SIU Carbondale presents

47TH ILLINOIS JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM

FEBRUARY 21 & 22, 2025

ILLINOIS JSHS
JUNIOR SCIENCE AND HUMANITITES SYMPOSIUM

SIU CARBONDALE
SOUTHERN ILLINOIS UNIVERSITY
STEM EDUCATION RESEARCH CENTER

CONTENTS

OBJECTIVES

PROMOTE research and experimentation in sciences, technology, engineering, and mathematics (STEM) at the high school level.

RECOGNIZE the significance of research in human affairs, and the importance of humane and ethical principles in the application of research results.

IDENTIFY talented youth and their teachers, recognize their accomplishments at symposia, and encourage their continued interest and participation in STEM.

EXPAND the horizons of research-oriented students by exposing them to opportunities in STEM within the Department of Defense, academia, industry, and government.

INCREASE the number of adults capable of conducting research and development.

The symposium is one of 49 similar regional programs conducted throughout the United State, Puerto Rico, and the Department of Defense Dependent Schools of Europe and the Pacific. Outstanding students from the regional symposia will be chosen to participate in the 63rd National JSHS. This year it will be held April 22-26, 2025, in Chantilly, Virginia.

The 2025 National JSHS will host 245 top high school qualifiers from the regional symposia, along with 130 teachers, mentors, faculty, military personnel, and others, celebrating student achievement and inspiring future scientists and engineers.

ILLINOIS JSHS
JUNIOR SCIENCE AND HUMANITITES SYMPOSIUM

"Research is formalized curiosity. It is poking and prying with a purpose." – Zora Neale Hurston

ACKNOWLEDGEMENTS

ILLINOIS JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM

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School of Earth Sciences & Sustainability
School of Mathematical and Statistical Sciences
SIU Athletics
SIU Medical School
SIU Morris Library
SIU University Honors Program
SIU Sustainability Office
Various SIU Offices
Various SIU Registered Student Organizations
SIUE Fuller Dome, Edwardsville
Bucky's Dome Home, Carbondale
Science National Honor Society of Marion High School
The Diversity Project
SIU Provost
Vice Chancellor for Research
Conference and Scheduling Services
Many other friends of SERC

IJSHS GENERAL INFORMATION

CONTACTS

Angela Henson ..... abox@siu.edu
Dr. Amanda Weidhuner ..... amweidhuner@siu.edu

MEALS

As a guest of the Holiday Inn, you are entitled to a complimentary breakfast at the hotel. All other meals will be provided in the Renaissance Room, Student Center – 1st Floor. Snacks and beverages will be available throughout the symposium. Receptions will include light snacks and beverages

PARKING

Parking tags should be hung on the rear-view mirror of your vehicle. Parking is available in all lots. You do not need to pay at the parking meter. We recommend parking located close to the Student Center or Morris Library.

PICTURES

The poster and oral participants are their intellectual property. Please do not take photos or videos of student work without the student's explicit permission.

SOCIAL MEDIA

Please respect all attendees and avoid sharing photos, videos, or intellectual property without explicit permission.

LANYARDS

Name lanyards identify you as our student guests. Lanyards should be always worn while you are on campus. Lanyards can be returned at the end of the symposium.

SHOWCASES

The two SIU showcase sessions will feature interactive engagement with SIU organizations, Bucky's Dome Home, and the SIUE Fuller Dome, providing insights into their programs.

DRUGS/ALCOHOL

The use of alcoholic beverages is NOT permitted at the IJSHS. Additionally, the use of any drug, or substances that are generally regarded to be detrimental, is forbidden.

CURFEW

The hotel requests that all students be in their rooms by 11 p.m., or earlier if required by the accompanying teacher. It is the responsibility of each teacher or chaperone to supervise his/her students and ensure that this request is enforced.

PRACTICE (ORALS)

Oral presentation practice slots are scheduled within the time blocks below. Presenters have been notified of their slots and should be ready to keep sessions on schedule. These time blocks are represented in the program with an asterisk (*)

- Block 1: 1:00 PM – 2:36 PM
- Block 2: 5:00 PM – 8:34 PM

All program times are subject to adjustment based on event needs.

PROGRAM: DAY 1 (FRIDAY)

1:00 - 3:15 p.m.

SIGN-IN
Art Gallery, Student Center, 1st Floor

POSTER SET-UP & ORAL PRESENTATION PRACTICE*
Art Gallery, Student Center, 1st Floor and Auditorium, Student Center, 2nd Floor

3:00 - 4:00 p.m.

DINNER AVAILABLE (BUFFET STYLE)
Renaissance Room, Student Center, 1st Floor

3:30 - 4:50 p.m.

OPENING CEREMONY
Renaissance Room, Student Center, 1st Floor

PRESENTATION OF COLORS
Air Force Cadets

GREETINGS
Dr. Sheryl A Tucker, SIU Provost and Vice Chancellor for Academic Affairs
Dr. Costas Tsatsoulis, SIU Vice Chancellor for Research and Dean of the Graduate School

KEYNOTE ADDRESS
Dr. Buffy Ellsworth, Professor and Associate Chair
Department of Molecular and Integrative Physiology, SIU School of Medicine
Research Focus: Pituitary gland development and function

WRAP UP

5:00 - 6:00 p.m.

