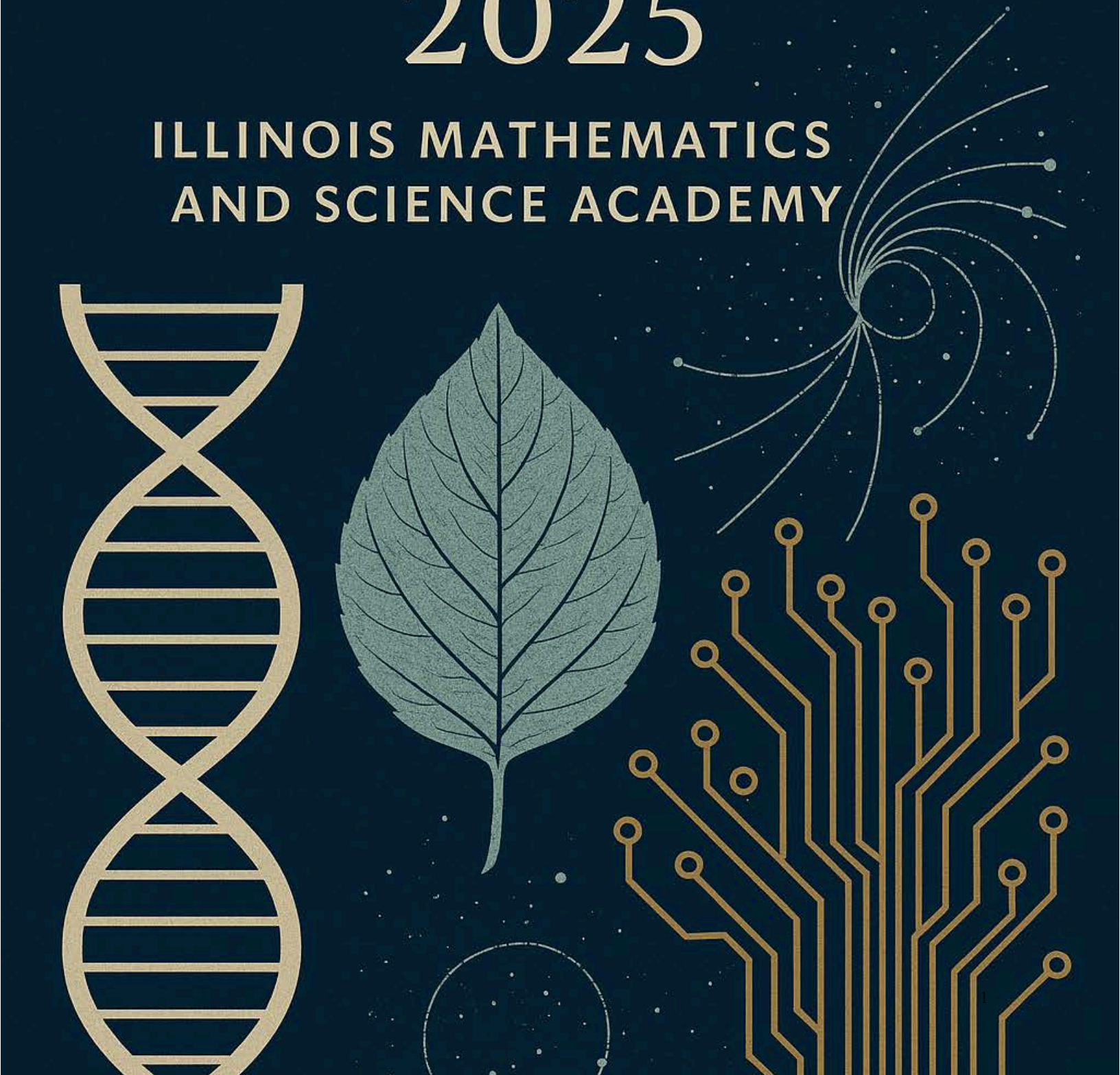
SUMMER SYMPOSIUM 2025

ILLINOIS MATHEMATICS AND SCIENCE ACADEMY



Summer Symposium 2025 | Contents

August 15, 2025

Dear IMSA Students, Faculty, Staff, and Friends,

Welcome to Summer Symposium 2025!

For nearly four decades, IMSA has worked to advance the human condition through educational innovation. The Summer Symposium is our annual showcase for the research projects that were conducted in IMSA's experiential learning programs between May and August. These programs include Student Inquiry and Research (SIR), IN2 Business Internships, and the Student Research and Experiential Learning Opportunity (SRELO) program.

This booklet contains abstracts for student projects ranging from biomedicine, to chemistry and physics, to mathematics and the social sciences, to entrepreneurship. Our students have worked hard on their projects, some individually, some in groups, and today is the day for them to present their findings. We have nearly 100 projects to share with you!

Many of our students are working with mentors at leading universities, research laboratories, and businesses. Some students have worked remotely with off-campus mentors. Other students have worked with IMSA's Faculty on campus. We would very much like to thank both our off-campus and on-campus mentors for their outstanding work with our students. Our programs would not exist were it not for their willingness to ignite and nurture creative, ethical, and scientific minds in the next generation.

In addition to thanking our mentors, we wish to thank IMSA's Faculty and Staff for supporting our student programs, and for their assistance with coordinating and hosting the Symposium. We hope you enjoy the event, and that you find it to be a rewarding and educational experience!

Sincerely,

IMSA President & CEO
Evan Glazer, Ph.D.

IMSA Principal's Office
Angela Rowley, Ph.D., Principal and CAO
Paul Gaszak, Ed.D., Dean of Academics and Equity
Anita Connors White, Ph.D., Dean of IMSA Scholars
Luke Berryman, Ph.D., Director of Experiential Learning

IMSA Summer SIR Management Team
Patrick Buck, Ph.D.
Cathy Cunz
Peter Dong, Ph.D.
Leah Kind, Ph.D.
Andrew Reif
Eric Smith, Ph.D
John Thurmond, Ph.D.

IMSA Business Internship
Sue Fricano, Innovation & Inquiry Program Manager

Summer Symposium 2025 | Presentations-at-a-Glance

Room A110

Students	Project Site	Project Title
Lorenzo Canali	Discovery Partners Institute	*A User-friendly Computational Tool for Cannabis Enzyme Product Classification*
Blake Hennings	IMSA	*Processing Data in Search of the Doubly Charged Higgs Boson and Dark Photon*
Ryan Kim	Southern Illinois University, Carbondale	*Stable DNA Monolayer Formation via Electrochemical Grafting on MoS_2 for Nucleic Acid Detection*

Room A113

Students	Project Site	Project Title
Daniel Limosnero	IMSA	*Evaluating Dark Photon Reconstruction Efficiency of a Boosted Decision Tree*
Ryan Mason, Ava Zou	University of Illinois at Chicago	*Ergonomic Work Environment Design Using Santos® 3D Modeling Software*
Jayaditya Akhauri (IMSA Scholar)	IMSA	*Simulation-based Analysis of Parameter Effects on Z' Portal Boson*

Room A115

Students	Project Site	Project Title
Vishnu Vijay, Isabella Alban, Vijnna Appasani, Aiden Chang, Atharv Kanchi	CSIL	*Curating Illinois' Statewide Hackathon for CS4IL*
Atharv Kanchi	University of Maryland, College Park	*Analysis of the Hidden Subgroup Problem in Quantum Computing*
Kennedy Su	Southern Illinois University, Carbondale	*Tracking Earthquakes and Thunder with Seismic Recordings*
Vishnu Vijay	Illinois Institute of Technology	*Machine Learning for QAM-16 Demodulation: Evaluating the Star, Cross, and Square Constellations as Hardware Alternatives*

Room A116

Students	Project Site	Project Title
Lucas He	SafeStart Medical	*Health Tech Operations and Research with SafeStart Medical*
Isaac Lee	University of Illinois Urbana Champaign	*Frost-Template Fabrication of Rough MetalSurfaces*
Lucas He	Ivy League Potential	*Sales Marketing and Scaling with Ivy League Potential*

Room A117

Students	Project Site	Project Title
Alyssa Gonzalez	Western Illinois University	*Rational Design of 6-Mercaptopurine-Riboside to Treat Acute Lymphoblastic Leukemia & Chronic Lymphocytic Leukemia*
Aimanohi Imoukhuede	University of Illinois at Chicago	*Research with Python using Pygame*
Dhivya Dharsne Kamaraj	University of Illinois at Chicago	*Research with Python using Pygame*
Joven Chinna, Lucy Ferron	Discovery Partners Institute	*Environmental Determinants of Bacterial Contamination in Recreational Waters in Chicago Beaches*

Room A119

Students	Project Site	Project Title
Nara Feng	University of Illinois Urbana Champaign	*Agrivoltaics: A Review of Co-Location Strategies for Agriculture and Solar Energy*
Gyuri Kim	University of Illinois at Chicago	*Solutes' Effects on Ice Formation and Ice Adhesion Strength*
Fatema Shikora	University of Chicago	*Urbanization and the Gut: A Comparative Study of Microbiome and Diet in Indian Populations*
Tanvi Khadse, Isabella Li	Discovery Partners Institute	*Evaluating Safety of GenAI Models in Workforce Development*

Room A121

Students	Project Site	Project Title
Dweny Geeth	Western Illinois University	*Rational Design of Phenobarbital Analog to Treat Seizures*
Shrigauri Hattarki	University of Illinois at Chicago	*Isolation and Evaluation of Environmental Bacteria for their Antibacterial Properties Against Selected ESKAPE Pathogens*
Katherine Jiang	University of Chicago	*Using Metropolis Monte Carlo Simulations and Integration of Quaternions to Sample Binding Angle Restraints*

Room A123

Students	Project Site	Project Title
Skyelar Reuter	Illinois Institute of Technology	*Anti-Inflammatory Potential of Strawberry Extracts in an LPS-induced In Vitro Model*
Kavyaa Naveen	IMSA	*Computational Investigation of Acetone*
Sophia Atanassov	IMSA	*Using the Computational Chemistry Tool SPARTAN to Estimate Physical Features of Acetyl Salicylic Acid (Aspirin)*

Room A129

Students	Project Site	Project Title
Damaris Benzar	Kane County Forest Preserve	*What is the population status of the American Kestrel in Kane County?*
Srimedha Veerathu	Rush University	*Effects of Antiretroviral Therapies on Monocyte-Derived Osteoclast Resorption Events*
Claire Wen	Western Illinois University	*Rational Design of a Fluoxetine Analog to Reduce Nausea Side Effects*
Jessica Jiang, Kelsie Li	Northwestern Medicine Proton Center	*Investigation of the variability in tissue composition for head neck, thorax, and abdominal proton plans*

Room A131

Students	Project Site	Project Title
Hannah Chen	IMSA	*Analyzing the Effects of the Mass of the Exotic Higgs Boson on Dark Photons Decaying to Lepton Jets*
Michelle Kim	Kane County Forest Preserve	*Predicting Habitat Functionality for Blanding's Turtles (Emydoidea blandingii)*
Titania Ward	South Holland, IL	*Youth Academic and Enrichment Support at River Oaks Community Education and Development*

Room A133

Students	Project Site	Project Title
Louis Chen	Southern Illinois University, Edwardsville	*Vision-Based Leaf Counting for Crop Analysis Using Segmentation Models*
Aarav Shah	Massachusetts Institute of Technology (MIT)	*Evaluating Multi-Patch Adversarial Attacks on Vision-Language Models*
Aarav Shah	Alchemy Software LLC	*Software Development at Alchemy Software LLC*

Room A135

Students	Project Site	Project Title
Kalyan Cherukuri	Northwestern University	*Control vs. Congestion: Learning to Untangle Mixed-Autonomy Flow*
Eric Chen	Western Illinois University	*The Rational Design of a Diphenhydramine Analog to Treat Allergies*
Phuockhang Le	Discovery Partners Institute	*LLM-based software supply chain attack*
Atmaj Shelar	Northwestern University	*Finite Element Modeling of Thermal Gradients and Heat Losses in Fe-W Redox Reactors*

Room A147

Students	Project Site	Project Title
Neil Sitapara	IMSA	*Guanine*
Andrew Sun	University of Illinois at Chicago	*Developing a Singleplayer Turn-based Strategy Game Using Godot*
Korel Gudukoglu (IMSA Scholar)	IMSA	*Setting a Limit on the Kinetic Mixing Parameter ε in Searches for Dark Photons Decaying to Lepton Jets*
Adriana Hernandez (IMSA Scholar)	IMSA	*Effect of Final State Radiation in the Dark Sector on Lepton Jet Detection*

Room A149

Students	Project Site	Project Title
Benas Stonys	Alchemy Software LLC	*Social Media Marketing with Alchemy Software*
Kieran Edwards, Ethan Chang	IMSA	*The Effects of Different Compounds on Glucose in Diabetic Blood & Urine*
Aryan Mansingh	APS Technologies	*Junior Software Developer*
Anjali Srinivasan (IMSA Scholar)	IMSA	*Glucose-lowering potential of fenugreek, cinnamon and stevia*

Room A150

Students	Project Site	Project Title
Jasmine Nuno	Chicago State University	*2025 Magnetic Nano Particles Applications in Cleaning for the DOD*
Cindy Gonzalez	Southern Illinois University, Carbondale	*Visualizing the BONDS and MOLECULAR interactions between p53 and MDM2*
Olivia Pan, Abigail Kinsland, Peter Panchev	Western Illinois University	*Generating Polarization States of Light for Use in Quantum Key Distribution*
Mbayie Tendong	University of Illinois at Chicago	*Synthesizing Magnetic Nanocomposites for Water Pollution Cleanup*

Room A151

Students	Project Site	Project Title
Sahasra Janagama	University of Illinois at Chicago	*Droplet Impact and Freezing Behavior on Cold Surfaces Under Controlled Environmental Conditions*
Henry Maginel	Johns Hopkins University - Applied Physics Lab	*Viability of Roof-Mounted Wind Turbines in Urban Settings*
Samaairah Kapoor, Larry Yang	Southern Illinois University, Carbondale	*Selected ESKAPE Pathogens Characterizing the Effects of Biostimulants on Plant Growth and Soil Microbes*

Room A152

Students	Project Site	Project Title
Nathan Catlett	IMSA	*Exploring Parameters to Separate Drell-Yan Background From Dark Photon Events*
Avery Lau	University of Illinois Urbana Champaign	*Flexible Photodiode Array for X-Ray Detection*
Maneth (Akaine) Perera	Southern Illinois University, Carbondale	*Prototyping New Systems for White Light Solar Flare Observation and Data Collection*
Paul Ratasuk	Illinois Institute of Technology	*Interactive Learning Interface for Understanding Safety with Large Language Models*

Room A155

Students	Project Site	Project Title
Michael Anderson	DMG Mori	*CNC Machining and Automation with DMG MORI*
Harish Chandar	Alchemy Software LLC	*User Interface and Feature Development for Cross-Platform Applications*
Ethan Charoenpitaks	Discovery Partners Institute	*Developer-focused dependency evaluation using IDE extension*
Dhruv Ravinuthala	Southern Illinois University, Carbondale	*Examining the efficacy of using 3D Models of Bravais lattices*

AC Pit

Students	Project Site	Project Title
Molly Federici, Bao Luong	Southern Illinois University, Carbondale	*Exploring Light Absorbance Properties of Functionalized Biphenyls for Organic Solar Cells*
Amelia Weingarz	Southern Illinois University, Carbondale	*Applications of Ground-Penetrating Radar on Historically Significant Cemeteries*
Radhini Panchal, Aashritha Kukunooru	IMSA	*The Effects of Natural Compounds on Synthetic Diabetic Blood and Urine*
Charlotte Paquette	Southern Illinois University, Edwardsville	*Spatial and Statistical Analyses of Cancer Mortality Rates 2008- 2022 in Illinois*

