IMSAloquium

2016

Walker C. Weyland

IMSAloquium
STUDENT INVESTIGATION SHOWCASE

April 2016

Dear IMSA Friends:

Welcome to the twenty-eighth year of the Student Inquiry and Research Program (SIR)! This is a program that is as old as IMSA. The SIR program represents our unending dedication to enabling our students to learn what it is to be an innovator and to make contributions to what is known on Earth. We have always believed that learning is best done by experience as opposed to study alone, and we continue to put this experience in the hands of our talented and driven young people.

The research cycle consists of five discrete stages: exploration, synthesis, planning, execution, and communication. Our students experience these five stages in a variety of different areas, as you will find by exploring the contents of this book. Through their rich experiences with the extraordinary individuals at the many universities, laboratories, companies, and other organizations who have partnered with IMSA, the students have made great strides in understanding each of these stages and in acquiring the ability to undertake them independently. Each student is making the journey along the path to become innovators who will go forward to create new knowledge upon which others can build.

We want to express our gratitude for the generosity and steadfast support of all the experts and leaders who have nurtured our remarkable students this year. We are well aware of the time, effort, and additional cost generously put forth by these amazing individuals and organizations. We could not have completed the work we have before us without your help! We are most grateful for what you have done and we hope to continue to work together going forward.

Please join us in celebrating the truly amazing accomplishments of the scientists and students of the SIR program!

Sincerely,

Sanza T. Kazadi, Ph.D.
Director of Student Inquiry and Research

José M. Torres, Ph.D.
President, IMSA

Illinois Mathematics and Science Academy
The World's Leading Teaching and Learning Laboratory for Imagination and Inquiry

Twenty-eighth Annual IMSAloquium
April 28, 2016

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ILLINOIS MATHEMATICS AND SCIENCE ACADEMY
The World's Leading Teaching and Learning Laboratory for Imagination and Inquiry

IMSAloquium:
Student Investigation Showcase
April 28, 2016

Schedule of Sessions

8:00 AM - 9:35 AM	**Session 1**
8:00 AM - 8:15 AM	Oral Presentation 1
8:25 AM - 8:40 AM	Oral Presentation 2
8:50 AM - 9:05 AM	Oral Presentation 3
9:15 AM - 9:30 AM	Oral Presentation 4
9:50 AM - 11:25 AM	**Session 2**
9:50 AM - 10:05 AM	Oral Presentation 5
10:15 AM - 10:30 AM	Oral Presentation 6
10:40 AM - 10:55 AM	Oral Presentation 7
11:05 AM - 11:20 AM	Oral Presentation 8
11:30 AM - 12:30 PM	Lunch
12:45 PM - 2:20 PM	**Session 3**
12:45 PM - 1:00 PM	Oral Presentation 9
1:10 PM - 1:25 PM	Oral Presentation 10
1:35 PM - 1:50 PM	Oral Presentation 11
2:00 PM - 2:15 PM	Oral Presentation 12

IMSAloquium Poster List and Presentation by Topic

NOTE: Posters will be displayed digitally this year. Please see IMSAloqium staff for more information.

Biochemistry

ID	Presenter	Title	Time	Room
A01	Allison Bai	Creation of a PAX3 with a FLAG Tag Tool	11:05	B-110
A02	Hannah Cavagnetto	Purification and Crystallization of Bacterial Direct Oxygen Sensor Phosphodiesterase PAS Domain	10:15	B-110
A03	Tiffany Ding Susriya Gangireddy	The Effect of Novel, Small-Molecule Drugs as Agonists or Antagonists on G-Protein Coupled Receptors	9:50	A-121
A04	Ethan Fisher	The Inhibition of Thioredoxin Glutathione Reductase in *Schistosoma mansoni*	8:50	B-101
A05	Johnathan Guo Tea Ryza	Characterization of the Cyanobacteria *Anabaena* sp. PCC 7120 and iPC	11:05	B-101
A06	Shin Imai	Comparison of Proteins from Cocaine Addicted and Control Mouse Brains using Proteomic Techniques	10:40	B-101
A07	Divya Jasthi Emma Mattson	Understanding the Role of RB-Binding Protein KDM5A in Cancer Cell Proliferation	8:25	B-101
A08	Priyankka Krishnan	Investigation on the Decomposition of Sugar Substitutes in Simulated Blood	9:15	B-101
A09	Wasan Kumar	In Vivo Identification of Tumor Cells in the Sentinel Lymph Node	9:50	B-110
A10	Amy Liu	Genetic Modification of Yeast Cell MATa in Order to Express α-factor	2:00	A-113
A11	Jair Powell	Amount of Five Oil Dispersant Ingredients that Remain in Water After Use and Their Toxicity to Cell Culture at Such Concentrations	10:40	B-110
A12	Malavika Ramnath	Biochemical Analysis of Ketamine Metabolites Using Liquid Chromatography-Mass Spectrometry	11:05	A-113
A13	Taylor Reyes Nicole Tartaglia	Manipulating Expression of LP502, PcyA, and Ho1 with pET28b and PETDuet Vectors in Chemically Competent *Escherichia coli*	9:15	A-113

Bioengineering

ID	Presenter	Title	Time	Room
B01	Daisy Bugarin Gina Jiang	Structural Insights Into the Functions of Microtubule and Microtubule-Associated Proteins	9:50	B-101
B02	Jason Chen	Creating a Micropipette System to Measure T Cell Binding Kinetics	10:15	B-115

B03	Mateusz Cikowski	Activity Monitoring and Fall Detection Using Smart Phones in Individuals With Neurological Problems	9:15	B-115
B04	Nicholas Damen	Determining Colorectal Carcinoma Treatment Effectiveness Using a Fractional Order Calculus (FROC) Model	8:00	B-125 Tellabs
B05	Lindy Hong Michelle Zhu	Computational Analysis of Spatial Organization of Chromosomes	10:40	B-125 Tellabs
B06	Meghana Kamineni	A Low Cost Efficient Electroencephalography Recording System to Determine the Correlation between Mental Visualization and Relaxation	9:50	B-115
B07	Devdhi Kasana	Endothelial Focal Adhesion Kinase (FAK) and Macrophage Polarization	8:25	B-115
B08	Benjamin Maher	The Construction of a Forearm Interface with a Wrist Brace for the Barrett Medical Proficio Robot	8:50	B-115
B09	Caitlin O'Callaghan	Novel Nano-ceramic Coating On Polymethyl Methacrylate Denture Base Material	10:40	A-119
B11	Shivani Senguttuvan	The Cytotoxic Effect of Melittin and TsAP 2 on pBR322 Vector DNA	8:00	B-115
B13	Deepshika Sudhakar	Microfluidic Oxygen Control: Effect of Microfluidic Device Geometry on Oxygen Gradient Stabilization	8:50	A-117
B14	Deepshika Sudhakar	Drosophila Bazooka Gene in Asymmetrical Division and Stem Cell Differentiation	9:15	A-117
B795	Heena Srivastava	Evaluating Spatiotemporal Gait Parameters and Subject Daily Mobility in Chronic Stroke Patients after High-Dosage Exoskeleton Training Program	8:25	B-125 Tellabs

