT, Morning Announcements

SWARAJ BHATTACHARYA



IMPROVED AUTOMATED DETECTION AND DETERRENCE SYSTEMS AGAINST SUICIDE DRONES

EXTRACURRICULARS United States Naval Sea Cadet Corps, Boy Scouts, Track and Field, Student Government club, Helping our Heroes club, Cooking, and long distance running.

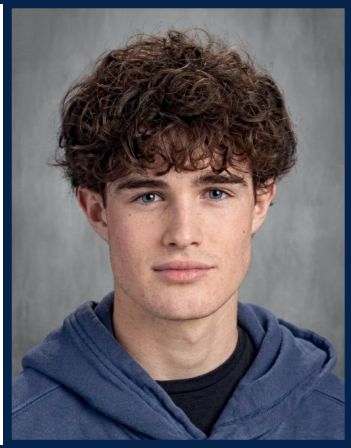
VYOM BHUWAN

ASTEROSEISMIC ANALYSIS OF PLANET-HOST STARS UNDER THE LIGHT OF RECENT DEVELOPMENTS OF NUCLEAR REACTION RATES



EXTRACURRICULARS Science Olympiad, Cricket, Robotics, and Content Creation: editing/producing videos

AUSTIN BRENNAN

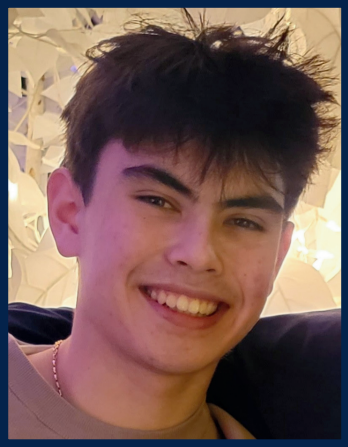


AN ANALYSIS OF OWNER COMPREHENSION OF AI TRANSLATED AUTOMOTIVE OBD-II DIAGNOSTICS AS COMPARED TO TRADITIONAL DTC/RULE-BASED SYSTEMS

EXTRACURRICULARS Car detiling, Building computers and video games, Pen and pencil drawing

EVAN BUHAIN

COMPARING THE IMPACT OF THERMOPHILIC, VERMI, AND COCKROACH FRASS COMPOSTING ON KEY INDICATORS OF SOIL HEALTH



EXTRACURRICULARS In addition to Science research I also participate in Debate, Model UN, track and field, and Tennis.

VICTORIA CHENG



ENHANCING PHENOTYPE-DRIVEN GENE PRIORITIZATION WITH LARGE LANGUAGE MODELS IN CLINICAL EXOME SEQUENCING

EXTRACURRICULARS Science Olympiad, Fencing, Violin, Tutoring, Avid Candy Crush Player

ELLYANNE CHLYSTUN-GITHAE

EVALUATING THE IMPACT OF AI LITERACY EDUCATION ON STUDENT OUTCOMES, ETHICAL AI USE, AND FUTURE WORKFORCE READINESS IN A RAPIDLY AUTOMATING ECONOMY



EXTRACURRICULARS

I have been a key speaker and done presentations at conferences, meetings, media interviews etc. I am a trained US military police academy cadet corporal (AED, CPR, First Aid). I sit on the New Castle Town's Sustainability Committee, face painting assistant at strawberry festing and an assistant gymnastics coach.

AZLAN CHOUDRY



COMPARING TEMPERATURE AND USAGE PATTERNS AND THE EFFECT THEY HAVE ON LITHIUM ION BATTERY DEGRADATION

EXTRACURRICULARS

Academic Challenge, Chappaqua Volunteer Ambulance Corp, Greeley New Today, Wrestling.

VIOLET CLINTON

IMPLICATIONS FOR POLLINATOR CONSERVATION: NOCTURNAL MOTH DIVERSITY AND ABUNDANCE ACROSS FOREST AND MEADOW HABITATS UNDER VARYING AMBIENT CONDITIONS IN WESTCHESTER COUNTY, NY



EXTRACURRICULARS

Cellist, Writer, Chappaqua Library volunteer and teacher of nature and writing classes, Writer for Stroll magazine, Science Olympiad, Sustainability Club, Greeley Growers, The Greeley Voice, Greeley News Today, Morning Announcements, and Chamber Orchestra

DYLAN CRUET-GHOSH



NEUROIMAGING EVIDENCE IN CRIMINAL COURTS: PROSECUTORIAL RESPONSES AND INTERPRETATION

EXTRACURRICULARS

Forest Preservation Club, Our Youth For the Climate Organization, Model UN, Greeley Advocates for Medical Supplies (GAMS), Tennis, Guitar

ABIGAIL DESROCHER

A PROTEOMIC STUDY OF THE PHARMACO-OMICS OF MAJOR DEPRESSIVE DISORDER



EXTRACURRICULARS I am part of the Chappaqua Volunteer Ambulance Corp (CVAC) Youth Corp and I am also a part of the DnD club.