Room B108

Students	Project Site	Project Title
Matthew Nowak	University of Illinois at Chicago	*Role of Nucleoporin93 in Cholesterol Regulation via SREBP2 Signaling*
Laksh Patel	Velexi	*Dictionary Learning for Classification of Functional Groups in Organic Molecule RamanSpectra*
Neel Shanbhag, Aara Lala	Southern Illinois University, Carbondale	*A Low-Cost, Open Source Cybersecurity Framework for Educational Institutions*
Jeev Hora, Oscar Chaplin	Western Illinois University	*Quantification of 3 Neutral Cannabinoids in Δ 9 -THC Analogs–Infused vaping oils by UHPLC-DAD with ESI/TOFMS Confirmation of Analyte Identity*

Room B110

Students	Project Site	Project Title
Nysa Bothe	Northwestern, Feinberg	*Examining if and how Light Exposure plays a role in Axis-I DSM Diagnoses in Patients with Delayed Sleep-Wake Phase Disorder*
Ashlyn Gupta	University of Illinois at Chicago	*Using Community Health Needs Assessments to assess cancer needs and priority*
Anushri Sinha	University of Illinois Urbana Champaign	*Synthesis and characterization of hydrogels for energy storage and soft robotics applications applications*

Room B115

Students	Project Site	Project Title
Amada Garcia	Southern Illinois University, Carbondale	*Develop engineered probiotic yeast that can convert plastic into food ingredients*
Muskaan Kapur	University of Chicago	*Evaluating the effects of the 1984-1995 Sikh Genocide through Spatial Data Science*
Mahima Krishnan	Southern Illinois University, Edwardsville	*Naturalization of Salt Creek streamflow*

Room B116

Students	Project Site	Project Title
Aini Ahmed	Southern Illinois University, Carbondale	*Performing Molecular Dynamic Simulations to Examine Cortisol-CBG and Prednisolone-CBG Interactions for Cortisol Biosensing Applications*
Kateryna Honchar	Southern Illinois University, Carbondale	*Video Collaboration and Production at the Intersection of the Arts and Sciences*
Shripranavi Savya	University of Illinois at Chicago	*Characterizing Inner Ear Hair Cell Mitochondria*

Room B133

Students	Project Site	Project Title
Amber Hwang	IMSA	*Calculating Properties of Beta D-Glucose through Molecular Modeling*
Hayeon Kwak	Western Illinois University	*Rational Design of Tramadol Analog to Relieve Pain*
Sonya Patel	University of Pittsburgh	*Exploring Color Spaces for Skin Tone Characterization*

Room B148

Students	Project Site	Project Title
Aadi Chandraya, Nicholas Mohyla	Rush University	*Systematic Review of the Effect of Exposure to Greenspace on Stress Biomarkers in Older Adults*
Amelia Du, Morgan Schray (IMSA Scholar)	IMSA	*The Effect of Date Sugar, Ginger, Cinnamon and Fenugreek on Diabetic Blood Glucose and Urine Glucose Levels*
Sofiya Patel	Alchemy Software LLC	*Productivity Software Design and Data Analysis with Alchemy Software*

Lecture Hall

Students	Project Site	Project Title
Harrison Jang	Velexi	*Developing a quantitative analysis method for FTIR spectra based on Random Projection Sparse Signatures*
Deen Kareem	Discovery Partners Institute	*Mapping Avian Influenza Hotspots Through GIS and Species Surveillance in Illinois*
Aditya Tiwari	Discovery Partners Institute	*H5N1 Modelling through the OneHealth Framework*
Roy Wang	Southern Illinois University, Carbondale	*Magneto-Optical Faraday Effect in Ferrocene*

Staff Lounge

Students	Project Site	Project Title
Noe Barocio Cardenas	Kane County Forest Preserve	*The Effect of Prescribed Burning on Rare Plants in Kane County*
Riyan Jain	Northwestern University, Evanston	*Redefining Western Blot Procedures: A Modified Approach for the Reliable Detection of Amyloid- Beta Oligomers (AβOs) in Alzheimer's Research*
Nehum Koti	IMSA	*Evaluating the Molecular Properties of Erythritol through Computational Chemistry*

Tell Labs

Students	Project Site	Project Title
Oscar Lee	Discovery Partners Institute	*Frost-Template Fabrication of Rough Metal Surfaces*
Izen Wong	IMSA	*Setting Limits on a Toy Model Using The CLs Method*
Saesha Sumeeth	Northwestern, Feinberg	*Wireless, Bio-Implementable Strain Gauge for Continuous Bladder Monitoring*

Summer Symposium 2025 | Presentation Abstracts

Abstracts are organized alphabetically by the second name of the first presenter.

Performing Molecular Dynamic Simulations to Examine Cortisol-CBG and Prednisolone-CBG Interactions for Cortisol Biosensing Applications

Presenter: Aini **Ahmed**

Mentor: Poopalasingam Sivakumar, Southern Illinois University

Excess or a deficiency of cortisol is attributable to many diseases and disorders, however, it remains a struggle to create a precise and accurate method of measuring blood cortisol. Biosensing of cortisol has become an increasingly popular method of measuring the amount of cortisol present in the human body and therefore stress. It is done by taking a sample of hair, saliva, sweat, or other bodily fluids to then perform spectroscopy and immunoassays to identify and quantify the targeted compound. At a molecular level, corticosteroid-binding globulin is bonded to cortisol, however, there are cases where prednisolone binds instead, causing the free cortisol to remain present and active in the blood stream. GROMACS was used to simulate the binding interactions when cortisol or prednisolone binds onto CBG. This paper elaborates on the differences between the two binding interactions and how this relates to future applications for optimizing biosensing of cortisol.

Simulation-based Analysis of Parameter Effects on Z' Portal Boson

Presenter: Jayaditya **Akhauri**

Mentor: Dr. Peter J. Dong

The hypothetical Z' portal boson is of particular interest in particle physics due to its potential role in connecting the Standard Model to a proposed dark sector, which can be detected via lepton jets resulting from dark photon decays. In this study, we use PYTHIA-based simulations to investigate how variations in dark final state radiation (DFSR), Z' mass, and intermediate mass individually affect Z' decay products. We quantify the impact of these parameters on lepton jet multiplicity, production cross section, and the expected event yield. Our results show that increasing DFSR increases lepton jet multiplicity and event yield, while leaving the cross section unchanged. Increasing the Z' mass produces a peak in lepton jet production near 2500, but generally reduces both event yield and cross section. Increasing the intermediate mass consistently reduces lepton jet multiplicity and cross section.

Curating Illinois' Statewide Hackathon for CS4IL

Presenter: Isabella **Alban**

Mentor: Mark Smithivas

CS4IL is a nonprofit organization focused on expanding equitable access to computer science education across Illinois. This project supported the planning of a statewide student hackathon by contributing to visual design, challenge development, and event coordination. Responsibilities included creating promotional materials, reviewing and revising hackathon problem statements, and offering feedback on timelines, user experience, and marketing strategy. To guide this work, research was conducted on best practices in hackathon planning, with a focus on inclusivity, challenge clarity, and student engagement. Networking events, such as CSPD Week in Springfield, and Speaker Series in downtown Chicago, were attended to better understand the broader CS/Tech education landscape in Illinois. Tools such as Canva were used to collaborate on flyers and documentation, while feedback was incorporated throughout the planning process. This experience contributed to a greater understanding of how technical skills, communication, and event strategy intersect in real-world CS education initiatives, and provided insight into how statewide organizations promote youth participation in computer science.

CNC Machining and Automation with DMG MORI

Presenter: Michael **Anderson**

Mentor: John S. Aussem

DMG MORI is a global leader in precision CNC machine tools and automation solutions. This internship focused on hands-on experience with both lathes and milling machines, emphasizing the use of CELOS and FANUC control systems. I explored CNC workflows from setup to execution, learned how to navigate and operate CELOS interfaces, and programmed basic parts using FANUC G-code. The project also involved observing and analyzing how automation is integrated into modern machining environments to improve efficiency and reduce cycle times. Throughout the internship, I contributed to machine operation testing and provided feedback on control system usability and workflow optimization. This experience deepened my understanding of the advanced manufacturing process and highlighted the critical role of digital control systems in smart factories.

Planning a Statewide Hack-A-Thon & Working to Establish Computer Science Within Illinois

Presenter: Vijnna **Appasani**

Mentor: Mark Smithivas

CS4IL is a nonprofit initiative dedicated to launching a state-wide hackathon in Illinois that welcomes students of all ages and skill levels. Unlike traditional hackathons that focus solely on coding, this interdisciplinary event incorporates robotics, mathematics, and logic based challenges to broaden accessibility and foster diverse problem-solving skills. Over the summer, our team advanced multiple aspects of the event design while also laying the groundwork for a legislative effort to promote computer science education across Illinois' public schools. Though still in its early stages, this policy initiative aims to mobilize student voices and drive systemic change in K–12 curriculum.

Using the Computational Chemistry Tool SPARTAN to Estimate Physical Features of Acetyl Salicylic Acid (Aspirin)

Presenter(s): Sophia **Atanassov**

Mentor(s): Dr. Joseph Golab, Illinois Mathematics and Science Academy

Quantum mechanics is what gives computational chemistry the ability to model and predict molecular properties and behavior of a specific molecule. Using quantum mechanical theories such as Hartree-Fock (HF), Density Functional Theory (DFT), and PM3 help solve Schrodinger's equation for a molecule and can also give theoretical yields for physical properties such as bond length, bond angle, lowest energy conformer, etc. These theories can be applied to molecules that cannot be tested experimentally or the experiments are costly. In this study, we aim to use SPARTAN, a computational chemistry tool, to predict the molecular and behavioral properties of acetylsalicylic acid, otherwise known as Aspirin. Specifically, we will test bond length, bond angle, lowest energy conformer, isodesmic prediction of heat of formation, and ionization potential in comparison to experimental values within different theories, such as HF or DFT, and sets to find the percent error that occurs for the specific data set we use. We can use these percentages as a guideline to help facilitate possible benchmarks for these properties in molecules and use them to predict possible properties for molecules we cannot run these experiments on at the given moment. In conclusion, computational tools within chemistry can help with giving insights on chemical properties that could be used from drug research to gene therapy and beyond.

The Effect of Prescribed Burning on Rare Plants in Kane County

Presenter: Noe Maximiliano **Barocio Cardenas**

Mentor: Monika Kastle, Kane County Forest Preserve

Prescribed burning is a common practice for land management in prairie ecosystems, used to reduce wildfire risks and improve habitat health. Rare plants are vital for maintaining biodiversity in an environment. However, its effect on rare plants is still under-researched. This study aims to uncover the effects of prescribed burning on the population size and reproductive output of two rare plants, the Lady's Slipper Orchid and the Royal Catchfly. We collected 10 years of observational data of the two rare plants across Kane County Forest Preserves, comparing populations before and after prescribed burns. A direct counting method, utilizing GPS markers and clicker counters, was employed to record the presence of reproductive and non-reproductive plants at consistent locations. Secondary observational data, such as deer browsing and unauthorized trails, were also collected. Our findings will help determine whether these rare species benefit from or are negatively affected by prescribed burning. The results we uncover could inform future conservation efforts and fire-managed prairie environments.

What is the population status of the American Kestrel in Kane County?

Presenter(s): Damaris **Benzar**

Mentor(s): Sadie Dainko, Forest Preserve District of Kane County

The American Kestrel (Falco sparverius) population has been on the decline since the 1970s. While several theories about their population drop have been investigated, a full explanation has yet to be established. By accurately measuring and tracking their population, we help provide the foundation for continued research, demographic modeling, and informed conservation strategies. We visited nest boxes, captured adult and juvenile American Kestrels, collected and recorded their data, and then finally banded and released them. Through our work, we were able to add to the existing database of information on the American Kestrel and gain insight into the demographics of this specific Kestrel community.

Examining if and how Light Exposure plays a role in Axis-I DSM Diagnoses in Patients with Delayed Sleep-Wake Phase Disorder

Presenter: Nysa **Bothe**

Mentor: Dr. Phyllis C Zee, Northwestern University

Delayed Sleep Phase Wake Disorder (DSWPD) is a circadian rhythm sleep disorder (CRSD) characterized by habitual delayed sleep onset and wake times relative to conventional times, which is often accompanied by impaired daily functioning and increased risk for medical and psychiatric comorbidities. Past studies have demonstrated a prevalence of Axis-I DSM diagnoses in patients with DSWPD, along with altered patterns of light exposure, which may delay the endogenous circadian phase and exacerbate the mental health outcomes. However, no study has directly examined whether and how timing, intensity and duration of habitual light exposure affects circadian phase and sleep to influence psychiatric symptoms in patients with DSWPD. Drawing from actigraphy data, sleep diaries that participants kept, light and activity monitoring, and data from structured clinical interviews for Axis-I DSM disorders, we will analyze the patterns of light exposure relative to conventional times and endogenous circadian phase. Psychiatric disorders and comorbidity rates will be compared between patients with DSWPD and controls. Results and conclusions are yet to be obtained.

A User-friendly Computational Tool for Cannabis Enzyme Product Classification

Presenter: Lorenzo **Canali**

Mentor: Dr. Sugyan Dixit, Discovery Partners Institute

Cannabis is a complex plant genus containing hundreds of bioactive compounds, such as cannabinoids and terpenes, which act on the human endocannabinoid system to produce a wide range of therapeutic and psychoactive effects. Clarifying how these compounds are biosynthesized, most importantly by enzymes like limonene synthase, can aid in therapeutic product development. This project focuses on understanding the relationship between structure and function in cannabis enzymes through bioinformatics and modeling tools. We integrate biological and physicochemical data to better understand the products made by different cannabis enzymes. Using Python libraries like Biopython and RDKit, we extract meaningful biophysical features and molecular descriptors from protein sequences and structures. So far, we've calculated features such as sequence length, molecular weight, amino acid composition, hydrophobic surface distributions, GRAVY scores, and isoelectric points. We plan to extract additional features that will offer further insight into the

biophysical properties of these enzymes. Eventually, we aim to train a machine learning model that can predict enzyme products based solely on their sequence.

Exploring Parameters to Separate Drell-Yan Background From Dark Photon Events

Presenter: Nathan **Catlett**

Mentor: Peter Dong

This research explores methods by which to distinguish lepton jets originating from Drell-Yan events and dark photon decays, a key challenge in the search for the dark photon. Using a theoretical framework of the dark photon implemented in PYTHIA 8.35, a Monte-Carlo generator for particle collisions at the LHC, parameters of delta R, pseudorapidity, invariant mass, transverse momentum, and the number of leptons per jet were examined with the intent of finding cuts that optimize the retention of dark photon events while suppressing as many Drell-Yan events as possible. The final cuts yield a 37.2-fold increase in the signal-over-background significance metric ($s/\sqrt{b}$), demonstrating substantial improvement in separating Drell-Yan from dark photons and providing potential guidance for future research.

Effect of Prosthetic Foot-Ankle Stiffness on Standing and Walking Performance in Transfemoral Prosthesis Users

Presenter: Dhivija Sai **Challa**

Mentor: Steven A. Gard, Northwestern University

During the stance phase of able-bodied walking, the foot and ankle form a roll-over shape that minimizes vertical body motion and enables efficient forward progression. This shape remains consistent across walking speeds due to adaptive joint stiffness. In contrast, passive prosthetic feet have fixed stiffness, so their roll-over shape is expected to vary with speed due to changing forces during stance. This study examines how walking speed affects the roll-over shape in a prosthesis user. Currently, it is hypothesized that as an individual's walking speed increases, the roll-over shape radii decrease. In this analysis, the data was collected from a subject walking at three different speeds with five combinations of keel and bumper (soft-hard, hard-hard, hard-soft, soft-soft, and medium-medium). To identify the roll-over shape radius, the subject's height, amputated side, ground reaction forces, center of pressure, marker locations in a 3D space, and speed were entered into a program which calculated the roll-over shape radius. This radius represents the radius of the center of pressure with respect to the shank coordinate system. It is used to understand how the foot interacts

with the ground and can be used to design and evaluate assistive devices like prosthetic feet and orthotic devices.