POSTER JUDGING*
Art Gallery, Student Center, 1st Floor

6:05 p.m.

DELIBERATION OF JUDGES

6:05 - 6:10 p.m.

WALK TO SIU MORRIS LIBRARY
Meet in Renaissance Room, Student Center, 1st Floor by 6:05

6:15 - 8:30 p.m.

SIU SHOWCASE & RECEPTION*
Auditorium and Rotunda, Morris Library, 1st Floor

8:30 - 9:30 p.m.

LEAVE FOR HOTEL*

PROGRAM: DAY 2 (SATURDAY)

7:30 a.m.

BREAKFAST

Holiday Inn – Complementary Breakfast

7:30 - 8:00 a.m.

OPEN POSTER SESSION SET-UP & ORAL PRESENTATION PREPARATION

8:05 - 8:50 a.m.

OPEN POSTER SESSION

Art Gallery, Student Center, 1st Floor

9:00 a.m. - 12:45 p.m.

ORAL PRESENTATION SESSION

Auditorium, Student Center, 2nd Floor
Presenters 1 - 5
Break (15 minutes)
Presenters 6 - 10

12:05 p.m.

DELIBERATION OF JUDGES

12 - 12:40 p.m.

LUNCH

Renaissance Room, Student Center, 1st Floor

12:45 – 3:10 p.m.

SHOWCASE SESSION

Bucky's Dome Home (Dome Home Committee)
SIU Morris Library (SIU Honors Students)

3:15 - 4:00 p.m.

AWARDS CEREMONY

Auditorium, Morris Library, 1st Floor

4:00 - 4:30 p.m.

RECEPTION

Rotunda, Morris Library, 1st Floor

2025 NATIONALS DELEGATION MEETING

Auditorium, Morris Library, 1st Floor

SHOWCASE SESSIONS

The Showcase Sessions introduce IJSHS participants and guests to STEM education, research, and innovation at Southern Illinois University (SIU). Students can explore at their own pace, engaging with information booths, hands-on experiments, and interactive exhibits to learn about SIU's academic programs and career pathways.

Some experiences will be structured, including Buckminster Fuller-themed presentations and activities, University Honors Students presenting their research, and a Library Tour highlighting SIU's resources. These sessions aim to offer immersive experiences, connecting students with faculty, researchers, and peers while discovering STEM opportunities at SIU.

FRIDAY

Explores the legacy of Buckminster Fuller with a presentation, hands-on activities, and a curated exhibit. Benjamin Lowder (SIUE) will discuss Fuller's innovations and lasting impact. Students will then engage in interactive activities, including the Dymaxion Map, Bucky Ball construction, and Diversity Project. A Morris Library exhibit will display models and artifacts related to Fuller's work. The evening concludes with a reception featuring light snacks and beverages, providing time for discussion, reflection, and networking.

> Benjamin Lowder preserves the legacy of Buckminster Fuller as Director of the miniature-earth geodesic dome at SIU Edwardsville and a board member of Fuller's historic Dome Home in Carbondale. He also serves as a liaison to the Estate of Buckminster Fuller, organizing tours and programs that highlight Fuller's impact on architecture, sustainability, and innovation.

SATURDAY

On Saturday, groups will alternate between a tour of the Buckminster Fuller Dome Home Museum and the Library Showcase Session, which includes a guided library tour and presentations by University Honors Students about their research and SIU opportunities.

> Buckminster Fuller and his wife, Anne, lived in their geodesic dome home in Carbondale from 1960 to 1971 while he was a professor at SIU. During this time, he earned a Nobel Peace Prize nomination, gained international recognition, and produced some of his most influential work. The Dome Home, added to the National Register of Historic Places in 2006, remains one of the most significant artifacts of Fuller's legacy.
>
> Although the Dome Home is not part of SIU, it is preserved by a dedicated team committed to maintaining Fuller's legacy and sharing his contributions to design, sustainability, and innovation with the public.
>
> Morris Library, the largest research library in Southern Illinois, houses over 2.6 million volumes and unique archives, including Buckminster Fuller's work. It serves as a hub for academic research and student learning.
>
> The University Honors Program provides high-achieving students with small, discussion-based courses, research opportunities, and faculty mentorship to enhance their academic experience.

KEYNOTE SPEAKER

DR. BUFFY ELLSWORTH is a Professor and Associate Chair in the Department of Molecular and Integrative Physiology at SIU School of Medicine. She holds a Ph.D. in Cell and Molecular Biology from Colorado State University and completed a postdoctoral fellowship at the University of Michigan. Her research focuses on pituitary gland development and function, particularly the role of forkhead transcription factors in gene regulation, using genetically engineered mouse models. She has secured a $2.77 million research grant for congenital hypopituitarism studies and has multiple NIH-funded projects, with numerous publications in leading endocrinology journals. Recognized for her contributions, she has received the NIH National Research Service Award, SIU's Excellence in Academic Medicine Award, and travel awards from The Endocrine Society. In addition to her research, she teaches courses such as PHSL 501 and PHSL 530/430 and contributes to SIU's medical school curriculum.