ROXANNE DUFF



THE USE OF BEHAVIORAL PATTERNS IN DIAGNOSING DISORDERS OF THE GUT-BRAIN INTERACTION

EXTRACURRICULARS Volunteer at a Soup Kitchen and other places, play softball, photography, and in the clubs GAMS and FPC

ZACHARY EISNER

UTILIZING UNILATERAL KNEE VALGUS MEASUREMENTS TO UNDERSTAND THE CORRELATION BETWEEN DKV AND RSI VALUES IN ADOLESCENT ATHLETES



EXTRACURRICULARS Club Baseball, Club soccer, ENOUGH club, Lil Ballers coach

SYDNEY ENDE



PHAGE-ANTIBIOTIC SYNERGY IN A BSL-1 BACTERIAL HOST

EXTRACURRICULARS soccer, flag, volunteer at special olympics, TA at temple

YUAN FAN

THE EFFECT OF AMBIENT TEMPERATURE ON LITHIUM-ION BATTERY STABILITY



EXTRACURRICULARS Swim, lifeguarding, Geometry Dash: Sonic Wave Victor

FARIS FATOUH



TECHNO-ECONOMIC AND FUEL CYCLE ANALYSIS OF THE EVINCI NUCLEAR MICROREACTOR

EXTRACURRICULARS Varsity soccer, MLS NEXT academy division club soccer, mechanics division of the robotics team, STEM Build and Design Club, competitive combat robotics, volunteering through local mosque in Tanzania, 3D printing business, personal Arduino and ESP32 projects

JORDAN FINK

SPATIAL ANALYSIS OF CHRONIC OBSTRUCTIVE PULMONARY DISORDER IN COLORADO AT THE COUNTY LEVEL, COMBINED WITH SOCIOECONOMIC AND ENVIRONMENTAL FACTORS



EXTRACURRICULARS In addition to science research, Jordan is a member of the debate team, a leader in the Student Leadership Council for the class of 2028 and is a Madrahim at his temple.

CRYSTAL FU



INTEGRATING GENE EXPRESSION AND MUTATION DATA TO PREDICT CANCER DRUG SENSITIVITY USING MULTI-OMICS FUSION NEURAL NETWORKS

EXTRACURRICULARS Competitive dance, visual arts, singing and creating music

ZACHARY GIBBS

DEVELOPMENT AND OPTIMIZATION OF AN ADAPTIVE WINGLET-CANT ANGLE SYSTEM FOR INDUCED DRAG REDUCTION ACROSS FLIGHT PHASES IN NARROWBODY AIRCRAFT



EXTRACURRICULARS Swimming, Science Olympiad, Traveling, Lifeguarding, Aviation, Geometry Dash: Acu Victor, Minecraft, Boy Scouts, Chess

AVIKA GOEL



A COMPARATIVE STUDY OF ICEBERG DISCHARGE IN THE LAST INTERGLACIAL AND HOLOCENE PERIODS USING SPATIAL AND TEMPORAL ICE-RAFTED DEBRIS (IRD) FLUX PATTERNS

EXTRACURRICULARS Along with science research, I play tennis, tutor, pet-sit, and belong to the sustainability and chemistry clubs at Greeley.

CAMILA GOMEZ

ARTICULATION AND RANGE OF MOTION OF LIMBS OF AGNOSTID SPECIES AGNOSTUS PISIFORMIS



EXTRACURRICULARS Science Olympiad middle school coach, Science Olympiad, rock climbing, and hiking

JASPER GOTTLIEB



THE ROLE OF KNOWLEDGE ABOUT NUCLEAR WASTE AND EVACUATION ON PUBLIC OPINION OF THE INDIAN POINT SHUTDOWN

EXTRACURRICULARS Robotics, DnD, Video games

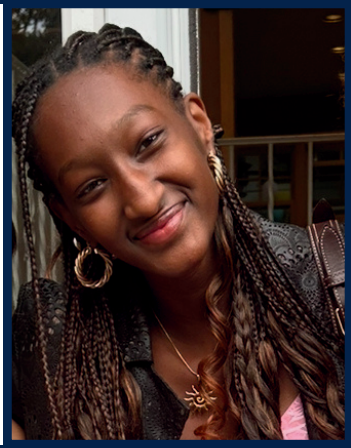
NATHANIEL GRISHMAN

INTERACTIONS BETWEEN PITCH ARSENAL COMPOSITION, VELOCITY, AND WORKLOAD AS PREDICTORS OF UCL INJURY RISK IN MAJOR LEAGUE BASEBALL PITCHERS

EXTRACURRICULARS Varsity football and baseball player, volunteer youth baseball coach, enjoys playing golf and watching sports.



AVA GUEYE



AN ANALYSIS OF SOCIAL NETWORKS AND OVERALL LIKELINESS TO DEVELOP ALZHEIMER'S DISEASE

EXTRACURRICULARS Outdoor Track and Field, Indoor Track and Field, Cross Country, Chappaqua Volunteer Ambulance Corps, Symphony Orchestra, and The Pantry

ANIKA GURSAHANI

LEXICAL ENTRAINMENT IN HUMAN–LLM DIALOGUE

EXTRACURRICULARS Pianist, Tutor, 914Cares Junior Advisory Board Member, Science Olympiad Event Supervisor and Competitor, Performing Arts Club Cofounder and Exec



ROMA HUGGAHALLI



UNDERSTANDING THE ROLE OF EL NIÑO AND LA NIÑA ON AEROSOL ATMOSPHERIC RIVERS USING MACHINE LEARNING APPROACHES

EXTRACURRICULARS Piano, Cello, New Castle Conservation Board Horseback riding, and Theraputic Horsemanship Volunteer

ELIZABETH IMPASTATO

USING BEHAVIORAL TESTING TO IDENTIFY NEUROLOGICAL IMPAIRMENT IN POST-ISCHEMIC MICE



EXTRACURRICULARS PJLC, Mount Kisco Ambulance, Varsity Ski Team

ARJUN JANGI



THE ROLE OF SOCIAL NORMS AS MODERATORS OF SOCIODEMOGRAPHIC DISPARITIES IN YOUTH COVID-19 BOOSTER UPTAKE

EXTRACURRICULARS Science Olympiad, Academic Challenge, The Greeley Voice, ESL Tutoring, Art

ALLEN JANKOVIC

EMERGENT COORDINATION THROUGH COMPETITION IN A 3D MULTI-AGENT ENVIRONMENT



EXTRACURRICULARS Robotics Team Driver, Self-Proclaimed SSL: Rocket League, Semi-Professional Tron Clash Royale, Tutoring