Biology

ID	Presenter	Title	Time	Room
C01	Eve Adami	Lysine Metabolism is a New Tumor Suppressor Pathway in Breast Cancer that is Deregulated by Obesity	10:40	B-116
C02	Ayan Agarwal Sahiti Pidaparti	Leukocyte Telomere Length and Risk of Mortality: A Systematic Review	12:45	A-115
C04	Jyotsna Bitra Binita Gupta	Inhibition of the Activity of Enzyme A in Rat Cardiomyocytes	10:15	B-101
C06	Nina Denne	Competitive Exclusion Between *Echinacea angustifolia* and *Echinacea purpurea*	9:50	B-125 Tellabs
C07	Heidi Dong Sarah Xu	Investigating Nanoluciferase as a Potential Proteome Stress Sensor	8:50	B-125 Tellabs
C08	Catherine Drake	Investigating B Cell Responses in Food Allergic Children	9:50	B-131 Grainger
C09	Sarah Eaton Jin Komerska	The Effect of Different Concentrations of Camptothecin on the Apoptosis of MCF-7, U937, and CEM Cancer Cells	8:50	A-113
C10	Angad Garg	Modeling Ability of Herpes Simplex Virus 1 to Induce Cell-to-Cell Fusion	8:00	B-110

C11	Herschel Gupta Yeeun Paik	The Role of Autophagy in HSV-Mediated Cell to Cell Fusion	10:40	B-131 Grainger
C12	Krishi Korrapati	Analysis of High Throughput Gene Array Data Identifies Common Cellular Pathway to Treat Hearing Loss	1:35	A-129
C13	Krishi Korrapati Niresh Kuganeswaran Thomas Wan	Molecular Mechanisms of Cancer Stem Cell Creation via High Nitric Oxide Adaptation	2:00	A-129
C14	Sweta Kotha	Effect of Fasting and Deoxycholic Acid Feeding in Xbp1-Knockout and Xbp1-Flox Control Mice	10:15	B-131 Grainger
C15	Katrina Kuhn	Characterizing the Host Immunologic Response to a Pouchitis-Associated Strain of *Bacteroides fragilis*	10:40	A-113
C16	Julien Mathie	Assessing the Viability of an Isolated Aquatic Ecosystem via Offseason Sampling	1:10	A-113
C17	Stefanie Ochoa Kyle Parker	Characterization of Chlorella Algae Virus PVCV-1 in Western Suburban Freshwater Bodies	1:35	A-113
C18	Jaeyoung Oh	The Role of DNA Methylation in Different Subtypes of Glioblastoma	12:45	B-131 Grainger
C19	Grace Park	Regulation of Genes Involved in Lipid Absorption by Bacterial Conditioned Media	9:50	A-113
C20	Sneha Pathuri	Cognitive Dysfunction in the Hemodialysis Population	8:50	B-110
C21	Sahiti Pidaparti	Telomere Length Versus Cotinine, Cadmium, and Lead Exposure	1:10	A-115
C22	Malavika Ramnath	Regulation of Mitochondria and Mitochondrial Oxygen Species by TGF-β	12:45	A-113
C23	Jennifer Rosauer	Investigating Factors Involved In Nassau Grouper Spawning Aggregation Dynamics In The Bahamas	9:15	B-125 Tellabs
C25	Yugan Sakthi	The Relationship between Protein Centrality and Essentiality in *Saccharomyces cerevisiae*	10:15	B-116
C26	Gissel Salas Kaitlyn Schmieder	The Effects of Ethanol on the Behavioral and Developmental Aspects of *Drosophila melanogaster*	1:10	B-131 Grainger
C27	Whitney Sloneker	Effect of Hormones on Breast Cancer Cell Line Enhancers	1:35	B-131 Grainger
C28	Mitchell Sun	Role of N-cadherin Adhesion Mediated Signaling in Regulating Stability of VE-cadherin Adhesions and Permeability Endothelial Barrier Function	11:05	B-125 Tellabs
C29	Nitya Talasila	The Protein Expression of CAV-1, COL1A2, and THBS2 proteins in the CaCo2 cell line.	1:35	A-115
C30	Nitya Talasila	Expression of Focal Adhesion Proteins in Ulcerative Colitis Associated Neoplasia	2:00	A-115

C31	Akshay Verma	TIM4 detection in Hepatic Stellate Cells	9:15	B-110
C32	Bingtao Xiang	Mechanisms of Host Viral Interactions Leading to Loss of Oral Tolerance in Celiac Disease Patients	2:00	B-131 Grainger
C33	Andy Xu	The Effects of Different Compounds on PLCβ-1 Activity in HL-1 Cells	8:25	B-110
C34	David Ying	Visualizing Bacterial Alarmone Induction and Antibiotic Survival in *Bacillius subtilis*.	9:50	B-116
C35	Mickinney Zhang	Identification of Hox Regulatory Domains for Appendage Diversity and Fin-to-Limb Transition (using Transgenic Zebrafish)	11:05	B-131 Grainger
C867	Vadini Agrawal	Factors Affecting the Transformation of 76R Variety Rio-Grande Tomatoes to Induce Expression of HopZ3 Effector Protein	10:40	B-206 Lect. Hall
C997	Catherine Chen	The Effect of Antibiotics on Gastrointestinal Motility and Gut Microbiota	12:45	B-206 Lect. Hall

Business

ID	Presenter	Title	Time	Room
D01	Jiabao Li	Using Demographical Information to Predict Work Performance Among Shiftgig, Inc. Employees: A Case Study of Temporary On-Demand Staffing	1:10	A-135
D02	Julian Litvak	Could Helpful Short-Term Rental Platforms be Negatively Affecting the Housing Market?	8:25	B-108
D03	Jonathan Liu	Using Big Data Analytics to Determine the Most Significant Attributes That Affect the Chances of Getting a Loan Approved	8:00	B-108
D04	Braden Saltus	A Case Study: Calculation of Total Addressable Market and Client-Side Economic Advantage of an On-Demand, Temporary Staffing Agency's (Shiftgig) Food Service Sector	12:45	A-135