ADMINISTRATIVE GREETINGS

DR. SHERYL A. TUCKER is the SIU Provost and Vice Chancellor for Academic Affairs. Research Emphasis: Molecular Spectroscopy, Chemical Analysis, Environmental Science, and Organized Media. Dr. Tucker earned her B.S. in Chemistry from Kent State University and her Ph.D. in Chemistry from the University of North Texas, followed by a Postdoctoral Research Fellowship at Duke University. Dr. Tucker has served at SIU since 2023.

DR. COSTAS TSATSOULIS is the SIU Vice Chancellor for Research and Dean of the Graduate School. Research Emphasis: Multiagent Systems, Case-Based Reasoning, Machine Learning, and Intelligent Image Analysis. Dr. Tsatsoulis earned his B.A. in German and B.S. in Electrical Engineering from Purdue University, followed by an M.S. and Ph.D. in Electrical Engineering from Purdue. Dr. Tsatsoulis has served at SIU since 2022.

DR. HARVEY HENSON is the Director of the SIU STEM Education Research Center. His research focuses on science education, geology, earthquake seismology, and applied geophysics. He earned a B.S. in Geology from Ball State University, followed by an M.S. in Geology/Geophysics and a Ph.D. in Science Education from SIU.
Dr. Henson has served at SIU for 39 years.

STUDENT BIOGRAPHICAL SKETCHES

AAMUKTHA YALAMANCHILI a senior at Adlai E. Stevenson High School, will present her research on The Relationship Between Brain Connectivity and New Learnt Skills Based On Cognitive Function Across Different Groups. Aamuktha is the co-founder of The Unknown Now, an organization dedicated to advancing neuroscience research and public awareness of neurological health. Passionate about the intersection of neuroscience and public health, Aamuktha aspires to pursue a career in medicine, focusing on innovative research and patient care.

ARYA PORE is a junior at Adlai E Stevenson High School. She is presenting her work on the optimisation of asymmetric PCR for a long DNA template in the poster session. This past summer, she worked with AEOP under Dr. Michael Norton at Marshall University, West Virginia. In the future Arya aspires to be a physician.

ASHRA ROSHY is a junior from Adlai E. Stevenson High School participating in IJSHS for the first time. She loves science and biology, exploring experimental investigation and other fields in Science Olympiad and healthcare in HOSA Future Health Professionals. In the future, she hopes to continue research in the biological sciences and hopes to be a medical professional.

AVIRAG HOSAKOTE is a sophomore that is part of the Illinois Math and Science Academy's Research, Inquiry Skills and Experimentation program. For IJSHS, Avirag has used a machine learning ensemble model to predict wet snow avalanches based on weather variables. Avirag is also interested in competition math and competitive coding, having won awards for both. In his spare time, he does independent research on other machine learning projects.

BRANDON ROSS is a sophomore from Governor French Academy. He will be presenting on medicinal chemistry and aspires to have a career in the field as well. Brandon has participated in numerous math competitions and would like to participate in future IJSHS events as well.

BRUCE TANG a senior at University of Illinois Laboratory High School is presenting his work on applying deep learning and explainable AI tools to computational biology. Bruce is the founder of his school's computer science club and is interested in studying the connections between biology, mathematics, and computer science. He looks forward to meeting other student researchers at the symposium.

HEATHER WANG is a senior at Southeastern High School where she is president of her FBLA chapter, active in FCCLA, FFA, cybersecurity club, and science club. Macy has won several special recognitions for her cybersecurity skills and for her science club project. She is a two-time national finalist for the Cyberstart America challenge. Her future plans include continuing her education at a college majoring in education.

STUDENT BIOGRAPHICAL SKETCHES

JONATHAN OUYANG a senior at University Laboratory High School, is presenting his research on the characterization of the universally conserved Developmentally-Regulated GTPases and structural implications for the Cation-Dependent GTPase motif. His research accolades include being awarded the Frankel Fund for Learning Innovation Research Grant, which partially funded his research, and being the first high schooler invited to the oral presentation section of the Undergraduate Research Symposium at the University of Illinois Urbana-Champaign. A state champion, he also captains his school's Scholastic Bowl team, which placed 8th nationally last year. Jonathan hopes to pursue a career in advancing artificial enzyme design to pioneer innovative solutions in pharmaceutical manufacturing, pollution management, and sustainable chemical synthesis.

KALYAN CHERUKURI a sophomore at the Illinois Mathematics and Science Academy, is presenting his research regarding techniques for robust image classification under adversarial Gaussian noise. He is a founding member of his school's Data Science & Visualization Club, and he is committed to promoting computer science education and advocating for the effective use of data. Kalyan is very excited to present his work and to learn from other students at the symposium.