User Interface and Feature Development for Cross-Platform Applications

Presenter: Harish **Chandar**

Mentor: Aidan Keighron

Half Full is a lightning-fast productivity tool that allows you to organize your life with just one click. Its core design is to cut through the clutter and have everything easily accessible with a click, hover, or keyboard shortcut. Tasks are automatically recolored using pattern-matching. Tasks can be quickly sorted using the intuitive task tray and daily bar. Whereas the desktop app has been in development for a long time, the mobile app only existed as a lightweight companion to the desktop app with no standalone functionality. I implemented feature parity with desktop to have Half Full Mobile function as a standalone app, as well as UI/UX tweaks that added polish to bring the app out of its MVP stage. This project involves React Native, Expo, and Firebase Firestore to develop cross-platform mobile ap plications that sync with the cloud. After the update was deployed, I transitioned to adding features to Half Full Desktop (built with ElectronJS and Firestore), where I focused on reducing clutter in the user interface. This internship project showcases full-stack cross-platform development and intuitive user workflows.

Building the First Statewide Hackathon with CS4IL

Presenter: Aidan **Chang**

Mentors: Mark Smithivas, Steve Svetlik

CS4Il is an organization that is focused on connecting computer science education throughout Illinois. A main focus of the business project for CS4IL was to design a hackathon that would be used statewide for high schoolers. This included researching coding problems, Studying MInecraft Education, and attending events in Chicago and Springfield. Over the course of the business project, CS4IL accelerated progress on the hackathon, completing a basic framework as well as a plan as to how the hackathon will play out. The most significant impact of the project was the connections made at events and the spread of the word throughout teachers for the CS4IL hackathon that will take place this fall.

The Effects of Different Compounds on Glucose in Diabetic Blood & Urine

Presenters: Ethan **Chang** & Kieran Edwards

Mentor: Dr. Sowmya Anjur, IMSA

Diabetes affects 11% of the population between the ages of 20-79, and common treatments such as insulin can be costly. Historically, natural remedies such as stevia, ginger, cinnamon, and turmeric were used to lower glucose. Modern studies have validated these treatments individually, showing glucose absorption abilities. However, no standardized comparison has been made across these compounds. Thus, this study directly compares the glucose-lowering abilities of the aforementioned compounds. Stock solutions were created using the herbs and added to (highly or slightly) diabetic blood samples with Benedict's reagent. Samples were heated, and glucose was estimated based on color change, using non-diabetic blood as a control. This procedure was repeated a second time, and then was repeated using urine samples. Results showed that ginger was most effective at lowering blood glucose, with cinnamon showing similar results. These findings suggest that the severity of hyperglycemia is most impacted by ginger intake, offering insight on what to consume for a cost-effective approach to diabetes management.

Quantification of 3 Neutral Cannabinoids in Δ 9 -THC Analogs–Infused vaping oils by UHPLC-DAD with ESI/TOFMS Confirmation of Analyte Identity

Presenters: Oscar **Chaplin**, Jeev Hora

Mentor: Liguo Song, WIU

Since the 2018 Farm Bill legalized hemp, a growing number of semi-synthetic cannabinoids, which are typically derived from hemp-extracted CBD, have emerged on the market, many advertised for their psychoactive effects. This has raised increasing concerns over consumer safety, product labeling, and regulatory oversight. An LC-UV method was developed and validated for quantifying Δ 9-THC-O-Acetate, 9(S)-HHC, and 9(S)-HHC-O-Acetate in a commercial vaping oil sample to support potency testing. The method demonstrated linearity from 0.08 to 50 µg/mL. Vaping oil was recovered using methanol, diluted to 50 µg/mL, and analyzed by the LC-UV method, providing a quantifiable range of 0.16 to 100% (w/w). Method specificity, confirmed by electrospray ionization time-of-flight mass spectroscopy (ESI-TOFMS), showed minimal interference from precursors, byproducts, and related isomers.

Developer-focused dependency evaluation using IDE extension

Presenter: Ethan **Charoenpitaks**

Mentor: Anuj Gautam

Many developers use libraries in order to achieve commonly-used tasks, as implementing such functionality by oneself can lead to bugs and the security properties of custom implementations may be difficult to verify. However, it is possible for malicious actors to publish malicious libraries or hijack existing benign libraries' distribution channels, in order to attack the developers who use said libraries in their code. In cases where developers use malicious libraries, this is often because the malicious library has a name similar to a real library, or appears to solve a developer's need while actually including malicious code. This type of attack is called a "supply chain attack", and the incidence rate of supply chain attacks has significantly risen with the rise of modern programming languages and package managers. Meanwhile, developers are beginning to use large language models to write their code, and large language models exhibit a tendency to propose that the user import deprecated libraries, libraries with misspelled names, or other unsafe libraries. In order to mitigate the risk of supply chain attacks, this work proposes a set of metrics that developers can use to evaluate dependencies they wish to include in their projects, and a developer-friendly extension to integrated developer environments (IDEs) that provides these metrics to the developer and helps them find high-quality dependencies. The metrics evaluate key characteristics such as known vulnerabilities, similarities between the source and packaged code, reproducibility, and maintenance status.

The Rational Design of a Diphenhydramine Analog to Treat Allergies

Presenter: Eric **Chen**

Mentors: Dr. Jin Jin and Dr. Zhang, Western Illinois University

Allergic reactions occur when the body overreacts to external stimuli, triggering a release of histamine, which binds to H1 receptors around the body, causing symptoms like sneezing, itchy noses, eyes, and skin, nausea, headaches, and in severe cases, anaphylaxis. The first-generation antihistamine drug diphenhydramine, commercially known as Benadryl, is often used to combat these effects. However, Benadryl has high blood-brain barrier (BBB) permeability, meaning it targets H1 receptors and muscarinic receptors in the brain, causing side effects such as sedation, dizziness, blurred vision, nausea, and others. This article focuses on the design of a diphenhydramine analog

that is more polar and larger than the original drug to decrease BBB permeability. Additionally, this project proposes a possible synthetic pathway for the analog drug.

Analyzing the Effects of the Mass of the Exotic Higgs Boson on Dark Photons Decaying to Lepton Jets

Presenter: Hannah **Chen**

Mentor: Peter Dong

The dark sector is a theoretical group of particles, and there may be a dark photon that exists and can interact with a portal, which can interact with both the dark sector and Standard Model particles. One particle of particular interest as a portal is the exotic Higgs Boson. When creating collisions, the main data points needed are the number of lepton jets and the cross section. By changing the mass of the exotic Higgs Boson, I found that detection is more sensitive to lower masses compared to higher masses. Additionally, after around 2000 GeV, sensitivity is lost, and it becomes very unlikely that any desired events will occur.

Vision-Based Leaf Counting for Crop Analysis Using Segmentation Models

Presenter: Louis **Chen**

Mentor: Dr. Rubi Quiñones, Southern Illinois University Edwardsville

Accurately estimating leaf count is critical for monitoring plant health, development, and yield potential, particularly in crops such as buckwheat and sunflower. Traditional leaf counting methods are manual, time-consuming, and prone to observer bias, limiting scalability in agricultural and ecological studies. While deep learning has enabled progress in automated phenotyping, most approaches rely on datasets with explicit leaf count annotations, resources that are scarce and expensive to produce. In this project, we use the CosegPP and CVPPP dataset to explore more about these constraints. The CosegPP dataset contains detailed segmentation masks but no leaf count labels, while the CVPPP dataset contains both segmentation masks and leaf count labels. We implement a two-stage system: deep learning models first segment plant regions, and then separate models infer leaf count from these segmented outputs. By evaluating combinations of segmentation and counting models, we assess how upstream mask quality influences downstream count accuracy. This approach enables effective use of partially annotated datasets and offers a scalable method for plant trait analysis, benefiting researchers in plant science, agriculture, and remote sensing.

Control vs. Congestion: Learning to Untangle Mixed-Autonomy Flow

Presenter: Kalyan **Cherukuri**

Mentors: Lihui Yi, Dr. Ermin Wei, Northwestern University

In complex traffic networks, adding new roads or "shortcuts" can paradoxically increase overall congestion, even with cost-free paths. This counterintuitive effect becomes even more intricate in systems that mix selfish human drivers with autonomous vehicles. Our project investigates how reinforcement learning, specifically an adaptation of Proximal Policy Optimization (PPO), can be used to mitigate this paradox in mixed-autonomy settings. We simulate traffic flow using a vector-based representation of agent behavior across paths, modeling humans with selfish routing strategies and autonomous agents with adaptive policies. Our experiments reveal that under certain network topologies, autonomous agents can converge to suboptimal equilibria, worsening overall delay. To address this, we introduce a reinforcement learning-based framework capable of identifying critical thresholds in agent population and network structure where control begins to break down. Our work contributes towards the nontrivial interaction between network topology, control dynamics, and agent behavior, offering tools to better design and manage future traffic systems that blend autonomy with human unpredictability.

The Effect of Date Sugar, Ginger, Cinnamon and Fenugreek on Diabetic Blood Glucose and Urine Glucose Levels

Presenters: Amelia **Du**, Morgan Schray

Mentor: Dr. Sowmya Anjur, Department of Student Independent Research at Illinois Mathematics and Science Academy, Aurora, IL.

Diabetes mellitus is one of the most prevalent noncommunicable diseases, impacting a quarter of the world's population; that number is only expected to rise. As such, there has been an unsurprising demand for antidiabetics. Unfortunately, antidiabetic medications are often expensive and can cause adverse side effects like nausea and abdominal pain. Therefore, there has been a recent surge in interest towards safe, naturally occurring compounds that can serve as antidiabetics. This study goal was to determine how diabetes mellitus of varying states of severity would be impacted by four natural compounds: ginger, cinnamon, date sugar, and fenugreek. All of these compounds were mixed in with synthetic blood and urine treated with various concentrations of glucose and the resulting solutions subsequently underwent the Benedict's test to measure the amount of reducing sugar in said solutions. Ultimately, fenugreek was found to be the most effective compound in both

blood and urine, followed by ginger in urine solutions and ginger in blood. Moderate diabetes seemed to be the most responsive to natural compound treatment.

Agrivoltaics: A Review of Co-Location Strategies for Agriculture and Solar Energy

Presenters: Nara **Feng**

Mentor: Xuzhi (Ronnie) Du, UIUC

Agrivoltaics, the dual use of land for both agricultural production and solar energy generation, is a relatively recent concept that has garnered increased attention over the past five years. It offers a promising approach to maximizing land-use efficiency while addressing the rising global demand for food and renewable energy. In my research, I conducted an extensive literature review of recent agrivoltaics studies to examine how photovoltaic (PV) panel installations impact crop yield, microclimate, crop growth, and overall energy output of the land. I also evaluated the economic feasibility of agrivoltaics systems and discussed their current limitations and drawbacks with my mentor. My analysis aims to provide a comprehensive overview of the field's progress and offer insights to guide future research in agrivoltaics.

Environmental Determinants of Bacterial Contamination in Recreational Waters in Chicago Beaches

Presenters: Lucy **Ferron** and Joven Chinna

Mentor: Dr. Marcia Renata Quadros da Silva, Discovery Partners Institute

This project aims to investigate the impact of environmental factors, such as weather patterns and wave height, on the levels of E. coli and enterococci in Chicago's 27 beaches. By gathering historical data on rainfall, temperature, wind, and wave height alongside results from bacterial monitoring, the primary factors that contribute to increases in contamination are pinpointed. An exploratory data analysis was conducted to find correlations and potential lag effects (for instance, elevated bacteria levels following storms or significant wave activity), thereby enhancing the understanding of the relationship between environmental conditions and water quality. Utilizing these findings, a predictive model was created that forecasts bacterial levels based on real-time weather and wave information. Model performance was evaluated using accuracy metrics and validated against historical data. The analysis indicated that rainfall, wave height, and beach crowding were significant predictors of elevated E. coli levels. This tool has the potential to assist water quality managers in issuing proactive beach advisories, mitigating public health risks, and optimizing monitoring efforts.

Develop engineered probiotic yeast that can convert plastic into food ingredients

Presenter: Amada **Garcia**

Mentor: Lahiru Jayakody, Southern Illinois University - Carbondale

This project explores a sustainable approach to food production by engineering yeast strains capable of converting plastic-derived compounds into edible ingredients. Utilizing terephthalic acid (TPA) and ethylene glycol, which are byproducts of microbial plastic degradation, three specialized yeast strains were developed for use in a 3D-printed food product. LJSJ 380, evolved for ethylene glycol tolerance, produces beta-carotene to add nutritional value and color. Saccharomyces cerevisiae BY4743, containing a plasmid encoding vanilla synthase, generates a clove-like aroma. Wild-type S. boulardii functions as the probiotic biomass component. Each strain was cultured in glucose or ethylene glycol media, and the resulting cells were harvested or sonicated to prepare functional biomass. These components were combined with ground oats to form a printable paste, producing a prototype cookie using 3D food printing technology. This system, known as microBite, demonstrates a proof-of-concept for converting waste into nutrition through synthetic biology. The work supports broader efforts to establish circular food systems and aligns with the goals of NASA's Deep Space Food Challenge by addressing food insecurity through closed-loop, waste-to-value solutions.

Rational Design of Phenobarbital Analog to Treat Seizures

Presenter: Dweny **Geeth**

Mentor: Dr. Jin Jin, Dr. Shaozhong Zhang, Western Illinois University

Phenobarbital, a barbiturate commonly used as an anticonvulsant, enhances GABA_A receptor activity to suppress neuronal excitability. However, its clinical use is limited by central nervous system side effects, particularly depression. This study proposes structural modifications to the phenobarbital molecule aimed at reducing effects of depression while maintaining its anticonvulsant efficacy. By introducing functional groups known to modulate serotonin pathways, the modified compound is designed to mitigate the phenobarbital-induced depressive effects. The introduction of a trifluoromethyl group is designed to improve blood–brain barrier permeability and metabolic stability. Additionally, incorporating an $O–CH_2–CH_2–NH_2$ moiety targets serotonin pathways to help mitigate depressive side effects while preserving anticonvulsant function. Utilizing pharmacophore and structural analysis, this proposal identifies potential chemical modifications that could enhance GABA selectivity and improve blood brain barrier permeability. A theoretical synthetic pathway was

also developed for the proposed compound. After the drug is synthesized, future plans include conducting structure-activity relationship studies, binding assays, and in vivo testing to evaluate pharmacodynamic and pharmacokinetic profiles. While this research is theoretical and requires experimental validation, it presents a promising drug molecule that optimizes existing anticonvulsant drugs while reducing side effects of depression.