Chemistry

ID	Presenter	Title	Time	Room
E01	Jake Bail Tavis Reed Patrick Swearingen	Synthesis of Organic Conducting Dendrimers	8:00	A-119
E02	Maya Costales	Optimal concentrations of Ethanol and Isopropanol for the dissolution of PMMA	8:00	B-206 Lect. Hall
E04	Ashu Gupta	Surface Functionalization of Polydimethylsiloxane Using Titanium Oxide Atomic Layer Deposition	11:05	A-119

E05	Ethan Heidrich	Modifying Clay-Based Germicidal Filters to Remove Harmful Metal Ions from Water	8:50	A-129
E06	Joseph Jagusah	An Exploratory Synthesis of a Chemical Group Common to Several Novel Biflavonoid Molecules	8:25	A-119
E07	Theodora Khan Corona Tsai	Synthesizing Conjugated Polymers that can Better Detect Nitroaromatic Compounds	9:15	A-119
E08	Kyle Anthony Leano	Variations on the Phenyl Groups of Bis-4-(N-carbazolyl)phenylphosphine Oxide for Host Layer of Blue Organic Light-Emitting Diodes	9:50	A-119
E09	Joy Qiu	Determination of Estrogen Metabolites by HPLC-ECD at Boron-Doped Diamond and Nitrogen-Incorporated Tetrahedral Amorphous Carbon Thin Film Electrodes	10:15	B-125 Tellabs
E10	Lily Anne TranCat	A Comparison of Two Blood Collection Methods for Monitoring Immunosuppressant Drugs in Transplant Patients	10:40	B-115

Computer Science

ID	Presenter	Title	Time	Room
F01	Michael Dow Samuel Zelman	User Defined Motion Counting	10:15	A-115
F02	Sachin Govind	Neural Networks and Machine Learning Applied to Classification of Cancer	9:50	B-206 Lect. Hall
F03	Addison Herr	Creating an Immersive Virtual Reality Representation of the Illinois Mathematics and Science Academy for use in the Oculus Rift, a Virtual Reality Head Mounted Display	10:15	A-135
F04	Cameron Hudgins Mark Rogers	Improving Wearable Activity Sensors using Hidden Markov Models for Outpatient Physical-Therapy Applications	9:50	A-115
F05	Joseph Hutter	Testing and Optimizing Trading Speed Using Lower-Level Embedding on Time Series Analysis Functions	1:35	A-135
F06	Timur Javid Tara Parkman Nathaniel Smith	Artificial Intelligence: Prospects, Pathways, Realities	2:00	B-206 Lect. Hall
F07	Alcaeus Lam	Optimizing Femtocell Bandwidth Allocation for Cellular Service Providers	10:40	A-115
F08	Rohit Mittapalli	The Impact of Experts and Error in Observation on Informational Cascades	11:05	A-115
F09	George Moe	MARTHA Speaks: Implementing Theory of Mind for More Intuitive Communicative Acts	8:25	A-121
F11	Anmol Nigam	Risk Maximization of Metal Futures through the Usage of	12:45	B-110

		Derivative Strategies		
F12	Abigail Paul	Analysis of the Accuracy of Color Filter Arrays by Color Sets and Arrangement in Digital Images	8:25	A-115
F13	Samuel Rousser Andriy Sheptunov	Comparing Efficiency of the Minimax Algorithm to Alternatives	8:50	A-115
F14	Pranav Upadhyayula	MARTHA Speaks: Implementing Artificial Intelligence and the Theory of Mind for Intuitive and Inferential Communicative Acts Involving Deeply Nested Layers of Rationality	8:50	A-121
F15	Sushil Upadhyayula	ChiQat-Tutor: A Natural Language Processing Component That Uses Artificial Intelligence to Interpret and Answer Student Queries	9:15	A-121
F16	Melissa Wen	Using the Monte Carlo Localization Algorithm to Allow for Effective Indoor Navigation	9:15	A-115
F17	Brian Yu	Designing a Website for Off the Shelf Data Acquisition Systems to Improve Their Accessibility	1:10	B-110
F817	Sean Ngo	Image Recognition and Tracking for Use in Augmented Reality Applications	11:05	B-116

Earth Science

ID	Presenter	Title	Time	Room
G855	Aspen Wheeler	Inferences of Subglacial Processes Under the West Antarctic Ice Sheet From Grain Surface Textures	1:35	B-206 Lect. Hall
G953	Walker Weyland	Comparing Biodiversity of Silurian Reefs in Illinois and Wisconsin Using Museum Collections and Unbiased Bulk Samples	1:10	B-206 Lect. Hall

Economics

ID	Presenter	Title	Time	Room
H01	Rohit Mittapalli	The Study of Bandwidth Allocation and Price Point on Revenue in Hetergeneous Networks	9:15	B-108
H02	Ravali Thimmapuram	The Effectiveness of Super Bowl Advertisements on the Sales of Major Car Manufacturing Companies	8:50	B-108
H03	David Xu	Determining the Effectiveness of Dividend Change as an Indicator of Price Movement	2:00	A-135

Education

ID	Presenter	Title	Time	Room
I01	Anna Barannikova	Effects of Agent-Based Modeling on Comprehension of the Macro and Micro Levels in the Natural World	2:00	A-117
I02	Xiomara	An Exploration of the Factors that Motivate Gifted and	10:40	A-123

	Cardona Elysia Sawyers	Talented Latino Males and Females to Engage in Science, Technology, Engineering and Mathematics.		
I03	Adam Grobman	Effects of Instruction in Advanced Planning on Computational Problem Solving in a Group Environment	1:35	A-117
I04	Isabel Lee	An Examination of The Correlation of a Child's Background to Their Enjoyment and Outlook on Science As Well as if it Changes Over Time	8:50	A-123
I05	Kameda Mallory Jeanette Suarez	Determining the Efficiency of Retention Initiatives for At-Risk Students in a Higher Educational Institution	10:15	A-123