KRISH PATEL is a 15-year-old freshman at the Governor French Academy who is extremely dedicated to presenting his findings on the correlation between accretion disk luminosity and black hole mass. Krish is an extremely ambitious student who plans to proceed with a career in astronomy and is looking forward to sharing his work and learning from others at the symposium.

LAKSH PATEL is a Junior at the Illinois Mathematics and Science Academy. He is the founder of IMSA's Cybersecurity Club, focused on mitigating phishing emails and educating the student body on the importance of digital security. His research, Adversarial Attack Mitigation in Formation Control of Multi-Agent Systems, protects systems of autonomous vehicles against cyber-attacks.

MARCUS KING a senior at the Governor French Academy, is presenting his research modeling water world atmospheric structures and compositions for use in future detections. He is passionate about astrophysics and serves as the state science fair's fundraising chair. Marcus is invested in science communication and hopes that his research can make a difference.

MEGHA NAMBISAN a junior at Downers Grove North High School, is presenting her research on aptamers and their ability to target specific proteins in non-small cell lung cancer. She is an active member of her school's HOSA and Women in Leadership Club. Megha looks forward to sharing her work and learning from other students at the symposium.

STUDENT BIOGRAPHICAL SKETCHES

MEHER GARG is a sophomore at Springfield High School and a student at IMSA RISE. Over the past two summers, she had the opportunity to work in a stem cell lab, researching brain cancer and studying the effects of retinoic acid on glioblastoma cancer stem cell differentiation. She is excited to present her findings and discuss the potential of this approach as a therapeutic option for this devastating disease. Meher is passionate about music and serves as the first violist for the Illinois Symphony Youth Orchestra. She takes pride in being part of varsity scholastic bowl and golf teams. Her primary academic interest lies in neuroscience, and she aspires to pursue a career in neuroscience research in the future.

NAVYA SHAH a sophomore at Neuqua Valley High School, is presenting research on somatic mutations as biomarkers for autoimmune disease diagnosis and prognosis. Passionate about public health and healthcare accessibility, she supports underprivileged communities through literacy and mental health initiatives. Navya looks forward to exploring how genetic research can advance precision medicine and engaging with fellow researchers at the symposium.

NIDHI SAGARAMO a Junior at Illinois Math and Science Academy. This is her second year participating in the IJSHS competition and is very excited to continue her journey! She has competed in eCybermission competition and is also a part of the AEOP Alumni Association. She hopes to continue her research in microbiology and regenerative medicine to help people all around the world!

POOJAK PATEL a junior at Illinois Math and Science Academy, is presenting his research on the role of neuronal nitric oxide synthase (nNOS) in Alzheimer's disease (AD). His project explores the potential of nNOS inhibition as a therapeutic strategy for AD, aiming to alleviate amyloid beta-induced neurotoxicity. Poojak is passionate about the intersection of computer science and neuroscience and has conducted research at Northwestern University. He is excited to share his work and learn from other students at the symposium.

RASHMI ADULKAR a junior at Neuqua Valley High School, is presenting her research on potential inhibitors targeting the HILPDA Protein, which is a primary cause of kidney cancer. She has a great passion for science and is the founder of her school's mental health club. She has found that having good mental health plays an important role in improving the well-being of cancer patients. She is excited to share her work, her personal connection to it, and to meet other students at the symposium!

SAHANA GARAPATI a junior in the IMSA - RISE program is presenting her research on the effects of the chemical Genistein on the blood brain barrier and its effects on Alzheimer's disease. Sahana is passionate about neuroscience and is taking college classes with University of Michigan to continue learning about the topic.

STUDENT BIOGRAPHICAL SKETCHES

SAMIL SHARMA a junior from Neuqua Valley, is presenting his research on the Effects of Molecular Propellants in Ion Thrusters on the Thrust. Samil is a member of his school's rocket club and is deeply passionate about aerospace. He is very excited to be sharing his work at the symposium.

SANJANA KOTHURI a junior at Metea Valley High School, is presenting her research on non-invasive blood cancer therapy. She is a volunteer at her local hospital, having experience assisting nurses and patients. Additionally, she has shadowed doctors practicing cell research in UTMB. She has a great interest in researching neuroscience and other types of cancer treatments.

SAVANNAH RAMSEY a senior at Southeastern Jr/Sr High, is presenting her research on eco-engineered floating wetlands as a technique to improve water quality. She was a finalist at the 2023-24 ISEF, where she competed against and connected with other competitors from all around the world. Savannah can't wait to share her work, meet new people, and make fun memories at the symposium!

SIDHARTH BRAHMANDAM a sophomore at Naperville North, is presenting his research about a hybrid quantum classical model for drug discovery. He is passionate about novel technology and service, founding a club that provides virtual reality to local senior centers. Sidharth is very excited to share his research and learn from others at the symposium.

SOHUM MEHTA a junior at the Illinois Mathematics and Science Academy, is presenting his analysis of lexical frequency in human learning. His work comes from his aspiration in computational neuroscience, bridging the gap between the mind and artificial intelligence, an exploration he has pursued from an independent study. Committed to making research accessible for all, Sohum feels motivated to share his work and contribute meaningfully to the coming age of technology.