HANNAH KECSKES



ECONOMIC COMPETITIVENESS OF BLUE AMMONIA COMPARED TO GREY AMMONIA

EXTRACURRICULARS Varsity Tennis, Student Leadership Council, and JCCA Volunteer

OWEN LANSFORD

THE REAL WORLD IMPLICATIONS OF PROMPT TONE IN REAL PROMPTS TOWARDS LLMS



EXTRACURRICULARS Piano, volunteering, debate club, math tutor, running

SHAILI MAGHEN



EVALUATING THE EFFECTS OF RHYTHMIC AUDITORY STIMULATION ON GAIT SPEED AND STRIDE IN INDIVIDUALS WITH PARKINSON'S DISEASE

EXTRACURRICULARS Soccer, Student-led initiative, A capella group, Letters for rose club, Assisting kid's cooking birthday parties, Volunteering at daycare.

SHAYLA MARSHALL

CAF-MEDIATED TGF-β SIGNALLING IN CMS4 PATIENT-DERIVED COLORECTAL CANCER ORGANOIDS: EFFECTS OF PATHWAYS INHIBITION ON TUMOR PROGRESSION



EXTRACURRICULARS Share, GAMS, Debate, Soccer, Track, Piano,

ALLISON MARTINEAU



VAGUS NERVE STIMULATION TO RELIEVE NECROTIZING ENTEROCOLITIS IN A NEONATAL RAT MODEL

EXTRACURRICULARS In addition to science research, I also participate in debate, track and field and the school newspaper.

JACE MATHEW

THE EFFECT OF EARLY ORAL LANGUAGE DEVELOPMENT ON READING COMPREHENSION OUTCOMES ON ELEMENTARY SCHOOL STUDENTS



EXTRACURRICULARS Certified Taekwondo Instructor and 2nd Degree Black Belt; Executive Member of SAMES Club; Active Member of NCUFY; Science Research Program

OLIVIA MCCANN



THE EFFECTS OF KINESIOLOGY THERAPEUTIC TAPE ON PERFORMANCE IN A VIRTUAL REALITY BASKETBALL GAME SIMULATION

EXTRACURRICULARS Lacrosse, soccer, volunteering, and I love to read.

RILEY MCKIE

THE ROLE OF EMOTIONAL ENGAGEMENT AND STIMULUS INTENSITY IN SHORT-FORM VIDEOS AND THEIR EFFECT ON PROSPECTIVE MEMORY



EXTRACURRICULARS Varsity Soccer, Winter Track & Field, Varsity Lacrosse, Model UN, S.H.A.R.E; Midnight Run Exec, Lifeguard, Soccer Referee

ELLEN MORALES AREAS



EVALUATING THE SUSTAINABILITY AND COST EFFICIENCY OF DIFFERENT CONCRETE PRODUCTION METHODS

EXTRACURRICULARS Lacrosse, tennis, volunteering at daycare, Model UN.

KELLY MORTON

FUNCTIONAL MODELING OF MST1/MST1R IN KERATINOCYTE WOUND HEALING: POTENTIAL INSIGHTS INTO GENETIC DRIVERS OF PSORIATIC SKIN DISEASE RISK

EXTRACURRICULARS School/Club Volleyball and beach Volleyball, President of Greeley Medical Supplies club, volunteer sorting and shipping medical supplies, member of HOSA club



JACK MURPHY



UNDERSTANDING THE MOTIVATORS FOR THE PURCHASE AND CONSUMPTION OF SPORTS AND ENERGY DRINKS

EXTRACURRICULARS Track and field, cross country, Academic Challenge, Greeley News Today, musical and nonmusical theater, combat robotics

TARA NAIR

EVALUATING ADDITIVE & UPF TRENDS IN US COMPLEMENTARY FOODS: A TWO DECADE ANALYSIS

EXTRACURRICULARS Debate, Varsity Swim & Dive, Singing, Greeley Voice & Science Greeley



EMILY ORLANDI



EVALUATING THE EFFECTS OF EDUCATIONAL INTERVENTION ON THE DYSLEXIC BRAIN: UNDERSTANDING THE ROLE OF BRAIN DIFFERENCES ON OUTCOMES

EXTRACURRICULARS Cross country, Track, History Club

MEGHAN PASCIONE

ANTI-MÜLLERIAN HORMONE LEVELS IN POLYCYSTIC OVARY SYNDROME: PREDICTING REPRODUCTIVE AND METABOLIC OUTCOME



EXTRACURRICULARS Playing soccer, skiing, BrightPrep tutoring, lifeguarding, and babysitting.

RYAN PAUL



EARLY STAGE IMPACTS OF DIFFERENT PLASTIC POLYMER CONCENTRATIONS ON NUTRIENT DYNAMICS IN FRESHWATER SEDIMENT MICROCOSMS

EXTRACURRICULARS Debate, Tennis, SHARE Executive, Tutoring, Science Research Program

JARNO PIACENTINI

EFFECT OF SOUND PRODUCED AT NIGHT BY AIRCRAFT ACTIVITY ON NOCTURNAL BIRD MIGRATION DENSITY IN THE GREAT PLAINS



EXTRACURRICULARS Science Research, Dungeons & Dragons, Birding (birdwatching), Creative Writing (fantasy and science fiction)

CHLOE PIL



PSYCHOLOGICAL AND PHYSICAL BARRIERS TO RETURNING TO SPORT AFTER ACL RECONSTRUCTION IN ADOLESCENT ATHLETES

EXTRACURRICULARS Varsity Lacrosse, Varsity Ski, JV Soccer, Club Lacrosse, Tutoring

PALOMA POURMAND

INFLAMIX ENHANCED: IMPROVING PREDICTION OF CYTOKINE RELEASE SYNDROME IN LYMPHOMA PATIENTS TREATED WITH CD3XCD20 BISPECIFIC ANTIBODIES



EXTRACURRICULARS Soccer, Snowboarding, SHARE, SAMES, Running, Photography

TAYLOR PRASAD



ENGINEERING THE FEASIBILITY OF DUAL-MODE VEHICLES: A COMPARATIVE ANALYSIS OF GROUND AND VTOL DESIGN INTEGRATION

EXTRACURRICULARS Besides science research, I am part of Model UN, compete in IEA (horseback riding), tutoring, and volunteering.