Engineering

ID	Presenter	Title	Time	Room
J01	Niharika Agrawal	Designing a Dual Air and Water Purifier	11:05	A-129
J02	Michael Alexandrovich	Development of a Transportation Network Analysis Algorithm to Assess System Resilience	8:00	A-131
J03	Spencer Andrews	Quantifying Excitement Using Rollercoasters	10:15	A-129
J04	Joshua Burke	Measuring Circulation Control Wings of an Unmanned Aerial Vehicle	1:10	B-125 Tellabs
J05	Kevin Chen Malik Roberson Christopher Rogers	Can Small Unmanned Aircraft Undertake Complex Tasks Efficiently?	10:40	A-129
J06	Stoyan Georgiev	Newly Built vs Renovated: Achieving Leadership in Energy and Environmental Design Certification Through the most Cost-Effective Method	12:45	B-125 Tellabs
J07	Rebecca Lisk	Designing a Water Purifier Using Shortwave Ultraviolet Light	8:25	A-129
J08	Jeremy Mateja	Connecting a Spectrometer to a High Power Telescope in Order to Gather Light From Stars	9:50	A-129
J09	Shannon McKay	Creating a Second, Chemical Stage for Germicidal, Ceramic Filters	8:00	A-129
J10	John Messina Edward Shi	Development of Visible Light Communications Prototype and Analysis of LED Configurations for Smart Lighting	9:15	A-129
J11	Paul Nebres	Shimming the Muon g-2 Magnet	8:00	A-117
J12	Michelle Park	Erbium Doped Yttrium- Aluminum- Garnet Laser Induced Microjet Aimed at Tattoo Usage	9:15	A-131
J13	Nathaniel Rabideau	Novel Organic Light-Emitting Diode Materials Testing Method	10:15	A-119

J14	Mylee Rolock	Creation of a Model to Predict Indoor Air Quality Using BEopt, EnergyPlus, and Python	8:25	A-131
J819	Evan Sun	Characterizing Icephobic Properties of Superhydrophobic Polypropylene Manufactured Using a Hot Emboss Method	1:35	B-125 Tellabs

English

ID	Presenter	Title	Time	Room
K01	Jin Komerska	What is Love?	9:50	A-117
K02	Angelina Liao	The Hiroshima Survivor's Tale in Manga, Memoirs, and Anime	10:40	A-117
K03	Samuel Okoli	Tropes and Trends	11:05	A-117

Environmental Science

ID	Presenter	Title	Time	Room
L01	Morgan Phillips	Effects of Sand Filters in Wastewater Treatment Plants on Microplastic Output	1:10	B-101
L02	Katherine Su	Assessing the Effects of Anthropogenic and Biogenic Ligands on Mercury Bioavailability	12:45	B-101

Fine Arts

ID	Presenter	Title	Time	Room
M01	Austin Choi Alexander Hughes	Absolute And Relative Pitch: Factors Into The Origin And Acquisition	2:00	B-101
M02	Isabella Spinelli	Analysis of Rachmaninoff’s String Quartets and its Application to Reconstruction	1:35	B-101

History

ID	Presenter	Title	Time	Room
N01	Amy Liu	The Influence of Daoist Principles on Acupuncture and Herbal Remedies, Techniques of Traditional Chinese Medicine	12:45	A-117
N02	Luke Morrical	The Destroyer of Worlds: An Understanding of Nuclear Strategy in the Twentieth Century	1:10	A-117

Mathematics

ID	Presenter	Title	Time	Room
O01	Ankit Agarwal Robert Lou	Application of the Ordered Erdos Ginzburg Ziv Theorem to the Non-Abelian Dihedral Group	8:50	B-116
O02	Emily Jia	Using the Laplacian Matrix as a Differential Operator in Quantum Graphs	8:00	A-115
O03	Violet	Predicting Grades of IMSA Students and Degree	8:25	B-116

	Konopka	Completion Based on Past GPA and Standardized Test Scores With Respect to the Type of School the Students Attended Before IMSA		
O04	Alan Liang	The Spectrum of Sparse Random Complex	9:15	B-116
O06	Sarah Mou Franklin Ye	Decomposition of the Gini Index into Non-Overlapping Subgroups	8:00	B-116
O915	Eshan Mehrotra	The Entangling Properties of Knots and Links	8:25	B-206 Lect. Hall

Medicine

ID	Presenter	Title	Time	Room
P01	Rakesh Chatrath	Determining the Effectiveness of Low-Dose Computerized Tomography Screenings in Detecting Early Stage Lung Cancer	1:10	B-108
P02	Roy Chiu	Exploration of Drug Encapsulation and Delivery Using Toroidal-Spiral Particles	1:35	B-108
P03	Sarah Dovgin	Utilizing Novel Scaffolds to Target Cytochrome-B of *Toxoplasma gondii* Tachyzoites	8:50	B-206 Lect. Hall
P04	Nikitha Garapaty	Development of a User-Friendly Biomedical Database	8:00	A-133
P05	Alexander Gonsalves	What is the Role of *Clostridium difficile* Carriage in Inflammatory Bowel Disease?	11:05	A-121
P06	Sachin Govind	Reprogramming of Veins Into Arteries for Cardiac Bypass Surgery	9:15	B-206 Lect. Hall
P07	Paxton Greco	The Effectiveness of Preventative Shoulder Exercise Programs in High School Softball and Baseball Athletes	12:45	B-108
P08	Cindy Ho Jessica Phung	Structural Considerations for Novel Small Molecule Agonists at the CXCR4 Chemokine Receptor	10:40	A-121
P09	Neal Modi	Effect of Cigarette Smoke Induced Chronic Obstructive Pulmonary Disease on Lung Endothelial Cells	8:25	B-133
P10	Sneh Patel	Levels of Transforming Growth Factor Beta and Programmed Cell Death 1 in Normal and Cancerous Pancreatic Cells	2:00	B-108
P880	Amy Xie	Correlating Biomarkers with Muscular Properties in Stroke	8:25	A-117

Neurobiology

ID	Presenter	Title	Time	Room
Q01	Jason Barraza	Better Understanding the Anatomical Changes of Spiny Projection Neurons in Parkinson's Disease Through 3D Reconstruction	10:40	A-133
Q02	Adrian	Development of an Antibody-Targeted PET Probe for Early	1:35	A-123