TANVI BODDUPALLI a junior at the Illinois Mathematics and Science Academy, is presenting her research on Evaluating the Effects of Nano and Microplastics on Epidermal Barrier Function. Her future goal is to get a medical degree (M.D.), veterinary degree (D.V.M.), or dental degree (D.D.S.).

STUDENT BIOGRAPHICAL SKETCHES

Cellular Evaluation and Simulated Predictive Modeling of nNOS-mediated AßO Neuropathology as Potential Therapeutic Applications in Alzheimer's Disease

POOJAK PATEL

Alzheimer's disease (AD) is a progressive neurodegenerative disease characterized by pathogenic accumulation of amyloid beta (Aß) oligomers in a mortality-inducing cognitive decline promoting and promoting feedback loop. One of the prominent forces behind the onset and progression of AD pathology is Aß oligomer (AßO) neurotoxicity, precipitating dysfunction in synaptic transmission and ultimately resulting in neuronal death. More recently, it has been shown that in both deaths signaling pathways activated by AßO involved neuronal nitric oxide synthase (nNOS) and thus nNOS presence may complicate AD progression in two avenues: 1. Complication via association with hyperphosphorylated tau, and 2. Complication via pro-neuroinflammatory signaling. The purpose of this study is to assess whether nNOS chemical inhibition could serve as a treatment target for AD if nNOS activity increases AßO-induced pathological signaling results. Assessment of nNOS will be conducted in both Alzheimer's disease representative models, MC65 and HT22, via phosphorylation of signaling targets and levels of neuronal death. A selective nNOS inhibitor will determine the feasibility of the compound to alleviate AßO-induced neurotoxic results in a dosage dependent fashion. To date, AßO exposure results in increases to levels of nNOS, tau phosphorylation, and neuronal death; however, preliminary results indicate treatment with the selective nNOS inhibitor significantly reduced all three. This study seeks to determine the role of nNOS in AD pathology and support nNOS inhibition as a viable therapeutic strategy to reduce degeneration of neurons in Alzheimer's disease.

Human Glioblastoma Cancer Stem Cells Differentiation by Retinoic Acid: A Potential Therapeutic Strategy

MEHER GARG

Retinoic acid (RA) can induce differentiation of human glioblastoma stem cell lines, LN-229, and U87-MG, into normal neurons, offering a potential treatment option for glioblastoma. Glioblastoma is a fatal cancer with an average survival of fifteen months despite best treatment. RA, a derivative of vitamin A, induces cell differentiation and is used in the treatment of acute promyelocytic leukemia. The effect of RA on glioblastoma cancer stem cell differentiation is not well understood. LN-229 and U87-MG glioblastoma stem cells were treated with RA at concentrations of 1.25, 2.5, 5, and 10 µM in media containing 2% or 10% fetal bovine serum (FBS). After 24-hour incubation, cells were treated for 5 days, fixed, and stained with TUJ1 antibodies to assess differentiation under a fluorescent microscope. FBS 2% inhibited stem cell growth, while 10% FBS promoted growth. RA concentrations of 10 µM with FBS 2% caused cell death. RA concentrations of 2.5 and 5 µM in both FBS 2% and 10% media induced differentiation in both cell lines. The optimal cell differentiation occurred at 5 µM RA with 10% FBS, particularly in the U87-MG line, which showed more pronounced differentiation than LN-229. RA induces differentiation and inhibits growth in glioblastoma stem cells, with the U87-MG line showing a stronger response. The combination of RA (5 µM) and FBS 10% promotes optimal differentiation, suggesting potential therapeutic applications for glioblastoma. Further testing and in vivo evaluation of RA is warranted for glioblastoma patients.

Water World Exoplanet Atmospheric and Spectral Data Analysis via Thermodynamic Modeling and Unsupervised Machine Learning

MARCUS KING

Recent discoveries like GJ 9827 d's water-rich atmosphere have brought to light an understudied class of exoplanets — water worlds. The discovery of water in this exoplanet atmosphere simultaneously showed current capabilities, with novel high-fidelity telescopes like JWST in use, yet also demonstrated a need to understand this class of planets better with many similar discoveries soon likely. The current understanding of water world exoplanet detection is limited by models — through modeling exoplanetary processes, astronomers develop expectations and can optimize their searches accordingly. Water worlds are currently known only by their key atmospheric signature, water vapor. This study develops thermodynamic models of water world atmospheres relative to pressure and temperature via equilibrium chemistry and uses these to create a database of synthetic spectra on which a K-means clustering model is trained to identify different water world subtypes. This study employs a grid resolution with 1.5 million equilibrium chemistry data points and over 5,000 synthetic spectra. This study also, in tandem, develops an analytical pipeline for modeling exoplanet atmospheres given an initial composition and pressure-temperature profile. To enhance model accuracy, aspects such as mixing between the atmosphere and underlying magma ocean were considered, and the parameter grid was specified to evaluate hot water worlds around M dwarfs. The model found significant correlations between water vapor, carbon dioxide, sulfur dioxide, hydrogen, and other volatiles in water world atmospheres, finding three clusters corresponding to regions of component abundance. This study marks a notable advancement in the modeling of these water world atmospheres.