Rational Design of 6-Mercaptopurine-Riboside to Treat Acute Lymphoblastic Leukemia & Chronic Lymphocytic Leukemia

Presenter: Alyssa **Gonzalez**

Mentors: Dr. Jin Jin, Western Illinois University, Dr. Shaozhong Zhang, Western Illinois University

Acute Lymphoblastic Leukemia (ALL) is rapidly progressing malignant cancer that originates in bone marrow and is typically fatal within months of a patient's prognosis. Likewise, Chronic Lymphocytic Leukemia (CLL) also begins in bone marrow, however is harder to diagnose because of the cancers slow growth and difficult prognosis. 6-Mercaptopurine (6-MP)is core drug used to treat ALL and CLL, however its clinical effects are hindered by the need for metabolic activation via hypoxanthine-guanine phosphoribosyltransferase (HGPRT), which is typically deficient or dysfunctional in Leukemia patients. My research proposes a rationally designed analog of 6-Mercaptopurine called 6-Mercaptopurine Riboside (6-MPR). 6-MPR is able to quickly enter cancerous cells, terminate key processes needed for cell replication, as well as expeditiously incorporating itself into DNA and RNA. The compound is synthesized from two substitution reactions. Several analytical techniques like column chromatography and nuclear magnetic resonance (NMR) spectroscopy were identified to test the purity and isolation of the final product. Future directions include properly synthesizing 6-MPR, in-vitro testing in Leukemic cell models, and subsequent structure activity relationship (SAR) studies. If the results are promising, the drug can proceed to in-vivo trials. This research highlights how structural modifications, such as a sugar addition, can drastically alter a drug's pharmacokinetics and therapeutic potential.

Visualizing the BONDS and MOLECULAR interactions between p53 and MDM2

Presenter: Cindy **Gonzalez**

Mentor: Poopalasingam Sivakumar, Southern Illinois University, Carbondale

Protein P53 is a tumor suppressor that is controlled by the e3 ubiquitin ligase MDM2. They bind together at the N-terminal transactivation domain of p53, involving specific residues. When the bond between p53 and MDM2 is dysregulated, it can result in tumor development then different cancers.

To better understand and visualize the binding and interactions of p53-MDM2, a program was created in Jupyter lab within a conda environment with the pdb code: 1YCR. We used ChimeraX to separate the p53 and MDM2 to access them individually. By using GROMACS we were able to use BioExcel Building Blocks to automate key steps. After running the program, we got an interactive 3D interface of p53, MDM2, and p53-MDM2. The analysis from 1YCR were also turned into graphs such as the RMSD and radius of gyration. Interfaces similar to this can help simulate different potential mutations that can be used for cancer treatment.

Setting a Limit on the Kinetic Mixing Parameter ε in Searches for Dark Photons Decaying to Lepton Jets

Presenter: Korel **Gudukoglu**

Mentor: Peter Dong

This study uses the PYTHIA event generator to explore how the kinetic mixing parameter (ε) for dark photons can be regulated by analyzing Higgs boson decays. In particle physics, ε describes the strength of interaction between dark sector particles and Standard Model particles. Luminosity plays a key role because it determines the expected size of our signal dependent on ε. By changing our luminosity, we can estimate the smallest ε values that could be detected. Even if no signal is observed, this would allow us to set a limit on ε. My results show that a minimum integrated luminosity of 635 fb^{-1} is required to set meaningful limits on dark photon production through a Standard Model Higgs. The current measured invisible decay width of the Higgs is 10.7%, meaning that up to 10.7% of Higgs decays could involve invisible particles such as dark photons. Matching the predicted lepton jet rates to what is observed in detectors will enable more precise constraints on ε, providing an important step toward understanding possible hidden sectors in particle physics.

Using Community Health Needs Assessments to assess cancer needs and priorities

Presenter: Ashlyn **Gupta**

Mentors: Jeanette Santana González, Dr. Yamilé Molina, University of Illinois at Chicago

Health disparities in cancer prevention, interventions, and treatment continue to exist in Chicago due to lack of access to screenings and medical risk factors for cancer. These disparities contribute to higher prevalence of cancer and worse outcomes, particularly among Black and Latinx communities in the South and West areas of Chicago. This study uses Community Health Needs Assessments(CHNAs) to better understand cancer properties, disparities, and needs to create targeted programs and interventions. 20 cancer priority Cook County zip codes were identified to administer

the CHNAs at. The CHNA questions were crafted to gather information on demographics, screenings, past cancer history, current health conditions and lifestyle, perspective on health issues, and areas of research and further study. The goal is to administer 2000 surveys with 1000 English and 1000 Spanish and to have 3 listening sessions. The purpose of listening sessions is to gather qualitative information on the target population's perspective on health resources, cancer screenings and concerns, lifestyle, and other health issues. Overall, this study aims to guide future research, outreach efforts, and inform the community on priorities, needs, and resources regarding cancer.

Isolation and Evaluation of Environmental Bacteria for their Antibacterial Properties Against Selected ESKAPE Pathogens

Presenter: Shrigauri **Hattarki**

Mentor: Dr. Mallique Qader, Institute of Tuberculosis Research, University of Illinois Chicago

Microbes with antibiotic properties are present in the natural world all around us, found in everything from soil to water to human tissue. In the drug discovery process, bacteria are isolated from natural samples, cultured, and simplified before testing against pathogens. A common set of pathogens used for testing are ESKAPE pathogens—highly antibiotic-resistant bacteria that pose significant threats to public health. In this research, environmental bacteria from water sources in Gurnee, IL were cultured, extracted, and fractionated using solid phase extraction (SPE). Each sample was separated by polarity into six fractionations. The fractionations were tested against Staphylococcus aureus, Acinetobacter baumannii, Pseudomonas aeruginosa, and a non-ESKAPE fungal pathogen, Candida albicans. Once the pathogen and fractions were incubated in 96-well plates at 37°C , the plates were read for their optical density by spectrophotometer. Out of 216 final fractions samples, one pond water fraction inhibited the growth of Staphylococcus aureus and was selected as a hit. This fraction was further analysed by liquid chromatography coupled to mass spectrometry (LC-MS) and determined to be the known antibiotic Gramicidin A. While this research did not lead to the discovery of a novel antibiotic compound, it demonstrates the use of natural environments as sources of medically significant microbial products, as well as the effectiveness of bioassay-guided fractionation as a tool in antibiotic screening.

Sales Marketing and Scaling with Ivy League Potential

Presenter: Lucas **He**

Mentor: Mr. Brad St.Ledger; Ivy League Potential, Director of Business Development; & Ms. Sonia Lal M. ED; Ivy League Potential, Founder

Ivy League Potential is an online college admissions counseling business that offers research opportunities, mentorship, SAT/ACT tutoring, and more. The company is going into new markets and scaling the company to the entire nation. During my internship, I worked under Mr. St.Ledger in the marketing department, specifically B2B sales. Along with other interns from UChicago, I contributed to the Go-to market strategy and assisted with prospecting every private high school in the US. We then started the sales pipeline, starting with sending a cold email and phone call to closing the deal with the private high schools. My work in this internship helped scale Ivy League Potential, strengthen the reputation and outreach of the company, and market to new customers. Through this opportunity, I gained valuable insights into the daily operations of marketing professionals and salesmen while supporting Ivy League Potential with their mission of giving advice and consultation to students all around the nation.

Processing Data in Search of the Doubly Charged Higgs Boson and Dark Photon

Presenter: Blake **Hennings**

Mentor: Peter Dong

We are currently in the process of searching for both the doubly charged Higgs Boson and the dark photon, both of which, if found, would have significant implications in the field of particle physics as a whole. In this search, we have collected a large amount of data from the CMS detector at the Large Hadron Collider, as well as generated our own data using Monte Carlo simulation. We are looking at various interactions that occur when two protons collide, and we are analyzing those interactions that have the same theorized signal of the doubly charged Higgs and the dark photon. In this project, we work on processing this data to create histograms and use the data in other aspects of the search as well.

Effect of Final State Radiation in the Dark Sector on Lepton Jet Detection

Presenter: Adriana **Hernandez**

Mentor: Peter Dong, Illinois Mathematics and Science Academy

In the Standard Model final state radiation allows for a photon to be radiated from a charged particle. Assuming the dark sector acts in a similar way we can assume that dark final state radiation would

result in dark photons and can be seen in an increase in the number of lepton jets produced. Using the PYTHIA Monte Carlo generator, I increased the FSR number between 0 to 50 to see the effects on the number of lepton jets, the effect on the separation between the leptons (DeltaR), and how it affected the number of leptons in a jet. What I found was that the number of leptons increased up to triple the normal amount, Delta R had a wider range, and more leptons were identified in the same jet.

Video Collaboration and Production at the Intersection of the Arts and Sciences

Presenter: Kateryna **Honchar**

Mentor: Matthew Williams

This project focuses on the creative translation of complex scientific research into a simple and engaging media format. Working with Chris Mandrell, a PhD candidate in Heliophysics at Southern Illinois University. We tried to create a song that explains the main goals and ideas of his doctoral dissertation. His work focused on observing patterns of coronal mass ejections (CMEs) to help improve models that allow accurate prediction of the X-class flares. Throughout two weeks, a team of three focused on lyrical writing, video production, and music composition. The final product, a music video, will be submitted to the international “Dance Your PhD” competition hosted by AAAS and Science. This project provides a unique opportunity to combine science and art, helping the audience to understand complex research in fun and creative ways, and most importantly, bringing attention to Chris Mandrell's work.

Calculating Properties of Beta D-Glucose through Molecular Modeling

Presenter: Amber **Hwang**

Mentor: Joseph Golab, Ph.D.

Glucose is a crucial molecule that is a primary energy source for countless living organisms. Beta D-Glucose is the form of glucose used in humans. Beta D-Glucose is also the monomer that forms the polymer, Cellulose. Cellulose has the potential to contribute to a sustainable future in textile, food, and packaging industries. Therefore, it is crucial to learn more about the properties of Cellulose to better understand the behavior and structure of the molecule. To obtain information about Cellulose, SPARTAN—a molecular modeling program—was used to perform calculations and compare experimental data about Beta D-glucose. These calculations predict the minimum energy coordinates, Heat of Formation, IR spectrum, and Ionization Potential of Beta D-glucose. The results

are shared in this presentation, along with a brief explanation of the methods used to compute the chemical properties.

Research with Python using Pygame

Presentors: Aimanohi **Imoukhuede**, Dhivya Kamaraj

Mentor: Pranav Bhounsule

Python is a widely used programming language known for its accessibility and rich ecosystem of libraries. This project focused on building video games from scratch by first learning the fundamentals of Python and then exploring its core libraries. Students began with NumPy and Matplotlib to understand concepts such as animation and data manipulation. These foundations were then applied using Pygame, a library used to create video games. By combining these tools, students were able to create their own individual video games.

*Redefining Western Blot Procedures: A Modified Approach for the Reliable Detection of Amyloid-Beta Oligomers (Aβ**O**s) in Alzheimer's Research*

Presenter: Riyan **Jain**

Mentors: Dr Raquel de Campos, PhD; Kirsten L Viola; Dr William Klein, PhD. Klein Lab, Northwestern University

Neurotoxic amyloid-beta-oligomers (AβOs) accumulate in patients with Alzheimer's Disease, driving cognitive decline and dementia. Determining their size via Western Blots (WB) could help create targeted therapies, but applying this analysis is particularly challenging for AβO aggregates. Such inconsistencies have led researchers to overlook WB for AβO studies for both one-dimensional (1D-) and two-dimensional gel electrophoresis (2D-PAGE). This study, in continuation of a previous study that adjusted SDS levels in the sample and running buffers and sample and antibody concentrations for classic WB, attempts to establish two-dimensional gel electrophoresis (2D-PAGE) as a technique for studying whole-proteomic distribution (across both size and pH) in AβOs. Our preliminary results indicate that when using modified initial conditions - 0.0375% SDS Running Buffer, 0.0% SDS Sample Buffer - for the WB on synthetic AβO samples, proteins around the 37 kDa mark, which weren't visible in the classic SDS-PAGE, were seen. This indicates that removing SDS from the sample buffer allows WB to be used on AβOs accurately while maintaining its high overall resolution. Similarly, 2D-PAGE with SDS works well to separate synthetic AβOs across both pH and molecular weight and holds great potential for providing valuable new insights into the molecular properties of oligomers.

Developing a quantitative analysis method for FTIR spectra based on Random Projection Sparse Signatures

Presenter: Harrison **Jang**

Mentor: Kevin Chu, Velexi Corporation

The purpose of this project is to offer an effective framework for analyzing chemical compositions and numerical concentrations through the use of IR spectroscopy. The focus is to interpret the IR Spectra in a quantitative manner, analyzing the intensity of the pure mixture. Using the relationship between absorbance and transmittance, a proper vector space needs to be created. Converting the y-axis/intensity of the IR Spectra is needed in order to satisfy the space. Also, this project will seek a relationship between coefficients of the mixture vector and the concentration of the pure spectra, which is a step for compiling the overall quantitative values we are looking for. The necessary knowledge of Linear Algebra and physics of IR spectroscopy is required to answer these questions. In order for these coefficients and vector space to be created, the usage of Python-based data analysis software will be required. Tools like NumPy arrays (numerically interpreting the raw data) and least squared regressions (determining the proper coefficients for the mixture spectra) are used to eventually get our desired output. Through coding and analysis, this project hones in on the enhanced interpretations of spectral features and offers a quantitative analysis on the IR spectra.

Droplet Impact and Freezing Behavior on Cold Surfaces Under Controlled Environmental Conditions

Presenter: Sahasra **Janagama**

Mentor: Sushant Anand, University of Illinois at Chicago

This project aims to investigate the dynamics of droplet impact on solid surfaces under varying low temperatures. This is accomplished using a set up that employs a high speed motion camera and shadowgraphy imaging techniques. Enabling high-resolution observations of the initial water droplet impact and behavior of the subsequent droplets, as they interact with the surface, data was collected using the Photron FASTCAM Viewer Software, which allowed recording at high frame rates. Understanding the dynamics of droplet impacts has significant real-world applications across multiple areas of study. The primary purpose of this study was to create an anti-icing spray by observing how the water droplets interact with surfaces under controlled conditions, from various elevations, the data can be used beyond this application.Moreover, this study is relevant in understanding the impact of ice formation on aircraft wings, specifically in how the moisture interacts with the surfaces under flying conditions. Additionally droplet impact plays a role in the

manufacturing industries, particularly in cold spray coating, where materials are protected against harsh conditions.

Investigation of the variability in tissue composition for head neck, thorax, and abdominal proton plans

Presenters: Jessica **Jiang**, Kelsie Li

Mentor: Hazel Wang, Northwestern Medicine Proton Center

During treatment planning for proton therapy, a 2.5-3.5% range uncertainty margin is applied to proton range calculations to sufficiently treat the target volume and account for inaccuracies in conversions to relative stopping power (RSP). However, this uncertainty margin is generalized throughout the body, regardless of the density-composition of the beam path, which varies based on tissue material and therefore region of treatment, potentially increasing the dose given to healthy tissue and organs at risk or providing insufficient dose to the target volume. This study aimed to refine this uncertainty margin by examining and calculating tissue-composition-derived clinical error margins specific to a proton beam. Tissue compositions were obtained from the Northwestern Medicine Proton Center patient CT database by intersecting beam-specific contours, 5% of the beam-specific maximum dose threshold contours, and body contours of patients. Uncertainty margins specific to tissue type were weighted based on this composition to determine mean uncertainties. This project is still in progress, thus no significant conclusions have been drawn.

Using Metropolis Monte Carlo Simulations and Integration of Quaternions to Sample Binding Angle Restraints

Presenter: Katherine **Jiang**

Mentors: Dr. Benoit Roux, Stephen Gee, Ivy Liu, The University of Chicago

Understanding molecular binding interactions and the orientation of ligands is essential for accurately modeling molecular interactions for drug discovery. Binding angle restraints are very important influences to how ligands engage with their targets, thus directly impacting the binding affinity. However, conventional molecular dynamics simulations often face limitations in sampling these angles. This project addresses these challenges by using the Metropolis Monte Carlo method combined with quaternion representations to more efficiently simulate and explore binding angle restraints, enabling a deeper understanding of ligand behavior in various systems. Herein, we implement Metropolis Monte Carlo algorithms to investigate how quaternion-based rotations are used and evaluate these changes to understand the free energy space the orientation provides. This

approach allows us to generate statistically valid groups of ligand orientations. By evaluating Metropolis Monte Carlo based sampling along with the integration of quaternions, we aim to demonstrate its advantages in studying binding phenomena and its potential applications in free energy estimation and drug design. This project ultimately contributes a computational strategy that can enhance the modeling of ligand-protein interactions, providing potentially valuable insights for biochemical and physical research and innovation.