AMY QIU

THE EFFECT OF IRON DEFICIENCY ON IL-2 AND IFN-γ CD4+ T-CELL CYTOKINE PRODUCTION



EXTRACURRICULARS Co-President: HOSA club, Chemistry Club executive, tutoring and track athlete

ANIKAITH REDDYJARUGU

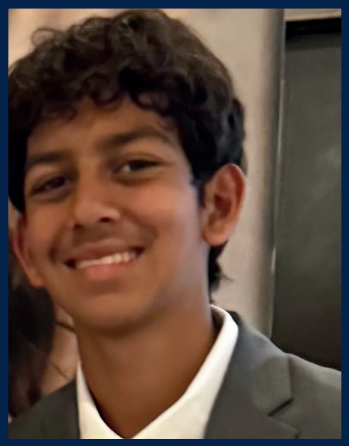


ALLEVIATING SECONDARY DAMAGE: POSSIBLE THERAPIES FOR POST-ISCHEMIC STROKE INFLAMMATION

EXTRACURRICULARS Club and Greeley Soccer, NCUFY (New Castle United for Youth), Millwood Fire Department, Chappaqua Volunteer Ambulance Corps

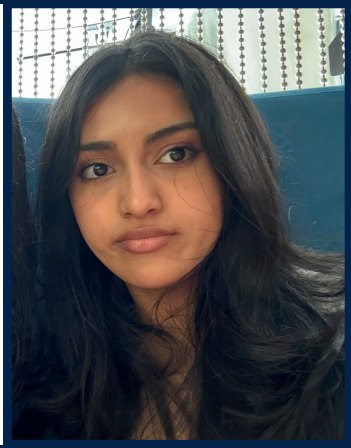
AARAV SHAH

PLANTATIONS AND NATIVE REGENERATION: UTILIZING LINEAR PROGRAMMING MODELS TO MINIMIZE TRADEOFFS WITHIN REFORESTATION STRATEGIES



EXTRACURRICULARS Debate, cello

ZARINA SHAHID

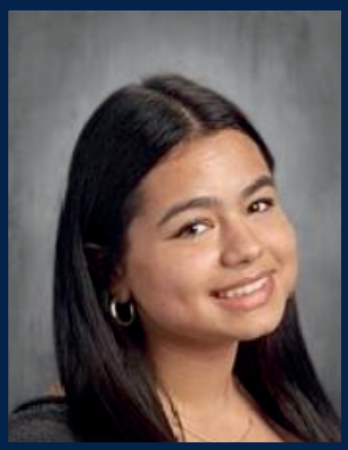


HIGH-FREQUENCY OSCILLATION (HFO) PATTERNS VARYING ACROSS PEDIATRIC AGE GROUPS IN EEG RECORDINGS USING THE 10–20 SYSTEM

EXTRACURRICULARS Greeley Theater, sculpture, Arabic reading classes, video editing, summer lectures in neurology and sociology

TATE SHALOV

THE IMPORTANCE OF RESEARCHING ADOLESCENTS AND YOUNG ADULTS INVOLVEMENTS IN CLINICAL TRIALS



EXTRACURRICULARS Ski racing and flag football

DEVAN SHARMA



IDENTIFYING HIGH-RISK TRAUMA PATIENTS BEFORE DETERIORATION: A MACHINE LEARNING MODEL FOR EMS-WITNESSED CARDIAC ARREST PREDICTION

EXTRACURRICULARS SHARE/L.I.F.T. Executive, Sports Analytics Club President, JV Boys Soccer, Club Soccer

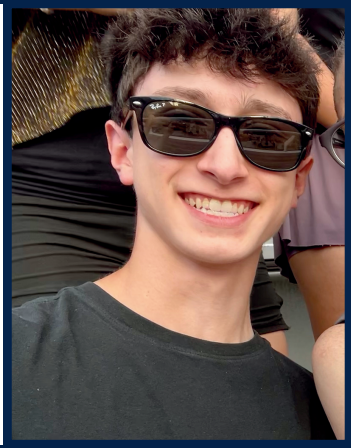
JULIA SILETTI

MENTAL HEALTH OF ADOLESCENT STUDENT ATHLETES: EXPLORING THE BARRIER BETWEEN HELP SEEKING AND WELL BEING



EXTRACURRICULARS Soccer, Lacrosse, SCOPE Club, Forest Preservation club

HARRISON SIMON



THE IMPACT OF THE ABSENCE OF SOCIAL MEDIA ON CORTISOL LEVELS IN ADOLESCENTS

EXTRACURRICULARS Outside of science research, I play football, tennis, and track. I also play the piano, and I am a member of the Model UN club.

NIKHIL SINGHAL

ANALYZING BRAIN TUMOR EHR DATA WITH MACHINE LEARNING PYTHON SCRIPT



EXTRACURRICULARS Tutor/instructor for math, running, Academic Challenge, Model UN, writing and reading, volunteering at donation centers

LUKE THOMAS



IMPACT OF REAL TIME MACHINE LEARNING ON SEPSIS OUTCOMES IN HOSPITAL SETTINGS

EXTRACURRICULARS Greeley Tennis, Greeley Literacy Initiative President, First Class Boy Scout, math instructor and music producer.