First In Silico Simulation to Predict Inhibitors Targeting the HILPDA Protein in Clear Cell Renal Cell Carcinoma (ccRCC)

RASHMI ADULKAR

Kidney cancer remains a formidable global health challenge, claiming over 13,780 lives and affecting more than 76,000 individuals in the United States in 2021 alone. Among its subtypes, clear-cell renal-cell carcinoma (ccRCC) emerges as the most prevalent and aggressive form, characterized by aberrant formation of lipid droplets in cancerous cells. Recent research (2024) unveiled that the HILPDA protein helps produce lipid droplets by converting glutamine into fatty acids, thereby fueling triglyceride accumulation and tumor progression. I hypothesize that small-molecule inhibitors can bind to and inhibit HILPDA, thereby disrupting lipid metabolism and preventing the progression of ccRCC. To identify potential inhibitors, I screened 5,000 compounds and conducted molecular docking simulations using the AutoDock Vina software. Six ligands exhibiting strong binding affinities and favorable interaction profiles with HILPDA were selected. The docking simulations were validated by comparing them with the druggable sites on HILPDA predicted by P2Rank, a machine learning-based method (P2Rank). The SwissADME software evaluated ligands based on their interaction patterns, binding energies, and clinical viability metrics such as drug-likeness, blood-brain barrier permeability, and gastrointestinal absorption. All selected ligands demonstrated high gastrointestinal absorption, with several showing potential for blood-brain penetration. This research represents a paradigm shift in ccRCC therapeutics, offering an innovative pathway, reducing disease burden, and catalyzing a breakthrough in the fight against one of the deadliest forms of kidney cancer.

Characterization of Rbg2: DRGs as Model Proteins for Reanalysis of the Cation-Dependent GTPase Motif

JONATHAN OUYANG

Developmentally-regulated GTPases (DRGs) represent a set of universally conserved GTPases with highly important function in translation and ribosome quality control. DRGs have been shown to be essential for the survival of many cancer cell lines, are implicated in an even wider variety of cancers, and are directly linked to human developmental disorders, particularly those neurological. Despite this, DRG characterization has not been well-done. Eukaryotic DRGs consist of two closely related paralogous proteins, DRG1 and DRG2. DRG1 has been characterized in yeast and human and has been shown to have potassium-dependent stimulation as part of a set of small-cation-dependent GTPases exhibiting a conserved motif around the G1 box. However, DRG2 has been largely uncharacterized despite its fundamental nature. In this paper, we conduct kinetic characterization of Rbg2, the yeast DRG2 homolog, show it has optimal activity well above physiological temperature, and also show that it is potassium-independent unlike all known DRGs to date. Novel activity of DRG2 with unprecedented speed and regulatory behavior indicates a new translational function hypothesized to be related to disome formation. Using sequence alignment and computational simulation of the DRGs as model proteins for this motif, we propose a redefinition and expansion of the cation-dependent GTPase motif to include several substitutable residues that wholly preserve functionality. Additionally, we find an unprecedented phenotypic characterization of Rbg knockout strains under osmotic stress growth conditions, a new result which implicates the Rbgs in osmotic stress response as well as ribosome quality control.

A Novel Analysis to Understanding Lexical Frequency in Cross-Modal Processing

SHOHUM MEHTA

This study investigates how lexical frequency (how common a word is) has a different impact on pictures rather than words that traditional studies have focused on. Research consistently shows high-frequency words presented as pictures benefit from priming or familiarity in naming tasks, yet they may involve extra conceptual processing that affects naming. Hypothesizing that pictures reduce the usual benefit of high-frequency words, a controlled naming experiment where fifty target concepts, evenly split between animals and tools, were presented in both textual and pictorial form to 24 native English speakers. The analysis started with leveraging continuous frequency measures from the English Lexicon Project, which classified each concept as either high- or low-frequency. Data were screened for accuracy and analyzed using statistical methods, including ANOVAs and mixed-effects models. The results significantly confirmed that high-frequency items were generally named more quickly across both pictures and words; however, pictures did not widen the usual gap between frequent and rare items as hypothesized. Instead, pictures were slower overall by ~128 ms, suggesting that their extra conceptual processing hides some of the benefits that typically accompany high-frequency words. Animals were also named faster than tools, and participants had slight improvements in speed with practice over many trials. Collectively, these findings support the notion that lexical frequency provides a significant boost in processing speed, but its effect is shaped by the modality of presentation. This analysis strongly contributes to advances in natural language processing and English language learners (ELL), optimizing retention rates and providing faster learning.