Analysis of the Hidden Subgroup Problem in Quantum Computing

Presenter: Atharv **Kanchi**

Mentor: Dheeran Wiggins

Quantum computing harnesses the principles of superposition and entanglement between particles to process information in new ways, enabling algorithms that can outperform classical algorithms on certain computational problems. A key source of this quantum speedup is the Hidden Subgroup Problem (HSP), a unifying framework underlying many efficient quantum algorithms. The goal of the HSP is to find a hidden mathematical subgroup within a larger group, given access to a function that "hides" the smaller group. Efficiently solving the HSP directly leads to faster algorithms for problems such as factoring and discrete logarithms. Our project focuses on the mathematical foundations and current research aimed at solving the HSP for nonabelian groups. We first developed the necessary mathematical background, including rudimentary group representation theory, linear algebra, and the axiomatic foundations of quantum theory. We then analyzed solutions to the abelian HSP with the Quantum Fourier Transform (QFT), along with the HSP for cyclic groups. Finally, we prepared a review of a paper detailing a solution to the HSP for dihedral groups, along with a review of mathematical results leading to the HSP.

Characterizing the Effects of Biostimulants on Plant Growth and Soil Microbes

Presenters: Samaairah **Kapoor**, Larry Yang

Mentor: Dr. Scott D. Hamilton-Brehm, Southern Illinois University Carbondale

This project explores how biostimulants affect plant development and soil microbiomes. According to the USDA, biostimulants are substances or microorganisms that, when applied to plants or soil, promote natural processes to enhance nutrient uptake, tolerance to abiotic stresses, and overall plant growth. While biostimulants can be made from any biological feedstock (food waste, algae, etc.), currently, it is not known what chemical property determines the effectiveness of the biostimulant. In this study, we examine effects of biostimulants produced by the novel process Oxidative

Hydrothermal Dissolution (OHD) and tested on multiple plant types: alfalfa, garden cress, sorghum, soybean, and corn. Data collection included measuring plant height, biomass weight, seed weight, and next-generation sequencing of the soil microbiome (bacterial and Fungal). Due to time constraints, corn, soybeans, and sorghum had been planted several months before our data collection. Because of Alfalfa and Garden Cress's rapid germination time, we tested four different OHD biostimulant products to assess the efficacy of a screening method to rapidly determine if an OHD product has an effect or not. This research aims to determine how OHD biostimulants affect the soil microbiome and how different plants respond physiologically as a sustainable agriculture application to reinforce food security.

Evaluating the effects of the 1984-1995 Sikh Genocide through Spatial Data Science

Presenter: Muskaan **Kapur**

Mentor: Dr. Crystal Bae, University of Chicago Center for Spatial Data Science

During the 1980s and 1990s, the Sikh community faced genocide in the form of extrajudicial killings, Operation Blue Star, and organized mob attacks. This paper tracks the effects of these attacks, using spatial data science to assess connections between the killings, demographic changes, and mass migration. The data originates in India 1981, 1991, and 2001 census reports, as well as records from the National Human Rights Commission. Using QGIS, ArcGIS, and GeoDa technologies, it has been sorted, mapped, and evaluated for trends. This information could help identify communities across India that need support as a result of the Sikh genocide, recognize patterns of corruption within the Indian government, and ensure justice for the individuals affected by these events.

Mapping Avian Influenza Hotspots Through GIS and Species Surveillance in Illinois

Presenter: Deen **Kareem**

Mentor: Anuj Tiwari, Discovery Partners Institute

This research aims to identify and predict avian influenza (bird flu) hotspots in Illinois by overlaying species distribution data for known viral carriers with the locations of poultry and dairy farms. Avian influenza presents serious risks to agriculture, public health, and the economy, as evidenced by the 2014–2015 U.S. outbreak that led to the loss of over 50 million birds and $3.3 billion in damages. Using GIS-based hotspot analysis and avian species surveillance data, we are developing a spatial risk-mapping tool to forecast high-risk zones. This model will help alert farmers and stakeholders to potential outbreaks before they occur, supporting early intervention and improving biosecurity

measures. By integrating real-time data, this project contributes to disease prevention efforts and long-term strategies for food security and animal health across the Midwest.

Evaluating Safety of GenAI Models in Workforce Development

Presenters: Tanvi **Khadse**, Isabella Li

Mentor: Alvin Chin, Discovery Partners Institute

The intention of this study was to determine if, and to what degree, the chatbots on DPI's AI Exchange platform (a GenAI model interface used to answer queries related to a specific area of study) would stray from adhering to responsible guidelines. Such guidelines encompass an analysis of the model's robustness, toxicity, stereotype bias, ethics, privacy, and fairness. After researching articles on the evaluation of other GenAI models, the alternative hypothesis was conceived: the chatbot would fail to appropriately follow the guidelines for responsible AI when subjected to adversarial testing and jailbreaking. This was tested using a method of measuring the responses, and labeling their harmfulness from on a scale of 0 to 2, through a domain of test inputs. The results of this investigation revealed that the chatbots frequently did not meet responsible AI guidelines, as ~30% of the prompts were considered to be harmful. These findings highlight the need for greater improvement of chatbots and AI in general, necessary for its future implementation.

Solutes' Effects on Ice Formation and Ice Adhesion Strength

Presenter: Gyuri **Kim**

Mentors: Christopher Carducci, Senior PhD Student, UIC; Dr. Sushant Anand, Principal Investigator, UIC

Countless research teams, commercial and military, have spent decades researching how to make surfaces less adherent to ice. However, in this pursuit to make ice-phobic surfaces, many use pure water in their experiments. Naturally forming ice, whether accreted on the wings of a high-altitude plane or built up from splashing sea spray on a naval vessel's hull, contains a vast array of salts that can greatly alter how ice forms and sticks to surfaces. We investigated how aqueous solutions of different wt% of salts affect the ice adhesion strength to stainless steel. We found that concentrated solute enriched liquid layers (SELL) form at the substrate surface and at the top of unidirectionally-frozen ice. The presence of a thick bottom SELL is believed to play a significant role in greatly reducing the ice adhesion strength, behaving similarly to a lubricating layer. Lastly, we found preliminary data that suggests the role of air channels in the formation of the bottom SELL.

Predicting Habitat Functionality for Blanding's Turtles (Emydoidea blandingii)

Presenter: Michelle **Kim**

Mentor: William Graser, Forest Preserve District of Kane County

Blanding's turtles (Emydoidea blandingii), a species of semi-aquatic turtle, are listed as endangered, threatened, or species of concern in all the states in which it occurs. Habitat loss and fragmentation are the greatest threats to their population, resulting in the need to find solutions that can counteract such problems. In this study, an open-source GIS-tool was used to predict habitat functionality regarding Blanding's turtles in the forest preserves of Kane County, Illinois. Parameters for the model included the mean migration distance of the species, quality and friction of biotopes in relation to them, and whether a biotope is a source habitat. The resulting model was compared with Blanding's turtle occurrence data collected from the forest preserves, as well as findings of previous studies concerning their habitat and movement patterns. The parameters were then adjusted for further accuracy. A successful model would be capable of assisting conservation efforts by indicating potential sites for population recovery and restoration measures.

Stable DNA Monolayer Formation via Electrochemical Grafting on MoS_2 for Nucleic Acid Detection

Presenter: Ryan **Kim**

Mentors: Mohammad Asad, Mohtashim H. Shamsi

In the status quo, adsorption-based nucleic acid detection suffers from limitations in probe orientation and surface stability. To overcome these challenges, we developed a stable electrochemical biosensing platform by covalently immobilizing amino-modified DNA probes (5AmMC6/TTCCTTCTTATCTTTTTCACTTTT) onto MoS_2-coated ITO electrodes. A threestep covalent functionalization strategy was employed: (1) surface activation via electrochemical grafting of iodoacetic acid at −1.4 V for 60 s to generate carboxyl-terminated MoS_2; (2) probe conjugation using EDC/NHS coupling chemistry with optimized DNA incubation (1 mM, 60 min); and (3) interfacial characterization. Electrochemical analyses, including cyclic voltammetry (CV) with $[Fe(CN)_6]^{3-/4-}$ and $[Ru(NH_3)_6]^{3+}$ redox probes, were used to evaluate electron transfer behavior, polarity effects, reversibility via anodic and cathodic peak separation (ΔE), and stability across 100-cycle scans. Electrochemical impedance spectroscopy (EIS) further quantified changes in charge transfer resistance during DNA immobilization. Complementary AFM and SEM imaging confirmed monolayer formation and revealed topographical evolution. The results demonstrate that covalent attachment substantially improves interfacial stability and performance compared to physisorption, with optimal functionality achieved at a grafting potential of −1.4 V.

Generating Polarization States of Light for Use in Quantum Key Distribution

Presenters: Abigail **Kinsland**, Olivia Pan, Peter Panchev

Mentors: Dr Aparna Kapale and Dr Kishor Kapale, Western Illinois University

With the rise of quantum computers, our current encryption methods are predicted to become obsolete, making sensitive data easily decryptable. However, Quantum Key Distribution (QKD) is a method that allows the sender to encrypt data and send it to the receiver through the use of a shared secret key. This secret key sharing protocol ensures that an eavesdropper would not be able to intercept said information or would reveal themselves in the process, keeping the key secure. The core principle of QKD involves using the polarization of light transmitted through an optical fiber, which is what we characterized in our experiments. By performing electro-optic modulation, we were able to identify the voltages on different wavelengths of light that we would need to send through lithium niobate and indium tin oxide to obtain the polarization states that would be needed to develop a QKD system.

Evaluating the Molecular Properties of Erythritol through Computational Chemistry

Presenter: Nehum **Koti**

Mentor: Dr. Joseph Golab

With the increase in global obesity, the use of low-calorie sugar substitutes such as Erythritol has grown considerably. A computational examination of the various properties of Erythritol (IR Spectrum, Isodesmic prediction of Heat of Formation (ΔH0f), etc.) was undertaken to determine the health implications of Erythritol by way of computational chemistry methods—semi-empirical: ab initio, PM3, Density Functional (w-B97X-D)/6-31G*, Hartree-Fock 6-31G. Spartan is a robust molecular modeling software application that simulates a wide range of computational chemistry tasks, replacing conventional experimental methods that may be costly or dangerous. We found that Erythritol's Heat of Formation was: -797.0290178 KJ/mol with percent error: 0.37% using HF/3-21G*. IP: 11.69 au with a percent error: -5.05 using HF/6-31G (LUMO energy). Dipole Moment: 2.94 debye with a percent error: 105.59% using HF/6-31G. We compared these results to the experimental data on NIST and found that we had accurate findings with the exception of Erythritol's dipole moment. The implications of this study on the various characteristics of Erythritol for human health remain to be determined, and more research is needed.

Naturalization of Salt Creek Streamflow

Presenter: Mahima **Krishnan**

Mentor: Sanoar Rahman, SIUE

The Salt Creek river streamflow was naturalized in order to measure the impact of the Clinton Lake Dam on Salt creek. Salt Creek is a major tributary of the sangamon river around central Illinois. The Clinton Lake Dam is a reservoir built in 1977-78 near the town of Shelbyville. To understand the impacts of the reservoir, data from 10 years before the dam was built to the present day was collected. The streamflow of Salt Creek was naturalized by finding historic daily data and using the Drainage Area ratio method to naturalize streamflow. The nearby Kickapoo river was used as a reference streamflow due to the similar hydrological characteristics and close proximity with Salt Creek. The errors were accounted for by NSE and percent bias, both of which were within a good range. Analysis of the data reveals how Clinton Lake Dam influenced the streamflow of Salt Creek.

The Effects of Natural Compounds on Synthetic Diabetic Blood and Urine

Presenters: Aashritha **Kukunooru**, Radhini Panchal

Mentor: Dr. Sowmya Anjur

Cases of type 2 diabetes mellitus are rising worldwide, and it is estimated that by 2050, there will be almost 800 million diabetics. One of its main effects is hyperglycemia, which is when there is too much glucose in the blood for the body to regulate. Natural compounds have been used in ancient communities as diabetic medicine; however, more research and clinical trials are needed to establish if they are effective or not. In this study, fenugreek, turmeric, cayenne pepper, and ginger were tested to see how they affect glucose levels in synthetic diabetic blood and urine. Different concentrations (1, 2, and 4 servings) of each compound were added to synthetic diabetic blood and urine, along with Benedict's reagent. Then, Benedict's test was conducted on the solutions to see the glucose levels. In order to address experimental error, all variables besides the concentrations of the compounds were kept the same. It was found that fenugreek was the most effective in terms of reducing the glucose level in both blood and urine, while ginger was the least effective in blood, and turmeric in the urine. It was also found that every compound tested was more effective in blood than urine.

Rational Design of Tramadol Analog to Relieve Pain

Presentor: Hayeon **Kwak**

Mentors: Dr. Jin Jin, Dr. Shaozhong Zhang, Western Illinois University

Analgesics are broadly used to relieve pain in the field of medicine. Nonetheless, many adverse effects accompany analgesics. To address this challenge, many scientists have modified the chemical structure of existing drugs. This project specifically examines tramadol, an opioid analgesic, and proposes a rational design to reduce tramadol-induced hepatotoxicity, a liver damage due to a decrease in antioxidant defence and lipid peroxidation. The rational design of tramadol analog incorporates an acetamide group, a functional moiety that can be found in both melatonin and N-acetycysteine. Melatonin, a major hormone in the pineal gland, is known to protect the liver from oxidative stress through its free radical scavenging effect and an increase in other antioxidant activities. Similarly, N-acetylcysteine stimulates the synthesis of glutathione, an antioxidant, and acts as a free radical scavenger itself. The addition of acetamide—common to these detoxifying agents—is expected to protect the liver against oxidative damage. A synthetic pathway for the tramadol analog is proposed in this study to facilitate the preparation of future studies for subsequent pharmacological testing.

A Low-Cost, Open Source Cybersecurity Framework for Educational Institutions

Presenters: Aarav **Lala**, Neel Shanbhag

Mentor: Dr. Thomas Imboden, SIUC Information Technology Department

Many educational institutions exist with constrained financial resources often lacking enterprise-level cybersecurity software. This lack of infrastructure leaves their networks exposed to malicious threats, creating concerns about the safety of the student and the faculty. Our work presents a Simulated School District which utilizes open source cybersecurity tools adapted to simulate and secure a school digital world. We utilized Proxmox for virtualization, running multiple virtual machines configured with Ubuntu and a Windows Server Operating System. We also simulated student machines with Fedora Linux, Chrome OS Flex, Windows 10 and 11. We created a designated centralized Wazuh Server that we used to monitor each agent activity across the endpoints. To manage internal network traffic, we created a custom Domain Name System setup, allowing devices to communicate via local hostname. To create appropriate permissions an Role Based Access Control system integrated with Microsoft Active Directory, enabling structured user permissions aligned with organizational roles and hierarchy. Additionally a OPNsense firewall was used, serving as a robust and affordable firewall without the need for third-party softwares. While the principles of Zero Trust Security have been added, full ZTA implementation remains as a work in progress. This simulated environment serves as a scalable, low-cost model for educational institutions seeking to adopt modern cybersecurity practices using free and open-source tools.