	Bebenek	Diagnostic Imaging of Alzheimer's Disease		
Q03	Lauren Bystrom	Tumor Location in the Brain and its Effect on Survival of Glioblastoma Muliforme Patients	9:50	A-133
Q04	Gloria Choi Kirstin Johnson	Effect of Outside Stimuli During Sleep Stages	1:35	B-115
Q05	Esther Chung	Manganese and Zinc Alzheimer’s Disease Diagnostic Probe	12:45	A-123
Q06	Divya Dureja	Morphological Properties of Diseased Astrocytes in the Hippocampus and Globus Pallidus	12:45	A-133
Q07	Nathan Errampalli Michael Qian	Understanding the Chicken Embryo Model for Alzheimer’s Disease-Related Research	1:10	A-123
Q08	Megan Estrada Wincy Phine Mejias	The Effects and Role of the Natural Compounds Curcumin and Diallyl Trisulfide on Glioblastoma Cell Lines	8:25	A-113
Q09	Nikitha Garapaty	Localizing GABAergic/Dopaminergic Hybrid Neurons	8:25	A-133
Q10	Alexis Giff	High-frequency Brain Activity Supports Architectonic Parcellation of Cortex	1:35	A-133
Q12	Cindy Ho	Nerve Terminal Degeneration in Painful Diabetic Neuropathy	10:15	A-121
Q13	Raghuram Koganti Jiaxuan Li	Using Electroencephalography and Functional Magnetic Resonance Imaging to Identify Regions of Epileptic Seizure	8:00	A-123
Q14	Ramyashree Lakshmanan Shivali Shukla	Assessing the Movement and Focus of Eyes During the Viewing of Advertisements with the use of Eye-Tracking Software	8:25	A-123
Q15	Isabel Lee	An Examination of the Effect of Increasingly Complex Visual Stimuli on Brain State and Activity	9:50	A-123
Q16	Jessica Lee	Ion Channels and Action Potentials in Primary Vestibular Neurons: Impact of Damage and Regeneration in the Vestibular Epithelium	1:10	B-116
Q17	Wincy Faith Mejias	Comparing the Sequence and Protein Structure Characteristics of Wild Type Copper-Zinc Superoxide Dismutase and Several Mutant Genotypes Commonly Associated with ALS	12:45	B-116
Q18	Sruti Mohan	The Analysis of Parkinson's Disease in Mice as Seen Through Astrocyte Morphology	1:10	A-133
Q19	Naima Muckom	Creating an N-Methyl-D-Aspartate Receptor 2B-Specific Vector with Green Fluorescent Protein and Optimizing a Transfection Protocol.	8:25	B-131 Grainger
Q20	Irisa Myint	Effects of Home-Based Progressive Resistance Training on the Body Composition of Older Adults with Advanced Multiple Sclerosis	11:05	B-115

Q21	Charmaine Ong	Optimization of a Phosphodiesterase (PDE) Assay to Determine the Effects of Vindeburnol on cAMP Levels	9:15	B-131 Grainger
Q22	Joseph Palakeel	The Efficacy of Neurofeedback when Applied to Post-Concussion Syndrome	1:35	B-110
Q23	Tim Pan	Creating Three-Dimensional Neuron Tracts Through Diffusion Tensor Imaging Applied To Post-Ischemic Stroke Patients	12:45	B-115
Q25	Shrey Patel	Identifying Toxic Amyloid-Beta Oligomers Species (AβOs) in Alzheimer's disease	2:00	A-123
Q26	Kate Pauss	An Electrocorticographic Study of Embodied Cognition in the Human Brain	2:00	A-133
Q27	Grace Ryan	Classifying Cortical Areas and Neurons Involved in Proprioception	1:10	B-133
Q28	Braxton Schuldt	The Effects of Antipsychotics on the Integrity of Thalamic Connectivity in Schizophrenia Patients	10:15	A-133
Q29	Anna Shabayev	Hand Movements and Hand Postures Encoded in the Brain	1:10	B-115
Q30	Aadit Shah	Inhibiting Epigenetic Histone Methylation Within Pediatric Brainstem Glioma via PRC2 Methyltransferase	1:35	B-116
Q31	Priya Sharma	Analyzing the Function of Induced Pluripotent Stem Cells in Parkinson's Disease	8:50	B-131 Grainger
Q32	Snigdha Sharma	Neonatal Alcohol Exposure Reduces the Volume of Cerebellar Lobules Without Affecting Number of Parvalbumin Interneurons in a Mouse Model of Fetal Alcohol Spectrum Disorder	8:50	A-133
Q33	Simon Su	Time-Course Acute Intermittent Hypoxia Therapy in Individuals with Spinal Cord Injury	8:50	B-133
Q34	Katherine Swerbenski	Analysis of the Affect Auditory Stimuli have on Brain States and Networks Using Functional Magnetic Resonance Imaging	9:15	A-123
Q35	Srivarun Tummarakota	Death of Subthalamic Nucleus Neurons due to Mitochondrial Oxidative Stress in Huntington's Disease Mouse Models	12:45	B-133
Q36	Neha Verma	Cellular Pallidostriatal Connectivity Within a Parkinson's Disease Model	11:05	A-133
Q37	Rongzhen Zhou	The Effect of Shared Emotional States on Helping Behavior in Rats and its Basis in Empathy	9:15	B-133
Q804	Rajangad Gurtatta	The Effects of Chronic Alcohol Exposure and Histone Deacetylase Inhibition on GABA-A Receptor Subunit Expression in the Rat Cortex	11:05	B-108
Q843	Khusbu Patel	Hippocampal Functional Connectivity in Breast Cancer Patients with CRCI	9:15	A-133

Physics

ID	Presenter	Title	Time	Room
R01	Kyle Bachinski	Medium Correction for Proton Final State Interaction for Lower Simulation Deviation	10:40	B-133
R02	Felicia Chen	Understanding the Analysis of Ultrasonic Propagation in Ablative Materials	11:05	B-133
R04	Kyle Brennan Feliciano	The Effect of Media on Heat Distribution by 1860 Nanometer Wavelength Infrared Radiation	1:35	B-133
R05	Alexander Gonsalves William Tong	Search for the Standard Model Higgs Boson in Associated *WH* Channels Resulting in $b\bar{b}$ Decay in DØ Data Using Matrix Element Analysis	1:10	A-121
R06	Aakash Lakshmanan	Decoherence and Dephasing Rates of the Fluxonium Qubit Under the Influence of Charge Noise	2:00	B-133
R07	Lisa Lin	A Comprehensive Look at Nucleon Decay Modes for the DUNE Experiment	1:35	A-121
R08	Tianyuan Lu	Modeling and Simulation of Radiation Doses and Nuclide Distributions in the Mu2e Experimental Hall with MARS15	10:15	B-133
R09	Liam McParland	Analysis of Neutrino Events From the NUMI Beamline With NOvA Near Detector	2:00	A-121
R10	George Moe Nicholas Nusgart	Improvements in Sensitivity and Background Modeling in $WH \rightarrow \ell\nu bb$ Matrix Element Analysis	12:45	A-121
R13	Jason Wu	Quench Degradation Limits and Mechanisms of High Current Density Ag/Bi-2223 Superconducting Tapes	9:50	B-133
R884	Jack Mueller	Analyzing Different Categories of Stars and Star-like Objects Within the Dark Energy Survey's Camera System	10:15	A-113
R910	Soomin Park	Field-Programmable-Gate-Array Implemented on Time-to-Digital Converter: Improving its Resolution	11:05	B-206 Lect. Hall
R958	John DeMastri	Bayesian Statistics and Estimating Stellar Masses in the Blind Cosmology Challenge and the Dark Energy Survey	1:10	A-129