GAYATHRI TUPILI

THE RELATIONSHIP BETWEEN WOMEN'S CARDIOVASCULAR DISEASE RISK AND SOCIAL INEQUITIES ACROSS U.S. REGIONS.



EXTRACURRICULARS PJLC member, GAMS club president, Math tutoring, Indoor and Outdoor track, SAMES club executive.

ARANTZA URREA



COMPARING VISUOMOTOR ADAPTATION AND MOTOR LEARNING STRATEGIES IN FIRST-PERSON SHOOTER GAMERS AND UPPER-LIMB PRECISION-BASED ATHLETES

EXTRACURRICULARS NYCFC Soccer, Track & Field, Flag Football, Hiking, AYSO Coaching, SHARE, NCUFY Summer Internships, Volunteer at White Plains Library, and PJLC

CECILIA VALDES

AIR-QUALITY DEGRADATION DURING HEAT-BASED HAIRSTYLING: EXPOSURE TRENDS, POTENTIAL RISKS, AND POTENTIAL MITIGATION STRATEGIES



EXTRACURRICULARS Studied violin since 2014 and currently performs through the Music Conservatory of Westchester and the Chamber Music Center of NY in orchestral, chamber, and community outreach. Awarded the Mary Lou Francis Merit Scholarship and a winner of the 2025 Avi Kavafian String Competition. In addition, she serves as President of the BIPOC club and plays tennis.

ARYA VENKATESH MISAWA



THE DISCOVERY OF ANTI-CANCER PEPTIDES WITH VARIATIONAL AUTOENCODERS

EXTRACURRICULARS Mathematics, Physics, Playing Chess, Hanging out with friends!

CHIHARU VENKATESH MISAWA

EFFECTS OF TRANSITION METAL ACTIVITY ON GLUTATHIONE REDUCTASE ACTIVITY: EVALUATING IMPACTS ON FERROPTOSIS



EXTRACURRICULARS Science Olympiad, HG Invitational Event Supervisor, White Plains Hospital volunteer, and I enjoy reading in my free time.

ADELA WANG



THE EFFECT OF ACRYLIC ACID CONTENT ON PH-DEPENDENT EQUILIBRIUM SWELLING OF POLY(ETHYLENE GLYCOL) DIACRYLATE HYDROGEL NETWORKS

EXTRACURRICULARS Science Olympiad, Cross Country, Track and Field, Robotics

SOPHIA WANG

TWO-STAGE MACHINE LEARNING SCREENING OF PROBLEMATIC INTERNET USE RISK IN YOUTH USING ACCELEROMETER AND SURVEY DATA



EXTRACURRICULARS Tennis, GWYOA, Tutoring

SOLON WEN



DETERMINING THE SPECIFIC BIOMECHANICS & INFLUENCES OF STIFFNESS IN CELLS

EXTRACURRICULARS Biology Club/USABO, Track and Field, Piano, Snowboarding, Horace Greeley's Jazz Band

JACKSON WONG

COMPARATIVE ANALYSIS OF ENZYMATIC PET DEGRADATION ACROSS SIMULATED OCEANS, LANDFILLS, AND TERRESTRIAL ENVIRONMENTS

EXTRACURRICULARS Wrestling, math tutoring, competition writing , working out/gym, competition math



DAVID YANG



SYSTEMIC VS INTRATUMORAL MECHANISMS OF PD-1/PD-L1 BLOCKADE

EXTRACURRICULARS I am on the tennis team and I like to do math competitions outside of research

LIA YEDID

AN ANALYSIS OF CHANGES IN HUMAN-TO-HUMAN RELATIONSHIPS THROUGH THE LENS OF AI CHATBOT COGNITIVE RELIANCE AND EMOTIONAL ATTACHMENT.

EXTRACURRICULARS Varsity tennis, HOSA, WiSTEM, volunteering, tutoring



ATHENA ZHANG



POTENTIOMETRIC PH MEASUREMENT IN UNBUFFERED SETTINGS WITH THREE-DIMENSIONALLY PRINTED ELECTROCHEMICAL FLOW CELLS

EXTRACURRICULARS Cross Country, Track and Field, Robotics, Debate, Fun & Arts Club, Crochet Club, Drawing and Painting

JUSTIN ZHANG

THE IMPLICATIONS OF PROTEOMIC STUDY REGARDING TETRAPOD EVOLUTION DURING ROMER'S GAP



EXTRACURRICULARS Music composition, Drawing, Piano

LUCAS ZHANG



EVALUATING THE ATTACK SUCCESS RATE AND INSTRUCTIONAL QUALITY OF LARGE LANGUAGE MODELS IN EDUCATIONAL SETTINGS THROUGH RED-TEAMING AND FINE-TUNING

EXTRACURRICULARS Physics Club, Badminton, Science Olympiad, Battle Cats Enjoyer

GOOD LUCK SOPHOMORES on June 6th at SOMERS SCIENCE FAIR

welcome

ASPIRING SCIENTISTS

""SOMEWHERE, SOMETHING INCREDIBLE IS WAITING TO BE KNOWN."