Flexible Photodiode Array for X-Ray Detection

Presenter: Avery **Lau**

Mentors: Dr. Qing Cao, Hyunjun Nam (University of Illinois Urbana-Champaign, Materials Research Laboratory)

This project explores the use of a novel flexible silicon membrane, along with avalanche photodiodes, as a possible alternative to existing materials used for parts of commercially used X-ray detector systems. Existing systems are bulky and prone to causing vignetting or defects in the resultant images; to remedy this, many detectors incorporate large optical enhancement systems, further reducing their compactability and economic efficiency. Additionally, existing systems require high doses of radiation to produce accurate images; repeated doses of this radiation in a short span of time can lead to long-term effects on patients. The use of flexible silicon in place of the rigid amorphous silicon used in current X-ray detectors presents a great step forward; by manufacturing photodiodes and thin-film transistors (TFTs) on the membranes before transferring them to a flexible substrate such as Kapton polyimide film, we can retain all of the excellent electrical properties of silicon while gaining significant amounts of mechanical flexibility. By combining this new system with special avalanche photodiodes (APDs) that are highly sensitive to singular photons, we aim to improve the overall efficiency and medical safety of X-ray detectors while making them viable for a broader range of purposes, such as nonintrusive industrial applications.

LLM-based software supply chain attack

Presenter: Khang **Le**

Mentor: Dr. Anuj Gautam, Discovery Partners Institute

82% developers use AI coding assistants in development in 2024 according to Stack Overflow. This could mean a security risk that could compromise a team project as the AI could give malicious open-source dependencies in its code carefully hidden in very legit looking repositories. Previous studies have modeled an attack where the AI coding assistants look for answers for a coding problem in online forum Stack Overflow, where the researchers had answered the problem but hiding a malicious code inside. They found an 84.29% success rate. Seeing that similar events could happen to libraries instead of code answers, we study the risk of libraries given by Gemini-2.5-flash and check the level of their vulnerability using OSSF Scorecard.

Frost-Template Fabrication of Rough Metal Surfaces

Presenter: Isaac **Lee**

Mentors: Nenad Miljkovic, Siyan Yang, Air Conditioning & Refrigeration Center at University of Illinois Urbana-Champaign

Rough metal surfaces are essential for applications like boiling heat transfer and interfacial transport, as they provide stable micro/nanoscale cavities for heterogeneous nucleation. While templating methods can create such surfaces, conventional templates often adhere too strongly to the substrate, hindering removal and scalability. Ice, although easily removable and ideal for a template, lacks the necessary surface roughness (≥300 μm) for optimal performance. This research studies the use of frost as a template, with an easily removable and naturally rough surface structure. A cylindrical aluminum block cooled to –90 °C was used to grow frost layers, which were measured for surface roughness at intervals up to 480 minutes. Once the frost had passed the target roughness, it was submerged in a UV-curable and cold liquid resin, then cured and solidified under UV light. After five minutes of curing, the frost was melted away, leaving a mold with the frost's microstructure. This mold was coated with a Chromium/Nickel layer using a vacuum sputtering and then placed in an electroplating bath. After electroplating, a metal layer was put into the mold. Removing the resin resulted in a rough metal surface with a roughness of over 300 μm, making it suitable for advanced heat transfer applications.

Linking Water Temperature Variability to Water Quality Dynamics in Beck Lake, an Urban Inland Lake in Chicago (2020–2024)

Presenter: Oscar **Lee**

Mentor: Anuj Tiwari, Discovery Partners Institute

This study examines the effect of climate variability on water quality in Beck Lake, an inland urban lake in Chicago, Illinois, from 2020 to 2024. The lake is maintained by the Chicago Park District and contains aquatic life such as Bluegill, Largemouth Bass, and Northern Pike. To determine climate influence, satellite-derived water temperature data were analyzed using time series segmentation and non-parametric trend analysis in Python. Breakpoints representing statistically significant changes in water temperature were calculated, and corresponding trends in water quality metrics during these segments were examined. Water quality indicators, including the Normalized Difference Chlorophyll Index (NDCI), Normalized Difference Turbidity Index (NDTI), total phosphorus (TP), and electrical conductivity (EC), were extracted from Sentinel-2 imagery using Google Earth Engine. Temporal patterns in these metrics were analyzed in Python using non-parametric methods to find their

response to water temperature shifts. The results show that periods of elevated water temperature are associated with increased chlorophyll and phosphorus levels, suggesting increased biological activity and nutrient loading. During warmer phases, change in turbidity and conductivity were also observed, indicating possible changes in physical and chemical processes within the lake. These results show clear temporal linkages between water temperature trends and water quality dynamics. Based on these water quality shifts, fish species like Bluegill, Largemouth Bass, and Northern Pike that are commonly found in the lake may face periodic stress from lower oxygen levels, algal blooms, and reduced water clarity during warmer, nutrient-rich periods. These conditions can affect their feeding, spawning, and overall habitat suitability. This study demonstrates the value of integrating Earth observation data with climate-sensitive indicators and non-parametric analytics to improve understanding of how urban aquatic ecosystems and life respond to climate variability.

Evaluating Dark Photon Reconstruction Efficiency of a Boosted Decision Tree

Presenter: Daniel **Limosnero**

Mentor: Dr. Peter Dong

Many theories have been proposed to explain the nature of dark matter, including some that suggest the existence of a dark sector with self-interacting particles and a massive dark photon that carries dark hypercharge. For our analysis, we assume that this dark photon is the lightest dark particle and can decay into Standard Model lepton jets. We aim to train a boosted decision tree (BDT) capable of discerning lepton jets generated by dark photon decays from other lepton jet sources like the Drell-Yan background. To do so, we first determine the maximum number of background events that can be used to train the BDT, train it, and evaluate its reconstruction efficiency on different dark photon sources. We also include results from a separate BDT trained on signal events originating from the Standard Model Higgs boson as the portal matter instead of our baseline portal of an exotic heavy Higgs.

Exploring Light Absorbance Properties of Functionalized Biphenyls for Organic Solar Cells

Presenters: Bao **Luong**, Molly Federici

Mentor: Lichang Wang, Southern Illinois University

This projects investigates how different substituent groups (NH_2, OCH_3, Cl, Br, CN, NO_2) influence the electronics and optical properties of biphenyl-based molecules for potential use in organic solar cells. Gaussian 16W is used to perform Density Functional Theory (DFT) calculations with the B3LYP functional and 6-31+G(d,p) basis set. Toluene is used as the solvent environment, modeled

using the Conductor-like Polarizable Continuum Model (CPCM). DFT is used to optimize the structure and calculate the HOMO-LUMO energy gap. Time-Dependent DFT (TD-DFT) is then applied to the optimized structures to determine absorption wavelengths and oscillator strengths. These properties provide insight into how well each functionalized molecule can absorb light across the solar spectrum. The goal is to explore how electron-donating and electron-withdrawing groups affect conjugation and change transfer behavior within the biphenyl core. By analyzing the relationship between characteristics and absorbance efficiency, this study aims to identify promising molecular candidates that enhance solar light capture. The work builds on past research in molecular engineering for organic photovoltaics and may help guide future material design for clean energy applications.

Viability of Roof-Mounted Wind Turbines in Urban Settings

Presenter: Henry **Maginel**

Mentor: Gabe Rogers Johns Hopkins Applied Physics Laboratory

The purpose of this project is to determine whether roof mounted wind turbines can supplement solar panels in urban areas, using the greater Chicago area as a benchmark. Also, it is to determine if increasing the height above the building would have a significant improvement in power using longer booms or floating turbines. The initial goal was to fully service skyscrapers, but that was deemed in-feasible due to the size of propellers required to offset the skyscraper's energy usage. For example, to produce just 3% of the power used at 110 N Wacker in Chicago, a turbine 22m in diameter is necessary, this could still be beneficial though, assuming that it uses standard electricity rates, 3% would be equivalent to $71780.76 per year. This is the reason behind a switch to examine shorter buildings with larger roof areas such as superstores like Walmarts. This trades height for reduced power consumption needs. However, even these smaller buildings do not seem viable to fully offset energy usage as, because of the lower wind speeds at their lower elevation, a 120m diameter propeller to power a Walmart fully, assuming the wind stayed consistent at 4.5m/sec. We plan to show graphs of the cost savings per year at various heights and diameters assuming average wind speeds per height.

Junior Software Developer

Presenter: Aryan **Mansingh**

Mentor: Kelsey Cozens

APS Data Technologies is a data management company focused on bringing innovative tools and platforms to businesses and cities across the world, established and run from downtown Aurora. APS has focused primarily on software development and bringing quality of life to the cities that its tools are implemented in. Over the course of the past two months, APS offered me opportunities to work directly on the software that they offer to their customers, a part of their application Destination Aurora. This app offers people in Aurora a variety of services such as information about businesses, local leaders, public transportation, etc. The project to which I was assigned is known as Smart Parking, an image recognition and tracking software which uses cameras streaming parking lot video to monitor and report empty parking spaces. This can then be offered to users as a service to report empty parking spots, or can be used by businesses to monetize parking during times of high traffic. This allows for better use of existing public infrastructure, improving quality of life while requiring few resources compared to physical advancements.

Ergonomic Work Environment Design Using Santos® 3D Modeling Software

Presenter: Ryan **Mason**

Mentors: Dr. Quintin L. Williams Jr. and Melissa Chio-Salinas

My internship focused on using the Santos 3D modeling software to simulate and evaluate ergonomic work environments. Santos is a predictive modeling tool that allows users to test workspaces for efficiency, comfort, and injury prevention before they are physically built. During the internship, I learned how to input human anthropometric data, simulate physical tasks, and adjust environmental variables to create more ergonomic and sustainable workplace designs. My work included analyzing reach, posture, visibility, and fatigue under different conditions and layout configurations. I used these tools to learn design improvements that enhance both worker safety and performance. The internship helped connect 3D digital modeling and real-world ergonomics, showing how predictive analysis can be crucial in reducing workplace injuries and optimizing workflows. This experience provided hands-on exposure to both technical software use and applied ergonomic principles used in the professional world.

A Systematic Review of the Effect of Exposure to Greenspace on Stress Biomarkers in Older Adults

Presenters: Nicholas **Mohyla**; Aadi Chandraya

Mentor: Dr. Ana Capuano, University of Chicago

Aging increases vulnerability to chronic inflammation and stress. Some evidence suggests forest exposure benefits both, but no systematic review has examined this in older adults. To synthesise evidence on how objectively experienced or programmed green-space exposure alters stress biomarkers in older adults. We searched PubMed and Scopus on August 5, 2025. Eligibility: (i) participants had to be older adults, (ii) exposure to natural greenspace, (iii) at least one stress-related biomarker obtained through biospecimens such as blood, saliva, urine, or hair. Seven intervention or controlled field studies published between 2012-2025 met the criteria. We captured population, biomarker assay, green-space "dose," and outcomes. Six studies have exposure to forests, and one to parks. The dose ranged from a single 30-minute exposure to overnight stays. Cortisol underwent significant changes in 4/4 studies that measured it. Furthermore, shown in 1 study for IL-6 and TNF-α, and 2 studies for CRP, all immunological and inflammatory stress biomarkers were shown to decrease after exposure. Across seven moderate-quality, heterogeneous studies, short-term or repeated immersion in forest or park environments consistently reduced stress biomarkers in older adults. More studies with standardised biomarker panels and rigorous controls are needed to guide age-friendly urban-greening strategies.

Computational Investigation of Acetone

Presenter: Kavyaa **Naveen**

Mentor: Joseph Golab, Illinois Math and Science Academy

Computational chemistry can be done in many ways. This study focuses primarily on acetone and its molecular properties although throughout the experiment other elements were tested. The results were found using Spartan which is an online software used specifically for computational chemistry. Geometry optimization was performed using both Hartree-Fock and Density Functional Theory (DFT) approaches. Measured values from Spartan were compared to actual values from the National Institute of Standards and Technology (NIST). The structure of acetone was analyzed to determine bond lengths, bond angles, dipole moments, molecular orbital energies, and the IR spectrum. The isodesmic heat of reaction was calculated through Spartan and also by hand. These values were an integral part of the research done on acetone.

Role of Nucleoporin93 in Cholesterol Regulation via SREBP2 Signaling

Presenter: Matthew **Nowak**

Mentors: Riya Makin, University of Illinois at Chicago; Arya Dalal, University of Illinois at Chicago; Dr. Monica Y. Lee, University of Illinois at Chicago

Endothelial cells (ECs) comprise the innermost lining of blood vessels and are involved in various features of vascular homeostasis. Dysregulation of the endothelium, therefore, promotes disease progression by triggering endothelial inflammation and consequent cardiovascular disease (CVD). EC dysfunction is the initial phenotype observed in the natural human aging process, a chronic state of systemic low-grade inflammation. Nucleoporin93 (Nup93), a crucial structural protein found inside nuclear pore complexes (NPCs), is depleted along with NPC degradation, allowing for pro-inflammatory signaling within ECs. Furthermore, previous studies identify an upregulation of the SREBP2 pathway in response to inflammatory stress signaling, a known cholesterol regulator. Given a possible correlation with Nup93 depletion and SREBP2 upregulation, we hypothesize senescent Nup93 depletion to have a downstream effect on total cholesterol levels in ECs via SREBP2 signaling. ECs were treated with a well-established model of Nup93 depletion and were used in qPCR to quantify gene expression. We observed a significant increase in LDLR and HMGCR, two canonical targets of the SREBP2 pathway, which governs cholesterol intake and biosynthesis. We also observed an upward trend of HMCGS1 expression. These findings suggest that Nup93 depletion affects cholesterol levels in ECs. To confirm these changes, we utilized Abcam's cholesterol ester assay to detect the amount of cholesterol in ECs. The use of this assay will allow us to conclude whether Nup93 depletion has a significant effect on cholesterol levels.

2025 Magnetic Nano Particles Applications in Cleaning for the DOD

Presenter: Jasmine **Nuno**

Mentor: Robert Richter, Chicago State University

The purpose of this experiment is to replace P-D680 types with a cleaner and effective method. This is due to the fact that the Department of Defense (DOD) uses this toxic chemical quite frequently and may have adverse effects on the environment. With the DOD often having to clean grease and oil off of parts, the amount of P-D680 types used is substantial. Using magnetic nanoparticles allows for a fast and environmentally friendly solution. With this experiment attempting to show the effectiveness of nano particles in cleaning . The effectiveness of magnetic nanoparticles was determined using protocols from 1998 standard practice for preparation of Contaminated Test Coupons for the

Evaluation of Cleaning Agents (ASTM International, 1998). The results show that magnetic nanoparticles composites have the potential to replace traditional cleaning solvents within the DOD.

The Effects of Natural Compounds on Synthetic Diabetic Blood and Urine

Presenters: Radhini **Panchal**; Aashritha Kukunooru

Mentor: Dr. Sowmya Anjur

Cases of type 2 diabetes mellitus are rising worldwide, and it is estimated that by 2050, there will be almost 800 million diabetics. One of its main effects is hyperglycemia, which is when there is too much glucose in the blood for the body to regulate. Natural compounds have been used in ancient communities as diabetic medicine; however, more research and clinical trials are needed to establish if they are effective or not. In this study, fenugreek, turmeric, cayenne pepper, and ginger were tested to see how they affect glucose levels in synthetic diabetic blood and urine. Different concentrations (1, 2, and 4 servings) of each compound were added to synthetic diabetic blood and urine, along with Benedict's reagent. Then, Benedict's test was conducted on the solutions to see the glucose levels. In order to address experimental error, all variables besides the concentrations of the compounds were kept the same. It was found that fenugreek was the most effective in terms of reducing the glucose level in both blood and urine, while ginger was the least effective in blood, and turmeric in the urine. It was also found that every compound tested was more effective in blood than urine.