Psychology

ID	Presenter	Title	Time	Room
S01	Baylee Blackburn	The Effect of Perspective Taking on Moral and Religious Convictions	1:10	A-119
S02	Kasey Cervantes	The Effect of Social Anxiety on Acute Responses to the Drug MDMA (Ecstasy)	2:00	A-131
S03	Madison Dong	Creating Deeper Engagement in Serious Video Games	12:45	A-119
S04	Samhita Inampudi	Cross-cultural Differences in Personality among Ethnicities in the United States and Races Worldwide	2:00	A-119
S05	Ryan Johnson	The Effect of Visual and Auditory Reaction and Memorization Based Tasks on Temporal Judgement	10:40	A-131
S06	Linnea Lee-	The Effects of Physical Activity on Linguistic	1:35	A-119

	Brown	Memorization		
S07	Jaszmine Simmons	Frequency of Marijuana Use and its Impact on Skill Development and Academic Achievement in Homeless Youth Populations	11:05	A-131
S08	Alexa Tyszka	Monogenic Diabetes and its Cognitive Difficulties Concerning Executive Function	12:45	A-131
S09	Zachary Ungerleider	How Students Adjust: Analyzing the Accuracy of the W-Curve Theory to IMSA Sophomores	9:50	A-131
S10	Amy Yu	The Relationship Between Parent Praise, Math Anxiety, and Students' Theories of Intelligence	1:10	A-131

Social Science

ID	Presenter	Title	Time	Room
T01	Alec Elston	A Study of Bias in Perceived Leadership Ability	9:15	A-135
T02	Gabriel Jankowski	Shinto and Japanese Youth Today	10:40	B-108
T03	Sarah Leahy Mackenzie Smith	Effects of Computerized Note-taking Versus Handwritten Note-taking on the Test Scores of Illinois Mathematics and Science Academy Students	8:50	A-135
T04	Tess Mangan	The Effects of Attending a Residential Summer Camp on Youth Between the Ages of 5 and 18	10:15	A-131
T05	Samantha Murphy	Genuine and Non-Genuine Smiles in Married Couples: Associations with Well-Being	10:15	B-108
T06	Mariah Yelenick	Correlations Between Hours of Sleep and Educational, Social, and Physical Characteristics	8:00	A-135
T07	Amy Yu	Perceptions and Effects of Science and Math Gender Stereotypes Upon Illinois Mathematics and Science Academy Students and Parents	1:35	A-131
T08	Tian Lin Yuan	Understanding the Effect of Design Education on Students' Outlooks of the Future	8:25	A-135

Space Science

ID	Presenter	Title	Time	Room
U02	Varun Iyer Nicholas Michuda	The Efficiency of the Large Synoptic Survey Telescope for Finding Planet Nine-Like Objects	11:05	A-135
U03	Milutin Perovic Karolina Podsada	Using Globular Clusters as Tracers of Dark Matter in the Virgo Cluster Dwarf Elliptical Galaxies	10:40	A-135
U04	Pranav Sivakumar	An Automated Search for Almost Dark Galaxies in the Sloan Digital Sky Survey	9:50	A-135
U05	William Tong	Comparing Waveform Templates in Extracting Astrophysical Information from Gravitational Wave Signals	8:00	A-121

U839	Melanie Hess	Measurements and Comparisons of Diffuse Interstellar Bands around the MBM12 Interstellar Cloud	10:15	B-206 Lect. Hall

Theology

ID	Presenter	Title	Time	Room
V01	Kadyn Geier	Daughters of Eve: Social Behaviors of Women in the Old Testament and Their Role in the Story of God’s Divine Plan	10:15	A-117

Time and Room Schedule for Presentations

8:00 - 8:15

Room	ID	
A-115	O02	**Using the Laplacian Matrix as a Differential Operator in Quantum Graphs** Emily Jia; Advisor(s): Niels Nygaard, Phadmakar Patankar
A-117	J11	**Shimming the Muon g-2 Magnet** Paul Nebres; Advisor(s): Brendan Kiburg
A-119	E01	**Synthesis of Organic Conducting Dendrimers** Jake Bail, Tavis Reed, Patrick Swearingen; Advisor(s): John Thurmond
A-121	U05	**Comparing Waveform Templates in Extracting Astrophysical Information from Gravitational Wave Signals** William Tong; Advisor(s): Vicky Kalogera, Brandon Miller
A-123	Q13	**Using Electroencephalography and Functional Magnetic Resonance Imaging to Identify Regions of Epileptic Seizure** Raghuram Koganti, Jiaxuan Li; Advisor(s): Todd Parrish
A-129	J09	**Creating a Second, Chemical Stage for Germicidal, Ceramic Filters** Shannon McKay; Advisor(s): Mark Carlson
A-131	J02	**Development of a Transportation Network Analysis Algorithm to Assess System Resilience** Michael Alexandrovich; Advisor(s): Megan Clifford, Casey Trail, Thomas Wall
A-133	P04	**Development of a User-Friendly Biomedical Database** Nikitha Garapaty; Advisor(s): Satyender Goel, Kathryn Jackson, Niloufar Safaenelli
A-135	T06	**Correlations Between Hours of Sleep and Educational, Social, and Physical Characteristics** Mariah Yelenick; Advisor(s): William Gentzler
B-108	D03	**Using Big Data Analytics to Determine the Most Significant Attributes That Affect the Chances of Getting a Loan Approved** Jonathan Liu; Advisor(s): Charles Downing
B-110	C10	**Modeling Ability of Herpes Simplex Virus 1 to Induce Cell-to-Cell Fusion** Angad Garg; Advisor(s): Dinesh Jaishankar, Deepak Shukla
B-115	B11	**The Cytotoxic Effect of Melittin and TsAP 2 on pBR322 Vector DNA** Shivani Senguttuvan; Advisor(s): Santosh Misra, Dipanjan Pan
B-116	O06	**Decomposition of the Gini Index into Non-Overlapping Subgroups** Sarah Mou, Franklin Ye; Advisor(s): Michael McAsey, Libin Mou
B-125 Tellabs	B04	**Determining Colorectal Carcinoma Treatment Effectiveness Using a Fractional Order Calculus (FROC) Model** Nicholas Damen; Advisor(s): Frederick Damen, Xiaohong Joe Zhou
B-206 Lect. Hall	E02	**Optimal concentrations of Ethanol and Isopropanol for the dissolution of PMMA** Maya Costales; Advisor(s): Leonidas Ocola