-CARL SAGAN

Anand Isha (Rainy)
Athanasoulias Rula
Basavaraju Ronav
Berishaj Dylan
Bittman Allie
Bordawekar Agastya
Busell Parker
Castenesda
Catherine
Chintomby Matthew
Cloherty Desmond
Cong Richelle
Cook Emily
Corr Colette
Coupey Eva
Covello Nate
Dritz Abigail
Duan Kaden
Embar Reyansh
Ennabi Jaimie
Epstein Ava
Fernandes Mina
Fijman Oliver
Fishman Rebecca
Giltman Eli
Goldberg Eric
Goldberg Sadie
Gomez Gerardo
Gulotta Cameron
Gurer Altay
Hack Johnny
Hollis Lukasz
Huang Justin
Huang Hannah
Kamensky Maddie
Kastner Sydney
Kaur Asthir
Knapp Sophia
Korby Riley
Kotagiri Gauttam
Kumar Ria
Kwong Ethan
Lamb William
Li Karsten
Ma Sean
Malik Hazuri
Martin Bradley
Mazin Cori
McIsaac Noel
Moraes Harriet
Muns William
Narayan Mihika
Pani-Chakravarty Ishaan
Reda Dean
Regan Harrison
Riegelhaupt Layla
Song Dylan
Song Tei
Suk Minyoung
Tambe Ebot Abigail
Valadez Mario
Valasco Amelia
Viswanathan Jaisan
Warner Joey
Whang Elliott
Wildstrom Truman
Williams John
Wolfberg Eve
Xu Phoebe
Xu Robert
Zhang Hailey

We Asked Sophomores to Describe Year One

"Science research has taught me the value of hard work and helped me grow as both a student and a person. I've gotten a deeper understanding of research, data collection, and presentations, all while genuinely enjoying the class."

Jace Mathew

"Science Research has really helped me come out of my shell as public speaker and connected me to so many amazing people. Thank you SciRes!"

Deven Amrute

"This year in science research has strengthened my habits of consistency and accountability by pushing me to manage my time, follow through on long-term goals, and take ownership of my work."

Nate Grishman

"Science research helped me learn how to figure out difficult situations on my own."

Tate Shalov

"This year of Science Research has helped me become a better researcher, scientist, and student."

Ryan Paul

"I feel like a completely different person than at the start of the year, as I have learned so much about how to conduct research, make a project, and reach out to mentors."

Nikhil Singhal

"Science research this year has taught me to push my own limits and helped me compete in WESEF which would have never been possible without this program!"

Kelly Morton

"Science research has taught me a lot about effective oral and digital communication and a lot about science at higher levels."

Jordan Fink

"Science research has impacted me as a student by inspiring me to think deeper on ideas."

Dylan Cruet-Ghosh

"It has made me more curious and social."

Jasper Gottlieb

"Science Research has helped me become better public speaker, but most importantly it has given me an outlet to study something that I am passionate about."

Fiona Allendorf

We Asked Juniors to Describe their 2nd Year

My favorite part of this year was presenting my project at WESEF and discussing it with the judges. I really enjoyed answering their questions and thinking on my feet—it pushed me to understand my research more deeply. It was also a great opportunity to connect with scientists and hear their perspectives. Those conversations made the experience feel real and meaningful, beyond just a school project. Overall, it helped me grow both as a researcher and as a communicator.

Kevin Yan

"This year I learned many new skills, especially writing a research paper and improving my time management. My favorite part of the year was attending WESEF and presenting my research, which was a very rewarding experience." -Livia Low

Livia Low

"One of my favorite parts of the program is that we are able to choose any topic that we are interested in, so everyone is focused on something unique. I always enjoy learning about my friends' work and sharing mine too."

Priyanka Talla

"The best part of my day is coming to research to get to work on my project along side like minded people."

Addison Pinnow

"These past two years, I've learned how much perserverance science research really takes; from journal article readings and finding a mentor sophomore year, to actually conducting the research. But being able to present my project and see everything I worked on come together made it incredibly rewarding. It made me proud not just of the results, but the process it took to get here."

Lasya Hota

"My process in science research has been a very unique and rewarding one. I learned the importance of communication and making the best with what you have, as have many of my peers. The program does an amazing job setting students up for their future outside of high school and guides them to develop important skills."

Alexis Oh

"Working through many challenges and setbacks is a natural part of Science Research, but it is one of the greatest feelings to be standing on a hill made of your research work and looking at a sunset."

Nicholas Serini

"Science Research taught me so many important skills and helped me see the result of hard work and dedication. I loved exploring my interests while conducting valuable research to improve the world. The community is so welcoming and supportive, and I can't wait for next year."

Olivia Regan

We Asked Seniors to Reflect on all Three Years

"Science research has been one of the most rewarding and valuable experiences that I have had in high school, and senior year is really where everything comes together. Finishing phase two of my research, submitting to STS, and presenting at WESEF for the last time were all such meaningful moments where I could really see all of the work that I had put in across the past three years."

Isabella Garcia

“Senior year is a time to reflect. Looking back, I’ve grown so much over the past three years in Science Research, and I’m grateful for the memories, teachers and mentors.”

Ryan Zhang

“Science research has been one of the most welcoming and inspiring communities at Greeley. Being allowed to pursue my own ideas and contribute to lasting research has been an incredible privilege. I am so grateful to Mr. Zupan, Dr. Argiros, and all of my classmates and friends for their constant support and encouragement!”

Sydney Tsao

“After three years of science research, what stands out most is the people I met and learned from. The experience helped me find my passion, figure out what I actually care about, and feel a lot more ready for college.”

Stella Myers

“When I look back at my three years in science research, I feel a multitude of things, but mainly gratitude. Gratitude to my parents and peers who helped me, to my mentor, and especially to Mr. Zupan. The process was intense, but it was such a unique opportunity that has prepared me for research in college and the rest of my life. ”

Uma Sharma

"Science research has been the single most impactful part of my high school journey, and has opened the doors for me to push myself into the type of work I will be doing in college and beyond."