Spatial and Statistical Analyses of Cancer Mortality Rates 2008-2022 in Illinois

Presenter: Charlotte **Paquette**

Mentor: Dr. Shunfu Hu

Cancer mortality in Illinois is problematic, partially because extreme disparities exist by factors such as race, gender, and socioeconomic status. The four objectives for this project are: 1) To analyze the spatial patterns of cancer mortality rates in Illinois from 2008 to 2022 and to assess if there were statistically significant clusters and outliers for 2022; 2) To determine whether there is a statistically significant correlation between cancer mortality rates and air pollution in Illinois for 2020; 3) To determine whether there is a statistically significant correlation between cancer mortality rates and percent in poverty in Illinois for 2020; and 4) To examine the relationship between the cancer mortality rates of metropolitan and rural counties in Illinois for 2022. These goals were achieved largely through ArcGIS Pro and IBM Statistical Package for the Social Sciences (SPSS). Results indicate significant geographic clustering of cancer mortality rates for 2022, a significant correlation between cancer mortality and poverty rates for 2020, and disparities between metropolitan and rural

counties for 2022. However, no statistically significant correlation was found between air pollution and cancer mortality rates for 2020. This work aims to expand cancer mortality research and guide policies to reduce disparities.

Dictionary Learning for Classification of Functional Groups in Organic Molecule Raman Spectra

Presenter: Laksh **Patel**

Mentors: Kevin Chu, Velexi Research

Since Chandrasekhara Venkata Raman discovered the Raman effect in 1928, vibrational spectroscopy has relied on human experts to interpret intensity peaks and identify functional groups. In this work we investigate whether unsupervised dictionary learning might recover those same insights without manual peak assignments. We assemble a diverse library of computed Raman spectra and apply a sparse‑coding algorithm to derive a compact dictionary of spectral atoms, each intended to capture a distinct vibrational motif. Individual spectra are then encoded as sparse combinations of these atoms, and we plan to train a classifier on the resulting codes to detect hydroxyl, carbonyl, nitrile and aromatic ring groups. By exploring a range of dictionary sizes, sparsity levels and classification thresholds, we aim to assess how closely data‑driven, sparse representations can approach centuries of expert spectroscopic interpretation. Preliminary analyses will inform whether this approach holds promise for fully automated Raman spectral annotation.

Productivity Software Design and Data Analysis with Alchemy Software

Presenter: Sofiya **Patel**

Mentors: Aiden Keighron, Jacob Purdue

Alchemy Software is a startup focused on building Half Full, a streamlined productivity and task management platform designed to simplify organization and help users focus on what matters. My business project centered on two key areas: front-end web development and behavioral data analysis. I contributed to designing and coding the main and pricing pages of the Half Full website, focusing on clean design, user accessibility, and conversion effectiveness. Simultaneously, I analyzed customer usage patterns using data from app reviews, usage timestamps, and App Store analytics to assess feature engagement and user retention. These insights guided feature improvements and strategic prioritization. Through this dual role, I helped enhance both the product's visual interface and its performance feedback loop, supporting the company's mission to create a smart, user-first productivity tool.

Exploring Color Spaces for Skin Tone Characterization

Presenter: Sonya **Patel**

Mentors: Nicole Tin, Velexi Research

A color space is a measurement of color through the specific organization of set colors and/or shades. As commonly used as it is, the RGB color space is not always effective at capturing how humans perceive color, especially when it comes to skin tones. Color spaces that account for different lighting, like CIELAB (lightness, red-green, blue-yellow) and HSV (hue, saturation, value), are much better at capturing skin tone because a lot of distortion is caused by different lighting conditions. This project aims to find a color space that consistently captures the same skin tone in different lighting conditions through Python-based analysis. Comparing lighting versus the blue-yellow measurement with CIELAB and hue versus value with HSV are both promising, but more analysis is necessary to determine which representation is most reliable.

Prototyping New Systems for White Light Solar Flare Observation and Data Collection

Presenter: Maneth **Perera**

Mentors: Dr. Corinne Brevik, Southern Illinois University Carbondale; Christopher Mandrell, Southern Illinois University Carbondale

White light solar flares are violent reconnection events of the Sun's magnetic field that can emit a wide range of the wavelengths of visible light. These flares can be powerful enough to create significant infrastructural disruptions due to their geomagnetic effects and thus are a focus of heliophysical research. This study details the composition and analysis of three days of solar data on June 9th, June 10th, and June 20th. We also describe the development of a new data collection system through automation of the observatory, along with the problems faced in both data collection and development. We found no white light solar flares on the days we took data, but white light solar flares occurred on June 17th and June 19th, illustrating the need for more consistent data collection systems to reduce the chance of missing a flare event. The development of more automated data collection systems means we can increase the efficiency of our observations and possibly observe more white light solar flares in future studies.

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Interactive Learning Interface for Understanding Safety with Large Language Models

Presenter: Paul **Ratasuk**

Mentor: Ren Wang, Illinois Institute of Technology

AI is currently at the forefront of the technological world, with large language models (LLMs) being one of the most noticeable applications. However, given the increased usage of LLMs, it is necessary to ensure that proper safety measures are put in place. Each model contains massive amounts of data, which can include personal data, trade secrets, and other sensitive information. Since not much is known about these security issues within the public, we created an interactive learning interface designed for beginners to AI to learn about these issues using comprehensive, hands-on activities to maximize retention. These activities, paired with graphics and simple explanations, will aim to provide an engaging and easy to understand experience for novices to AI. This will not only allow aspiring coders to learn more about LLMs in an easy to understand way but also spread awareness about potential safety issues to a wider audience.

Anti-Inflammatory Potential of Strawberry Extracts in an LPS-induced In Vitro Model

Presenter: Skyelar **Reuter**

Mentors: Peter Geevarghese Alex, Casey Weisfuss, Britt Burton-Freeman, Indika Edirisinghe, Illinois Institute of Technology

Chronic low-grade inflammation is associated with metabolic diseases and characterized by elevated cytokine levels. Fruits rich in polyphenols such as anthocyanins, flavonols, and glucosinolates have demonstrated antioxidant and anti-inflammatory properties in both in vivo and in vitro models.

Strawberries (STR) are a rich source of these compounds, which have shown promising anti-inflammatory effects. This pilot study investigated the effects of STR on lipopolysaccharide (LPS)-induced inflammatory responses in human blood in vitro. Blood was taken from healthy adults (n=6) and exposed to STR extract (100ng/mL), LPS (2.5ng/mL) + STR extract (100ng/mL), LPS (positive control), and saline (negative control) for 4 hours at 37^0C. RNA was isolated using PAXgene® tubes for qRT-PCR analysis of gene expression (IL-6, Nrf2). IL-6, TNF-α, and IL-1□ protein levels were measured in plasma via Luminex method. LPS significantly increased pro-inflammatory cytokines ($p < 0.05$ vs. control). However, adding STR to LPS significantly reduced the cytokines ($p < 0.05$), suggesting the anti-inflammatory properties of STR. Changes in gene expression were not statistically significant. This study offers valuable insights into the potential of in vitro models to study the anti-inflammatory effects of fruits.

Characterizing Inner Ear Hair Cell Mitochondria

Presenters: Shripranavi **Savya**

Mentor: Dr. Anna Lysakowski, University of Illinois Chicago, Department of Anatomy and Cell Biology

Inner ear hair cells depend on tightly regulated mitochondrial dynamics to meet their high metabolic and calcium-buffering demands. Previous studies using electron tomography have identified specialized mitochondrial subpopulations in vestibular and cochlear inner ear hair cells. In vestibular Type I hair cells, large mitochondria are frequently positioned near the cuticular plate and striated organelle, regions that require significant energy and calcium regulation. This suggests that mitochondrial positioning may be functionally important. In this study, we investigated whether crista junctions (CJs), key internal mitochondrial structures, are non-randomly distributed in relation to the cuticular plate. To explore this, IMOD software was used to reconstruct 3D models of mitochondria from electron tomograms, and we applied an MTK subroutine to randomize CJ locations for a spatial proximity analysis. We then used statistics (t-tests) to compare the observed CJ distribution to the randomized models. This approach allowed us to test whether the actual CJ arrangement reflects purposeful spatial organization. Understanding how mitochondrial structures are positioned within hair cells may help us to better recognize early signs of dysfunction, which could contribute to age-related sensory loss, including hearing and balance disorders.

Evaluating Multi-Patch Adversarial Attacks on Vision-Language Models

Presenter: Aarav **Shah**

Mentors: Dr. Pooya Khorrami, Ms. Danielle Sullivan, MIT Lincoln Laboratory

This project investigates the vulnerability of Vision-Language Models (VLMs), such as OpenAI's CLIP, to adversarial patch attacks. In recent years, these VLMs have gained popularity in use cases such as image classification, content moderation, and image-text retrieval. However, they are concerningly vulnerable to adversarial patch attacks, where an attacker can place a high-saliency sticker anywhere on an image to throw off a model's prediction. To demonstrate this, an ablation study was conducted to compare the effects of simple occlusion with colored patches that were adversarially optimized to mislead the model. Additionally, the study evaluates the transferability of these white-box single patch attacks across different CLIP architectures, including ResNet and Vision Transformer (ViT) backbones. Lastly, a novel multi-patch white-box attack is proposed, where multiple patches are trained for different model types and applied simultaneously to increase black-box attack success. This ensemble-style approach aims to enhance transferability without collapsing model-specific information into a single universal patch. Experimental results demonstrate the practical risks adversarial patches pose to real-world VLM deployments, even when the underlying architectures are unknown.

Software Development at Alchemy Software LLC

Presenter: Aarav **Shah**

Mentor: Aiden Keighron

Alchemy Software LLC is a startup focused on intuitive and customizable productivity tools. Their main product is Half Full, a flagship all-in-one productivity application that is meant to appeal to both the regular consumer and power users. The primary focus of this internship was enhancing the mobile experience by implementing new features, with one of the major projects being a reactive screen time management tool.Unlike traditional solutions that require users to set time limits in advance (that are often ignored), our approach allows users to set usage limits after launching an app, promoting more mindful and in-the-moment decisions. The cross platform app was built using React Native, with Kotlin for Android-specific functionality and Swift for iOS development. Functionality of this screen time system was integrated into Half Full Mobile, and is now available on the App Store and Google Play store.

Finite Element Modeling of Thermal Gradients and Heat Losses in Fe-W Redox Reactors

Presenter: Atmaj **Shelar**

Mentors: John Misiaszek, David Dunand, Northwestern University

This research project focuses on optimizing the design and scalability of iron-tungsten (Fe-W) redox reactors for carbon capture and utilization (CCU) through finite element modeling (FEM). The Fe-W technology offers a promising single-step solution to convert raw industrial flue gas (e.g., from cement, steel, and waste incineration) into carbon monoxide (CO) while mitigating sintering issues with tungsten-doped iron powders. However, scaling up the reactor requires a thorough understanding of thermal gradients, heat losses, and energy efficiency under operational conditions. Using FEM, this study will simulate thermal profiles in stainless-steel reactors of varying sizes, filled with porous Fe-W powder in metallic or oxide states. Key scenarios include: (1) heating from room temperature to high temperatures (700–800°C) under stagnant and flowing gas conditions, (2) redox cycling at 800°C with exo-/endothermic reactions, and (3) cooling phases. The model will incorporate boundary conditions such as water-cooled ends (80°C), heat fluxes, and gas flow effects to evaluate thermal conductivity and reactor viability. Outcomes will inform reactor design for commercial-scale deployment, addressing challenges like energy consumption and thermal management. This work directly supports the startup's mission to provide a low-cost, scalable CCU technology while advancing sustainable industrial decarbonization.

Urbanization and the Gut: A Comparative Study of Microbiome and Diet in Indian Populations

Presenter: Fatema **Shikora**

Mentor: Maanasa Raghavan, University of Chicago

Understanding how factors such as geography, diet, and lifestyle shape the human gut microbiome is key to identifying population-level microbial patterns and their consequences for human health, especially as many global traditional (rural) populations are rapidly undergoing urbanization. In this study, I analyze microbiome (16S rRNA) and diet/lifestyle survey data from urban and rural members of two distinct human groups in India: the Austroasiatic population from Central India and the Himachal population from the North Indian Himalayas. The goal of this project is to investigate how urban versus rural lifestyle influences dietary behaviors and, consequently, the gut microbial composition. Using data analysis techniques including dietary frequency comparisons, bar chart visualizations, and principal components analysis, I examine how consumption of key food groups (milk, wheat, rice, red meat, fish, yogurt, and alcohol) varies across the two groups and urban versus rural lifestyles. My hypotheses suggest significant lifestyle-based differences in several of these

variables, though the direction and strength of effects vary by group, which in turn impact the composition of gut microbiota in these groups. For example, milk and fish frequencies differ between urban and rural groups in both populations, while wheat and yogurt differ only in the Austroasiatic group. Rice and red meat show minimal variation. All data processing and visualization were performed using R, a programming language I learned during this project. I will present my findings through comparative figures and summary statistics, with the aim of highlighting how geography and lifestyle intersect to shape dietary behavior and influence gut microbiome diversity.

Synthesis and characterization of hydrogels for energy storage and soft robotics applications
Presenter: Anushri **Sinha**
Mentors: Mayur S. Prabhudesai, Paul V. Braun, University of Illinois at Urbana-Champaign
Hydrogels, soft crosslinked networks of hydrophilic polymers, are increasingly explored for applications in energy storage and electronics due to their tunable mechanical and functional properties. This study presents a two-part investigation into the thermal and electrical behavior of such systems. First, hydrogels were synthesized with sodium acetate trihydrate (SAT), a phase change material capable of storing and releasing heat during crystallization. As part of an on-going project, the thermal conductivity of a series of SAT-hydrogel composites, formulated and cast into narrow vials, was characterized using the transient line heat source method. The next phase focused on electrically conductive hydrogels composed of acrylic acid and varying concentrations (0-10%) of PEDOT:PSS, a conductive polymer blend compatible with aqueous processing. The hydrogels were solvent-cast into fi lms 1 mm thick, thermally polymerized, and then characterized for composition using thermogravimetric analysis (TGA), rheological properties using rheometry, and visual inspection using optical microscopy; both before and after swelling. Results provide insight into the effect of PEDOT:PSS content on the mechanical properties of the hydrogel systems, allowing for potential utilization in the design and engineering of soft robotics and sensing applications.

Glucose-lowering potential of fenugreek, cinnamon and stevia
Presenter(s): Anjali **Srinivasan** & Kaleia Lin
Mentor: Sowmaya Anjur, IMSA
This study examined the glucose-lowering potential of three natural plant-based compounds—fenugreek, cinnamon, and stevia—using Benedict's reagent in a simulated diabetic model of blood and urine. Samples containing glucose at 0.15 g/100 mL and 0.25 g/100 mL were treated with either 2 mL or 4 mL of each compound. Fenugreek consistently produced the greatest

reductions in Benedict's test values for both blood and urine, indicating a marked decrease in glucose concentration. Cinnamon showed minimal to moderate reductions in urine glucose, primarily at higher volumes, while stevia exhibited little to no effect under any conditions. Two-Way Factorial ANOVA revealed significant effects of both compound type and treatment volume ($p < 0.0001$), confirming statistical reliability. The most pronounced effect occurred with 4 mL of fenugreek, where Benedict's values consistently reached 5.00 with a standard deviation of 0.00, indicating complete reproducibility. These findings align with prior research suggesting fenugreek enhances glycemic control through soluble fiber and bioactive constituents. The results demonstrate a dose-dependent glucose-lowering effect, strongest in fenugreek-treated samples. Given its accessibility, safety profile, and consistent performance under simulated diabetic conditions, fenugreek emerges as a promising candidate for supporting blood sugar regulation in at-risk or diabetic populations.