8:25 - 8:40

Room	ID	
A-113	Q08	**The Effects and Role of the Natural Compounds Curcumin and Diallyl Trisulfide on Glioblastoma Cell Lines** Megan Estrada, Wincy Phine Mejias; Advisor(s): Don Dosch
A-115	F12	**Analysis of the Accuracy of Color Filter Arrays by Color Sets and Arrangement in Digital Images** Abigail Paul; Advisor(s): Phadmakar Patankar
A-117	P880	**Correlating Biomarkers with Muscular Properties in Stroke** Amy Xie; Advisor(s): Kristen Jakubowski, Sabrina Lee
A-119	E06	**An Exploratory Synthesis of a Chemical Group Common to Several Novel Biflavonoid Molecules** Joseph Jagusah; Advisor(s): John Thurmond
A-121	F09	**MARTHA Speaks: Implementing Theory of Mind for More Intuitive Communicative Acts** George Moe; Advisor(s): Piotr Gmytrasiewicz
A-123	Q14	**Assessing the Movement and Focus of Eyes During the Viewing of Advertisements with the use of Eye-Tracking Software** Ramyashree Lakshmanan, Shivali Shukla; Advisor(s): Todd Parrish
A-129	J07	**Designing a Water Purifier Using Shortwave Ultraviolet Light** Rebecca Lisk; Advisor(s): Mark Carlson
A-131	J14	**Creation of a Model to Predict Indoor Air Quality Using BEopt, EnergyPlus, and Python** Mylee Rolock; Advisor(s): Brent Stephens
A-133	Q09	**Localizing GABAergic/Dopaminergic Hybrid Neurons** Nikitha Garapaty; Advisor(s): Rajeshwar Awatramani, Giuliana Caronia-Brown, Jean-Francois Poulin
A-135	T08	**Understanding the Effect of Design Education on Students' Outlooks of the Future** Tian Lin Yuan; Advisor(s): Erin Huizenga
B-101	A07	**Understanding the Role of RB-Binding Protein KDM5A in Cancer Cell Proliferation** Divya Jasthi, Emma Mattson; Advisor(s): Elizaveta Benevolenskaya
B-108	D02	**Could Helpful Short-Term Rental Platforms be Negatively Affecting the Housing Market?** Julian Litvak; Advisor(s): Liad Wagman
B-110	C33	**The Effects of Different Compounds on PLCβ-1 Activity in HL-1 Cells** Andy Xu; Advisor(s): Gary Aistrup, William Marszalec, J. Andrew Wasserstrom
B-115	B07	**Endothelial Focal Adhesion Kinase (FAK) and Macrophage Polarization** Devdhi Kasana; Advisor(s): Dolly Mehta, Pascal Yazbeck
B-116	O03	**Predicting Grades of IMSA Students and Degree Completion Based on Past GPA and Standardized Test Scores With Respect to the Type of School the Students Attended Before IMSA** Violet Konopka; Advisor(s): Don Porizo
B-125	B795	**Evaluating Spatiotemporal Gait Parameters and Subject Daily Mobility in**

Tellabs		**Chronic Stroke Patients after High-Dosage Exoskeleton Training Program** Heena Srivastava; Advisor(s): Arun Jayaraman
B-131 Grainger	Q19	**Creating an N-Methyl-D-Aspartate Receptor 2B-Specific Vector with Green Fluorescent Protein and Optimizing a Transfection Protocol.** Naima Muckom; Advisor(s): Amanda Gross, Roger Kroes, Joseph Moskal, Mary Schmidt
B-133	P09	**Effect of Cigarette Smoke Induced Chronic Obstructive Pulmonary Disease on Lung Endothelial Cells** Neal Modi; Advisor(s): Kishore Wary
B-206 Lect. Hall	O915	**The Entangling Properties of Knots and Links** Eshan Mehrotra; Advisor(s): Louis Kauffman

8:50 - 9:05

Room	ID	
A-113	C09	**The Effect of Different Concentrations of Camptothecin on the Apoptosis of MCF-7, U937, and CEM Cancer Cells** Sarah Eaton, Jin Komerska; Advisor(s): Don Dosch
A-115	F13	**Comparing Efficiency of the Minimax Algorithm to Alternatives** Samuel Rousser, Andriy Sheptunov; Advisor(s): Phadmakar Patankar
A-117	B13	**Microfluidic Oxygen Control: Effect of Microfluidic Device Geometry on Oxygen Gradient Stabilization** Deepshika Sudhakar; Advisor(s): Dave Eddington
A-121	F14	**MARTHA Speaks: Implementing Artificial Intelligence and the Theory of Mind for Intuitive and Inferential Communicative Acts Involving Deeply Nested Layers of Rationality** Pranav Upadhyayula; Advisor(s): Piotr Gmytrasiewicz
A-123	I04	**An Examination of The Correlation of a Child's Background to Their Enjoyment and Outlook on Science As Well as if it Changes Over Time** Isabel Lee; Advisor(s): Bryan Wunar
A-129	E05	**Modifying Clay-Based Germicidal Filters to Remove Harmful Metal Ions from Water** Ethan Heidrich; Advisor(s): Mark Carlson
A-133	Q32	**Neonatal Alcohol Exposure Reduces the Volume of Cerebellar Lobules Without Affecting Number of Parvalbumin Interneurons in a Mouse Model of Fetal Alcohol Spectrum Disorder** Snigdha Sharma; Advisor(s): Justin Rhodes
A-135	T03	**Effects of Computerized Note-taking Versus Handwritten Note-taking on the Test Scores of Illinois Mathematics and Science Academy Students** Sarah Leahy, Mackenzie Smith; Advisor(s): Amy Keck
B-101	A04	**The Inhibition of Thioredoxin Glutathione Reductase in *Schistosoma mansoni*** Ethan Fisher; Advisor(s): David Williams
B-108	H02	**The Effectiveness of Super Bowl Advertisements on the Sales of Major Car Manufacturing Companies**

Ravali Thimmapuram; Advisor(s): Pradeep Chintagunta

B-110 C20 **Cognitive Dysfunction in the Hemodialysis Population**
Sneha Pathuri; Advisor(s): Kenneth Wilund