Hybrid Quantum-Classical Model for Molecular Generation: Integration of a QCBM and LSTM to Identify Novel Ligands for A2a Receptor

SIDHARTH BRAHMANDAM

In this project Drug discovery is a challenging, expensive, and time-consuming process often spanning a decade and requiring an investment of at least $2.5 billion. Further, Drug discovery targeting complex proteins like the A2a adenosine receptor which is related to neurodegenerative diseases such as Parkinson's is challenging because of the vast chemical space of drug-like molecules, often theorized as 1060 molecules. This study hypothesized that a hybrid quantum-classical approach, integrating a Quantum Circuit-Born Machine (QCBM) and a Long Short-Term Memory (LSTM) network, could effectively model molecular distributions and generate novel molecules with high binding affinity for the A2a receptor. This model first expanded a dataset of 10 known inhibitors with the STONED SELFIES algorithm, randomly mutating a training set of molecules while preserving their chemical validity. These molecules were converted into their binary Morgan Fingerprint, representing a high dimensionality probability distribution. The QCBM then learned from this data and represented this distribution as pure quantum states, which was the input to an iterative LSTM that generated novel compounds based on the features extracted from the QCBM. Finally, a docking simulation was used to produce the binding affinity of the generated molecules, and the three best performers were presented as the results. In conclusion, this work establishes a novel methodology that combines the advantages of classical and quantum computing, successfully generating a number of molecules with high binding affinity to the A2a receptor. By accelerating drug discovery pipelines, such approaches could address unmet medical needs, improving outcomes for millions lacking effective treatments. to identify the age of a

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Analysis of Contactin-3 Expression in Cortical Interneuron Subtypes

ASHRA ROSHY

Cortical interneurons (INs) are a diverse group of INs important for regulating excitatory pyramidal neuron (EPN) activity– with dysfunction in certain IN types contributing to neurological disorders such as epilepsy and schizophrenia. Among cortical INs, Chandelier cells (ChCs) are noted for their powerful EPN innervation; however, the molecular mechanisms underlying ChC dysfunction remain poorly understood. One protein potentially involved in ChC-specific innervation is Contactin-3, though its specificity in ChCs compared to other IN types, such as Vasoactive Intestinal Peptide (VIP) and Somatostatin (SST) cells, is not confirmed. In this study, we investigated the gene expression of Contactin-3 in ChC, VIP, and SST cells in mouse brain tissue using the RNAscope technique. We hypothesized that Contactin-3 expression would be significantly higher in ChCs than in VIP or SST cells. Our results showed that the average RNAscope particle counts for VIP, SST, and ChC cells were 1.368, 1.790, and 3.842 particles, respectively. Statistical analysis using one-way ANOVA revealed a significant difference between the groups ($p = 0.00064$, $F(2, 54) = 8.455$). No significant difference was found between VIP and SST cells ($p = 0.4161$). These findings support our hypothesis, suggesting that Contactin-3 is involved in ChC-specific innervation and could serve as a potential target for therapeutic interventions aimed at treating ChC-related disorders. machine learning was used to predict the likelihood that a skin lesion belongs to Basal Cell Carcinoma, Melanoma, or Squamous cell carcinoma, the three major types of skin cancer. As well as diagnosing the type of skin cancer, we used our model to identify the age of

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Silico Design and Simulation of Aptamer-Mediated Enrichment Strategies for CD8αα+ CAR T-Cells

SANJANA KOTHURI

CAR T-cell therapy treats malignant tumors by extracting T-cells from the patient's 2 blood and modifying the receptors to kill cancer cells. Enrichment is the process of separating 3 CAR T-cells from unmodified T-cells. Aptamers are genetic information molecules that connect 4 the T-cell receptor to the B-cell receptor. Recently, Kacherovsky et al. have designed aptamers 5 that specifically bind to the CD8αα+ CAR T-cells and can be used to enrich the receptor. We 6 hypothesize that the aptamers can selectively bind to the CD8αα receptor on CAR T-cells and 7 help their enrichment. The 3D structure and binding sites of CD8αα+ were identified using 8 the software AlphaFold3, P2Rank, and ChimeraX. To see which aptamer can bind best to 9 CD8αα, aptamer structures were predicted using web servers VFold2d and VFold3D using their 10 respective DNA structures and the dot-and-bracket notations. Once all necessary structures were 11 created, the docking process began to eliminate aptamers that don't bind to the binding site of 12 CD8αα by using HDOCK and PLIP. Aptamers can further be decided for CAR T-cell therapy if 13 they have many interactions of hydrogen bonds and less binding energy. The A3 aptamer was 14 applied to all three criteria and was concluded to be the most suitable aptamer for CAR T-cell 15 therapy. By identifying the most effective aptamer, CAR T-cell therapy can be advanced to 16 enrich normal T-cells to have the most suitable receptor and bind to the identified aptamer to 17 show success in cancer removal efficiency. I