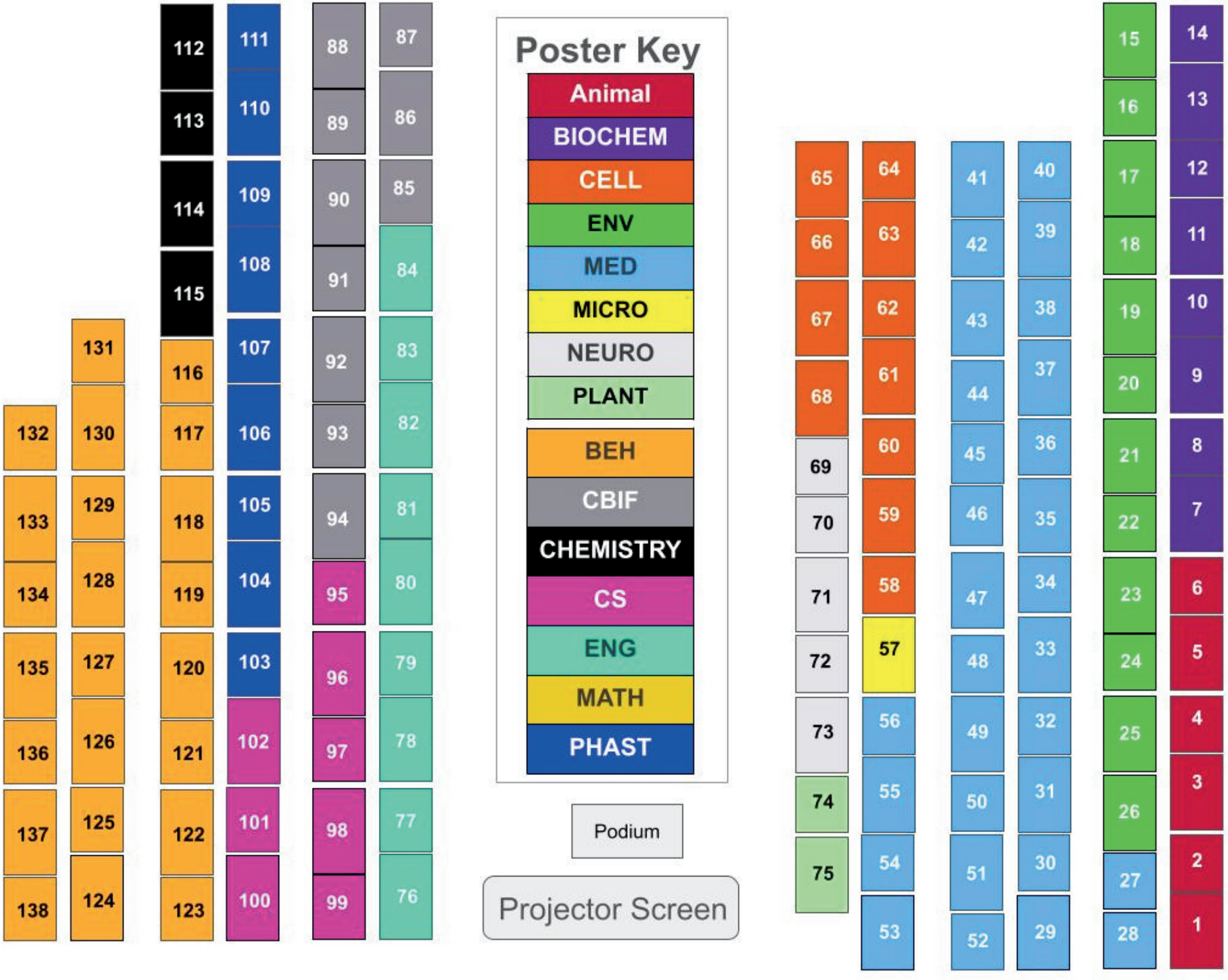
Kevin Guo

“The world of research isn’t always the easiest. We will all approach challenges, whether they are in a lab, a classroom, or in life. What matters is how we react to these challenges and I can say with confidence that if it weren’t for this science research course, I would not be prepared to face the challenges that await me in college with full enthusiasm.”

Lorelai Nocca

“The resources, support, and memories given to me by the research program here have been invaluable to my education and has greatly shaped who I am and what my life looks like today. It is a one of a kind community and I don’t know if a student could find experiences and driven students like this anywhere else at Greeley.”

Dayuan Cheng


Poster Key
Animal
BIOCHEM
CELL
ENV
MED
MICRO
NEURO
PLANT
BEH
CBIF
CHEMISTRY
CS
ENG
MATH
PHAST
Podium
Projector Screen
112 111 88 87
113 110 89 86
114 109 90 85
115 108 91 84
107 92 83
116 106 93 82
117 105 94 81
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65 64 41 40 15 14
66 63 42 39 16 13
67 62 43 38 17 12
68 61 44 37 18 11
69 60 45 36 19 10
70 59 46 35 20 9
71 58 47 34 21 8
72 57 48 33 22 7
73 56 49 32 23 6
74 55 50 31 24 5
75 54 51 30 25 4
53 52 29 26 3
27 2
28 1