Wireless, Bio-Implementable Strain Gauge for Continuous Bladder Monitoring

Presenter: Saesha **Sumeeth**

Mentor: Dr. Arun Sharma, Northwestern University, Stanley Manne Children's Research Institute

The pressure of the bladder is critical to treat the neurogenic bladder dysfunction in the patients with myelomeningocele, or severe spina bifida, where loss of bladder control can cause kidney damage, urinary tract infections, and even death. The development of semi-invasive implantable bioelectronic devices that can sense bladder pressure opens the door for a new generation of urodynamics (UDS) tools. However, long-term biocompatibility needs to be confirmed. A foreign body response (FBR)-type of chronic inflammation may contribute to the worsening of bladder dysfunction and a slowed recovery. This study quantifies the host inflammatory response by histological and immunohistochemical characterization of FBR markers in response to a wireless bio-implantable strain gauge for continuous bladder monitoring. Mononuclear cell infiltration was evaluated by using hematoxylin and eosin (H&E) staining, while Masson's trichrome staining was used to evaluate collagen deposition and vascular change. IHC directed against inflammatory markers: CD68 for macrophages and myeloperoxidase (MPO) for neutrophils. This is in line with our results demonstrating the strain gauge's potential for chronic implantation. Together, the results show the capabilities of the device toward chronic bladder pressure monitoring while also demonstrating that biocompatibility of the device, an important consideration for its clinical uses.

Social Media Marketing with Alchemy Software

Presenter: Benas **Stonys**

Mentors: Aiden Keighron, Jacob Purdue

Alchemy Software is a technology focused on improving productivity through its app, *Half Full*. *Half Full* streamlines calendar and task management. Over the summer, interns participated in a business project that combined creativity and marketing. *Half Full's* business project included video editing, social media marketing, web design, and front-end development. Throughout the summer, interns created engaging promotional content, contributed advertisement strategies, and started work on an analytics website to monitor important performance metrics. Interns were encouraged to delve into software they were not confident with, building critical skills for future job opportunities. Throughout the project, interns were given experience in a tech environment while also benefiting the business. Social media efforts expanded *Half Full's* potential clients, while internal tools improved the ability of the company to track growth and determine effective strategies.

Developing a Singleplayer Turn-based Strategy Game Using Godot

Presenter: Andrew **Sun**

Mentor: Pranav Audhut Bhounsule, University of Illinois Chicago

This project involved the design, development, and playtesting of a single-player, turn-based strategy game. The goal was to explore game development as both a creative and technical discipline, with a focus on designing mechanics, dynamics, and aesthetics (MDA) to deliver a satisfying user experience. The game, titled Babel, centers on the player leading a civilization by constructing platforms and buildings vertically to escape rising floodwaters while balancing food and resource supplies. Babel was built using the Godot game engine and programmed in its native GDScript language. Some noteworthy game mechanics include the isometric tile-mapping system, scrolling tile-based display, and file save system. All graphics and audio, excluding the font, were created from scratch. Key challenges included transitioning the project from pygame to Godot, calculating and implementing the math behind the isometric graphics, and wrangling Godot's complex built-in UI controls. Balancing elements such as building costs, production rates, and game speed took many iterations of testing and refinement. The final product is a playable and exportable prototype complete with core mechanics such as win conditions, save/load functionality, and menu UI.

Synthesizing Magnetic Nanocomposites for Water Pollution Cleanup

Presenter: Mbayie **Tendong**

Mentor: Dr. Robert Richter, Chicago State University

The present experimental study investigated the optimal chemical formulas for creating strong magnetic nanoparticles and assessed their ability to absorb various dyes. To conduct this experiment, chemical compounds such as Iron(III) Chloride (FeCl3), Iron(II) Sulfate (FeSO4), activated carbon, and cellulose were combined to make magnetic nanocomposites. Once the strongest solutions were identified, they were then combined with dyes such as methylene blue, alizarin yellow, and malachite green to determine how much of each dye they could absorb. The results of this experiment show that magnetic nanoparticles are highly effective at absorbing dyes. Since many different types of dyes end up contaminating bodies of water and disrupting the ecosystem of aquatic species, magnetic nanoparticles would make cleaning up pollution much easier, helping to protect the environment.

H5N1 Modelling through the OneHealth Framework

Presenter: Aditya **Tiwari**

Mentor: Dr. Anuj Tiwari

OneHealth, an initiative by the World Health Organization, intends to unify the measures of health between Human, Animal, and Environmental health for the overall good. Computational methods for implementing this framework are in their infant stages, mainly focusing on correlations between aspects of each individual element to create a holistic approach to mitigating zoonotic and anti-microbial resistance disease. Our research extends this approach by implementing and highlighting the internal dynamics between systems in traditional SIR (Susceptible-Infected-Recovered) models, focusing specifically on developing forecasting systems for spillovers for H5N1 or Avian Influenza as an example of implications of zoonotic diseases. Through Ordinary Differential Equation (ODE) and Continuous Time Markov Chain (CTMC) modeling, we follow migratory birds through North and South environments to track virus shedding patterns to local poultry and the chance of spillover to humans. Additionally, the metrics produced by this model and our further analysis in research allows us to infer possible trends in viral spread in order to mitigate H5N1 in the case of possible epidemic scenarios. This work sets a baseline for future research using models through the OneHealth framework and informs policy about important holistic metrics for intervention.

Effects of Antiretroviral Therapies on Monocyte-Derived Osteoclast Resorption Events

Presenter: Srimedha **Veerathu**

Mentors: Jessah Goldner, Dr. Jennillee Wallace, Rush University

Antiretroviral therapies (ARTs) have significantly improved the prognosis of human immunodeficiency (HIV) patients, but long-term ART use is associated with increased risk of osteoporosis. ARTs work by inhibiting various stages of the HIV life cycle including entry, reverse transcription, integration, and maturation; this allows the immune system to reduce the viral RNA. The objective of this research was to determine the effects of different ARTs on osteoclast-mediated bone resorption events that contribute to bone loss. CD14+ monocytes were isolated from human blood , which were then differentiated into matured osteoclasts. These cells were then treated with both individual and combination drugs, including bictegravir (BIC), tenofovir alafenamide (TAF), emtricitabine (FTC), abacavir (ABC), dolutegravir (DTG), bictarvy, and triumeq, with H2O and VEH as the controls. After calculating the percent of eroded surface based on the quantification of the pit and trench events, the ART-treated samples trended at a lower eroded surface in comparison to the controls. TAF resulted in the least surface erosion, suggesting it had the least impact on bone degradation. Studies are also being conducted on the neurological effects of these ARTs.

Machine Learning for QAM-16 Demodulation: Evaluating the Star, Cross, and Square Constellations as Hardware Alternatives

Presenter: Vishnu **Vijay**

Mentor: Dr. Carol Davids, Illinois Institute of Technology

This project explores the effectiveness of the Square, Star, and Cross constellations in Quadrature Amplitude Modulation (QAM) systems, with the goal of improving machine learning based classification of radio signal transmissions. Traditional communication systems rely on expensive and inflexible hardware for signal decoding. However, this research, conducted in Dr. Davids' lab and sponsored by INdigital, investigates a software based alternative using an AI model trained on QAM-16 data to reduce hardware dependency and improve efficiency. We have trained decision tree and random forest models on simulated data representing each constellation, achieving up to 93% accuracy with the Square constellation. Performance metrics, including prediction accuracy and speed, reveal trade-offs: while the Square constellation consistently outperforms others in accuracy, the Cross constellation offers significantly faster prediction times but a lower accuracy. Our next steps are to test the constellations using real-world signals and demodulate the received signals with our models instead of using hardware. The project also investigates the effects of constellation shape,

exploring how phase and amplitude variation affect model performance. Ultimately, this research aims to inform the development of faster, cost-effective, and ML-driven communication systems, advancing the practicality of constellation-based signal decoding in real-world environments.

Curating Illinois' Statewide Hackathon for CS4IL

Presenters: Vishnu **Vijay**, Vijnna Appasani, Atharv Kanchi, Isabella Alban, Aidan Chang

Mentor: Mark Smithivas

CS4IL is a nonprofit organization focused on expanding equitable access to computer science education across Illinois. This project supported the planning of a statewide student hackathon by contributing to visual design, challenge development, and event coordination. Responsibilities included creating promotional materials, reviewing and revising hackathon problem statements, and offering feedback on timelines, user experience, and marketing strategy. To guide this work, research was conducted on best practices in hackathon planning, with a focus on inclusivity, challenge clarity, and student engagement. Networking events, such as CSPD Week in Springfield, and Speaker Series in downtown Chicago, were attended to better understand the broader CS/Tech education landscape in Illinois. Tools such as Canva were used to collaborate on flyers and documentation, while feedback was incorporated throughout the planning process. This experience contributed to a greater understanding of how technical skills, communication, and event strategy intersect in real-world CS education initiatives, and provided insight into how statewide organizations promote youth participation in computer science.

Magneto-Optical Faraday Effect in Ferrocene

Presenter: Roy **Wang**

Mentor: Bumsu Lee, Southern Illinois University Carbondale

Ferrocene is a metallocene compound composed of an iron atom sandwiched between two cyclopentadienyl rings. Because of its distinct electronic and magnetic properties, recent interest has grown in the field of advanced organic display and quantum technology. However, the behavior of Ferrocene when exposed to external magnetic fields and polarized light is relatively unexplored. This project will investigate Ferrocene using high-sensitivity optical techniques, with a Magneto-Optical Faraday system coupled with a lock-in amplifier to generate hysteresis loops and polar plots through the Magneto-Optical Faraday Effect. These measurements will be plotted across magnetic field cycles, and can be used to understand the unique magneto-optical properties of Ferrocene. This

project aims to understand Ferrocene's behavior under an external magnetic field, and assess its viability in future applications in optical and quantum technologies.

Youth Academic and Enrichment Support at River Oaks Community Education and Development

Presenter: Titania **Ward**

Mentor: Sonya Harrington

River Oaks Community Education and Development Corporation (ROC ED) is a community organization committed to offering students in the area a safe, educational and fun place to learn, grow and socialize. Several trainings were completed; including for CPR, mandated reporter, and student health and wellbeing training, each resulting in certifications lasting 2 years. The focus of this summer internship was to assist in the academic lessons of the teachers, as well as support grade-school-aged students in the development of social emotional learning (SEL) skills. Over the summer, support staff were asked to interact with the students throughout the day, help them with assignments, and create afternoon activities for them to engage with. Additionally, support staff strengthened their leadership, communication, and problem-solving skills in a classroom environment and gained hands-on experience in classroom management and curriculum support. The ROC ED continues throughout the school year as a before and after school program, focused on preparing students for the day and winding them down in the afternoon.

Applications of Ground-Penetrating Radar on Historically Significant Cemeteries

Presenter: Amelia **Weingarz**

Mentor: Dr. Harvey Henson, Southern Illinois University

Midwestern cemeteries established by European settlers in the early to mid-1800's often contain unmarked graves, due to limited resources or the absence of long-term maintenance. These graves may hold historical significance by providing data on population size and burial conditions. One such example is the John Smith Cemetery, in Carbondale IL, which was recently reclaimed by descendants of the original founder, John Smith. Under the Illinois Human Remains Act (20 ILCS 3440), burial sites that are over 100 years old are legally protected. A ground-penetrating radar (GPR) system can be used to noninvasively identify the potential locations of these graves. This system sends radar signals up to 7 meters below ground that penetrate through undisturbed topography and bounce off irregularities caused by anomalies present. The results appear as reflective signals in the GPR programs, allowing the identification of rectilinear shapes within the soil, which can be interpreted as signs of a grave shaft (Henson 2008). Our study was a survey of the John Smith cemetery to identify

potential unmarked graves and assist in understanding their historical significance. In the process, we were able to identify multiple rectilinear anomalies that could correlate with the client's known unmarked and misplaced graves.

Rational Design of a Fluoxetine Analog to Reduce Nausea Side Effects

Presenter: Claire **Wen**

Mentors: Dr. Jin Jin, Western Illinois University; Dr. Zhang, Western Illinois University

Fluoxetine, commonly known as Prozac, is a widely prescribed antidepressant and the first SSRI (selective serotonin reuptake inhibitor) approved by the FDA. While effective in treating depression, anxiety, and other disorders, it frequently causes early-onset nausea, which often leads to treatment discontinuation. This side effect is usually thought to be linked to serotonin's interaction with 5-HT_3 receptors in the gut and brainstem rather than its intended antidepressant target. To address this, we designed a modified version of fluoxetine by attaching an imidazole ring to its amine side chain. This idea was inspired by ondansetron, a drug that prevents nausea by blocking 5-HT_3 receptors and also features an imidazole group. The goal of this modification is to preserve fluoxetine's antidepressant activity while reducing nausea through potential 5-HT_3 receptor interaction. A proposed synthesis pathway involves a nucleophilic substitution reaction between 3-iodo-1-phenylpropanol and imidazole. Future directions include testing for metabolic stability, blood-brain barrier permeability, and serotonin transporter binding. This project shows how small and targeted changes in drug structure can improve both therapeutic outcomes and patient experience.

Setting Limits on a Toy Model Using The CLs Method

Presenter: Izen **Wong**

Mentor: Peter Dong

Our group is conducting an exotic dark photon search. If we do not observe sufficient signal in our data to constitute a discovery, then we will need to set a limit upon the expected mass of the dark photon. This limit is essentially an interval in which the dark photon cannot be found with a certain level of confidence (usually 95%). Our limit would then be added to a collection of pre-existing limits, aiding future dark photon searches by narrowing their scope. This project aims to test the CLs method as a way of calculating these limits. As our dark photon search is not completed yet, this project will set limits on a toy model of a similar analysis using a counting experiment, the same method our group will use for the main analysis.

Health Tech Operations and Research with SafeStart Medical

Presenter: Luke **Yin**, Lucas He

Mentor: Dr. Richard Vazquez MD FACS, SafeStart Medical, CEO/CMO

SafeStart Medical is a health information technology company focused on improving surgical safety by reducing medical errors, streamlining perioperative workflows, and promoting patient-centered care. Their platform helps eliminate communication failures and prevent never events, which are serious but avoidable surgical complications. During our internship, we shadowed Dr. Vazquez closely to observe and better understand how a health tech startup operates, as well as how clinical insights are translated into digital tools that improve patient outcomes. We contributed to SafeStart's mission by offering student perspectives on internal discussions regarding product communication and outreach strategies. Our research findings helped inform partnerships with other organizations by highlighting concerns from a patient-centered perspective. Through this experience, we gained valuable insights into the daily operations of med-tech organizations while aiding SafeStart in advancing its goal of safer, more efficient surgical care.

Overview of Workplace Ergonomics; What is its Significance?

Presenter: Ava **Zou**

Mentor: Dr. Quintin Williams

Ergonomics uses the study of interactions between humans, tasks, tools, and their environment to design systems that are tailored for the human body to fit their capabilities and limitations. It plays a crucial role in maintaining human well-being and optimizing workspace performance in career settings. Employing ergonomics in the workspace may help with preventing health concerns: work-related musculoskeletal disorders (WMSDs), strains on physical/mental health, early retirement from WMSDs, etc. However, the knowledge and training of ergonomics is lacking in many fields. As modern work increasingly involves extended periods of time in the same position, repetitive motions, etc., the importance of ergonomic principles is highly stressed, influencing setting layout, tool design, etc. for the most optimal work environment. Integrating ergonomics into the design process leads to not only a healthier, but also more productive work flow, ultimately benefiting both individuals and organizations.