Explainable Graph Attention Networks for Protein-Protein Interaction Prediction

BRUCE TANG

Identifying and understanding protein-protein interactions (PPI) is a critical step in characterizing the biological functions of proteins, understanding disease pathology, and designing theraputic treatments. Researchers have proposed deep learning architectures for PPI prediction to mitigate the cost and high noise limitations inherent to experimental PPI methods. However, these models suffer from suboptimal protein input representations, information leakage, and a lack of explainability, which hinders their integration into real-world experimental research workflows. This paper proposes MAPLE-GNN, a multi-head dynamic graph neural network architecture augmented by hybrid-feature protein graph representations. This representation integrates insights from protein language models (PLMs), local secondary structure features, tertiary structure features, and relative sequential and spatial edge features to enhance PPI prediction performance. To maximize the effectiveness of this graph representation, I combined multi-head dynamic graph attention networks with self-attention graph pooling mechanisms for meaningful graph representation extraction. Across 10 strict train-test splits, MAPLE-GNN achieves 91.26% accuracy, 94.26% precision, 93.73% specificity, and a Matthews correlation coefficient (MCC) of 82.69%. I further evaluated the explainability of MAPLE-GNN by comparing its predictions with ground truth annotations on 10 protein binding interfaces. Innovative graph-based explainable AI visualization methods demonstrate the ability of MAPLE-GNN to extract relevant residue information for predicting physical protein-protein interactions. My work stands at the forefront of structure-based protein-protein interaction prediction, offering a transformative perspective of the PPI prediction landscape.

POSTER PRESENTATIONS

The Relationship Between Brain Connectivity and New Learnt Skills Based On Cognitive Function Across Different Groups
AAMUKTHA YALAMANCHILI

Optimization of Asymmetric PCR for generation of Single Stranded DNA from Long DNA Templates
ARYA PORE

Wet Avalanche Prediction Based On Weather Patterns in the GTSR (Going-to-the-Sun-Road) Corridor of Glacier National Park using Machine Learning
AVIRAG HOSAKOTE

Analysis of 20S Proteasome Inhibitor Toxicity
BRANDON ROSS

Energy Analysis and Improvement of a Major Intersection
HEATHER WANG

Overcome Gaussian Noise to Robust Image Classification Against Adversarial Gaussian Noise via Heterogeneous Activation Function Selection and Bayesian Optimization
KALYAN CHERUKURI

The Correlation Between Black Hole Mass and Accretion Disk Luminosity
KRISH PATEL

Adversarial Attack Mitigation in Formation Control of Multi-Agent Systems
LAKSH PATEL

POSTER PRESENTATIONS

Anti-EGFR Aptamers as Targeted Therapy for Non-Small Cell Lung Cancer (NSCLC)
MEGHA NAMBISAN

Somatic Mutations as Biomarkers for Autoimmune Disease Diagnosis & Prognosis
NAVYA SHAH

A novel strategy for mitigating mycosis infections through the application of a naturally derived mycocidal remedy
NIDHI SAGARAM

Energy The Role of Genistein Modeling Estrogen in the Blood Brain Barrier as a Treatment for Alzheimer's Disease
SAHANA GARAPATI

Effect of Molecular Masses on Ion Propulsion Thrust
SAMIL SHARMA

Eco-Engineered Floating Wetlands: A Promising Technique to Improve Water Quality
SAVANNAH RAMSEY

Evaluating the Effects of Nano and Microplastics on Epidermal Barrier Function
TANVI BODDUPALLI

PRESENTATION JUDGES

ORAL PRESENTATIONS JUDGES

Dr. Andrew Wood, Plant Biology
Dr. Anas Alsobeh, Computer Science
Aryan Illiat, Physics
Dr. Bumsu Lee, Physics
Dr. Rana Salameh, Computer Science
Dr. Rebecca Burgess, Biochemistry and Molecular Biology, SIU School of Medicine

POSTER PRESENTATION JUDGES

We extend our deepest gratitude to the 24 professors, assistant professors, and graduate students who generously volunteered their time and expertise as Poster Judges for this year's Illinois Junior Science & Humanities Symposium (IJSHS). Representing the College of Engineering, Computing, Technology, and Mathematics, the College of Agricultural, Life, and Physical Sciences, the College of Arts and Media, and the School of Medicine, your contributions are invaluable in making this event a success.

This symposium would not be possible without you. May you continue to inspire and mentor young scientists while advancing your own successful journey of research and innovation.

Carl Sagan once said, "Somewhere, something incredible is waiting to be known."
Thank you for helping guide the next generation of scientists as they embark on their journey of discovery.
We sincerely appreciate your support and hope you will consider joining us again in the future.

— STEM Education Research Center 2025 IJSHS Team

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Dear Students, Families, Teachers, and Friends,

Thank you for being a part of SIU IJSHS 2024! We truly appreciate the time, effort, and enthusiasm you brought to this event. For many of you, this was quite a journey from home, and we are incredibly grateful that you made the trip. We sincerely hope you had an inspiring, engaging, and memorable experience. High school seniors, congratulations on all you have accomplished and will accomplish this year! We hope for you the very best as you move forward into the next chapter of your journey. Returning students, we hope to see you again next year and look forward to witnessing your continued growth and achievements. Parents and teachers, your unwavering support and encouragement play a vital role in these students' success. Thank you for all you do to nurture their curiosity, passion, and pursuit of excellence.

Before you go, please take a moment to complete the 2024 IJSHS Survey—your feedback is invaluable in helping us improve and shape future events.

Thank you for coming!
Safe travels, and we hope to see you again soon.

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