LISTEN TO ALL PRESENT THEIR RESEARCH IN THE GYM

Number	Name	CATGORY	YR
1	Liu, Isabella	Animal	JR
2	Singhal, Nikhil	Animal	SO
3	Vijil, Aadhya	Animal	JR
4	Cheng, Victoria	Animal	SO
5	Garcia, Isabella	Animal	SR
6	Fu, Crystal	Animal	SO
7	Wang, Brady	BIOCHEM	SR
8	Venkatesh, Arya	BIOCHEM	SO
9	Rojek, George	BIOCHEM	JR
10	Wong, Jackson	BIOCHEM	SO
11	Nocca, Lorelai	BIOCHEM	SR
12	Wang, Adela	BIOCHEM	SO
13	Mullen, Samuel	BIOCHEM	SR
14	Orlandi, Emily	BIOCHEM	SO
15	Pinnow, Addison	ENV	JR
16	Buhain, Evan	ENV	SO
17	Gopikrishna, Parvathy	ENV	JR
18	Goel, Avika	ENV	SO
19	Oh, Alexis	ENV	JR
20	Kecskes, Hannah	ENV	SO
21	Levine, Meredith	ENV	SR
22	Huggahalli, Roma N	ENV	SO
23	Paskowitz, Kate	ENV	SR
24	Shah, Aarav	ENV	SO
25	Seelam, Srihaan	ENV	JR
26	Yan, Kevin	ENV	JR
27	Martineau, Allison	MED	SO
28	McCann, Olivia	MED	SO
29	Al-Mufti, Jude	MED	SR
30	Alarcon Zambrano, Federico	MED	SO
31	Tong, Emma	MED	SR
32	Amrute, Deven	MED	SO
33	Balcetis, Jonas	MED	SR
34	Desrocher, Abigail	MED	SO
35	Rutman, Eve	MED	SR
36	Eisner, Zachary R	MED	SO
37	Feig, Emma	MED	JR
38	Fink, Jordan B	MED	SO
39	Golub, Zoe	MED	SR
40	Grishman, Nate	MED	SO
41	Myers, Stella	MED	SR
42	Impastato, Elizabeth	MED	SO
43	Morton, Kelly	MED	SO
44	Gueye, Ava	MED	SO
45	Nair, Tara	MED	SO
46	Pascione, Meghan	MED	SO

Number	Name	CATGORY	YR
47	Pil, Chloe	MED	SO
48	Pourmand, Paloma	MED	SO
49	Reddyjarugu, Anikaith	MED	SO
50	Duff, Roxanne	MED	SO
51	Shahid, Zarina	MED	SO
52	Shalov, Tate	MED	SO
53	Thomas, Luke N	MED	SO
54	Allendorf, Fiona	MED	SO
55	Valdes, Cecilia	MED	SO
56	Yang, David	MED	SO
57	Knapp, Emma	MICRO	JR
58	Marshall, Shayla	CELL	SO
59	Hota, Lasya	CELL	JR
60	Qiu, Amy	CELL	SO
61	Reddyjarugu, Saket	CELL	JR
62	Agarwala, Kiran K	CELL	SO
63	Chen, Cindy	CELL	SR
64	Wen, Solon C	CELL	SO
65	Tsao, Sydney	CELL	SR
66	Venkatesh Misawa, Chiharu	CELL	SO
67	Guo, Kevin	CELL	SR
68	Ende, Sydney	CELL	SO
69	Fijman, Caleb	NEURO	JR
70	Samuelson, Clara	NEURO	JR
71	Livne-Tarandach, Shahak	NEURO	JR
72	Talla, Priyanka	NEURO	JR
73	Battu, Mukul	NEURO	SR
74	Regan, Olivia	PLANT	JR
75	Marchesano, Andy	PLANT	JR
76	Prasad, Taylor	ENG	SO
77	Yang, Edward	ENG	JR
78	Morales Areas, Ellen	ENG	SO
79	Aron, Riya	ENG	JR
80	Fatouh, Faris K	ENG	SO
81	Harris, Benjamin	ENG	SR
82	Bhattacharya, Swaraj	ENG	SO
83	Cheng, Dayuan	ENG	SR
84	Gibbs, Zachary	ENG	SO
85	Dang, Jason	CBIF	JR
86	Fu, Warren	CBIF	SR
87	Khurana, Anya	CBIF	JR
88	Kumar, Rishi	CBIF	SR
89	Lamb, Madeline	CBIF	JR
90	Ramirez, Ryan	CBIF	JR
91	Talla, Naveen	CBIF	SR
92	Vijil, Aditi	CBIF	JR

Number	Name	CATGORY	YR
93	Vu, Emily	CBIF	JR
94	Xue, Henry	CBIF	JR
95	Lansford, Owen K	CS	SO
96	Jankovic, Allen	CS	SO
97	Chung, TingRay	CS	SR
98	Brennan, Austin	CS	SO
99	Kamal, Adam	CS	SR
100	Sharma, Devan	CS	SO
101	Zhang, Ryan	CS	SR
102	Zhang, Yuxing	CS	SO
103	Piacentini, Jarno	PHAST	SO
104	Huang, Albert	PHAST	SR
105	Clinton, Violet	PHAST	SO
106	Stryker, Sam	PHAST	SR
107	Zhang, Justin	PHAST	SO
108	Tseng, Rudolf	PHAST	SR
109	Gomez, Camila	PHAST	SO
110	Beaton, Stella	PHAST	SO
111	Bhuwan, Vyom	PHAST	SO
112	Paul, Ryan	CHEMISTRY	SO
113	Zhang, Athena	CHEMISTRY	SO
114	Fan, Yuan	CHEMISTRY	SO
115	Choudry, Azlan	CHEMISTRY	SO
116	Chlystun-Githae, Ellyanne	BEH	SO
117	Correia, Chris	BEH	JR
118	Cruet-Ghosh, Dylan	BEH	SO
119	Gottlieb, Jasper	BEH	SO
120	Gursahani, Anika	BEH	SO
121	Harrison Simon	BEH	SO
122	Jangi, Arjun S	BEH	SO
123	Khanna, Ashna	BEH	JR
124	Low, Livia	BEH	JR
125	Maghen, Shaili	BEH	SO
126	Mathew, Jace	BEH	SO
127	McKie, Riley	BEH	SO
128	Murphy, Jack	BEH	SO
129	Nayudu, Chankya	BEH	JR
130	Serini, Nicholas	BEH	JR
131	Sharma, Uma	BEH	SR
132	Siletti, Julia	BEH	SO
133	Tao, Connie	BEH	JR
134	Tupili, Gayathri	BEH	SO
135	Urrea, Arantza	BEH	SO
136	Wang, Sophia	BEH	SO
137	Yedid, Lia	BEH	SO
138	Lansford, Eve	BEH	SR



Celebrating Our Achievements and Future Researchers