B-115 B08 **The Construction of a Forearm Interface with a Wrist Brace for the Barrett Medical Proficio Robot**
Benjamin Maher; Advisor(s): James Patton

B-116 O01 **Application of the Ordered Erdos Ginzburg Ziv Theorem to the Non-Abelian Dihedral Group**
Ankit Agarwal, Robert Lou; Advisor(s): Micah Fogel

B-125 Tellabs C07 **Investigating Nanoluciferase as a Potential Proteome Stress Sensor**
Heidi Dong, Sarah Xu; Advisor(s): Sue Fox, Richard Morimoto, Anan Yu

B-131 Grainger Q31 **Analyzing the Function of Induced Pluripotent Stem Cells in Parkinson's Disease**
Priya Sharma; Advisor(s): Ben Hiller, Jeffrey Kordower, David Marmion

B-133 Q33 **Time-Course Acute Intermittent Hypoxia Therapy in Individuals with Spinal Cord Injury**
Simon Su; Advisor(s): Zev Rymer, Milap Sandhu

B-206 Lect. Hall P03 **Utilizing Novel Scaffolds to Target Cytochrome-B of *Toxoplasma gondii* Tachyzoites**
Sarah Dovgin; Advisor(s): Kamal El-Bissati, Farida Esaa, Rima McLeod, Ying Zhou

9:15 - 9:30

Room ID

A-113 A13 **Manipulating Expression of LP502, PcyA, and Ho1 with pET28b and PETDuet Vectors in Chemically Competent *Escherichia coli***
Taylor Reyes, Nicole Tartaglia; Advisor(s): Don Dosch, C. Robyn Fischer

A-115 F16 **Using the Monte Carlo Localization Algorithm to Allow for Effective Indoor Navigation**
Melissa Wen; Advisor(s): Phadmakar Patankar

A-117 B14 **Drosophila Bazooka Gene in Asymmetrical Division and Stem Cell Differentiation**
Deepshika Sudhakar; Advisor(s): Jun Cheng

A-119 E07 **Synthesizing Conjugated Polymers that can Better Detect Nitroaromatic Compounds**
Theodora Khan, Corona Tsai; Advisor(s): John Thurmond

A-121 F15 **ChiQat-Tutor: A Natural Language Processing Component That Uses Artificial Intelligence to Interpret and Answer Student Queries**
Sushil Upadhyayula; Advisor(s): Barbara Di Eugenio

A-123 Q34 **Analysis of the Affect Auditory Stimuli have on Brain States and Networks Using Functional Magnetic Resonance Imaging**
Katherine Swerbenski; Advisor(s): Todd Parrish

A-129 J10 **Development of Visible Light Communications Prototype and Analysis of LED Configurations for Smart Lighting**
John Messina, Edward Shi; Advisor(s): Peter Clancy

A-131	J12	**Erbium Doped Yttrium- Aluminum- Garnet Laser Induced Microjet Aimed at Tattoo Usage** Michelle Park; Advisor(s): Jai-ick Yoh
A-135	T01	**A Study of Bias in Perceived Leadership Ability** Alec Elston; Advisor(s): Michelle Hoehn
B-101	A08	**Investigation on the Decomposition of Sugar Substitutes in Simulated Blood** Priyankka Krishnan; Advisor(s): Sowmya Anjur
B-108	H01	**The Study of Bandwidth Allocation and Price Point on Revenue in Hetergeneous Networks** Rohit Mittapalli; Advisor(s): Randall Berry
B-110	C31	**TIM4 detection in Hepatic Stellate Cells** Akshay Verma; Advisor(s): Xiao Wang
B-115	B03	**Activity Monitoring and Fall Detection Using Smart Phones in Individuals With Neurological Problems** Mateusz Cikowski; Advisor(s): Arun Jayaraman, Luka Lonini, Krishna Mummidisetty
B-116	O04	**The Spectrum of Sparse Random Complex** Alan Liang; Advisor(s): Dominic Dotterrer
B-125 Tellabs	C23	**Investigating Factors Involved In Nassau Grouper Spawning Aggregation Dynamics In The Bahamas** Jennifer Rosauer; Advisor(s): Kristine Stump
B-131 Grainger	Q21	**Optimization of a Phosphodiesterase (PDE) Assay to Determine the Effects of Vindeburnol on cAMP Levels** Charmaine Ong; Advisor(s): David Braun, Douglas Feinstein
B-133	Q37	**The Effect of Shared Emotional States on Helping Behavior in Rats and its Basis in Empathy** Rongzhen Zhou; Advisor(s): Peggy Mason
B-206 Lect. Hall	P06	**Reprogramming of Veins Into Arteries for Cardiac Bypass Surgery** Sachin Govind; Advisor(s): Kishore Wary

9:50 - 10:05

Room	ID	
A-113	C19	**Regulation of Genes Involved in Lipid Absorption by Bacterial Conditioned Media** Grace Park; Advisor(s): Eugene Chang, Kristina Martinez
A-115	F04	**Improving Wearable Activity Sensors using Hidden Markov Models for Outpatient Physical-Therapy Applications** Cameron Hudgins, Mark Rogers; Advisor(s): Mark Albert, Jessie Pichleap
A-117	K01	**What is Love?** Jin Komerska; Advisor(s): Crystal Randall, Tracy Townsend
A-119	E08	**Variations on the Phenyl Groups of Bis-4-(N-carbazolyl)phenylphosphine Oxide for Host Layer of Blue Organic Light-Emitting Diodes** Kyle Anthony Leano; Advisor(s): John Thurmond

A-121	A03	**The Effect of Novel, Small-Molecule Drugs as Agonists or Antagonists on G-Protein Coupled Receptors** Tiffany Ding, Susriya Gangireddy; Advisor(s): Brittany Hopkins, Richard Miller
A-123	Q15	**An Examination of the Effect of Increasingly Complex Visual Stimuli on Brain State and Activity** Isabel Lee; Advisor(s): Todd Parrish
A-129	J08	**Connecting a Spectrometer to a High Power Telescope in Order to Gather Light From Stars** Jeremy Mateja; Advisor(s): Eric Hawker
A-131	S09	**How Students Adjust: Analyzing the Accuracy of the W-Curve Theory to IMSA Sophomores** Zachary Ungerleider; Advisor(s): Quinton Backstrom, David Evenson
A-133	Q03	**Tumor Location in the Brain and its Effect on Survival of Glioblastoma Muliforme Patients** Lauren Bystrom; Advisor(s): Lei Wang, Paula de los Angeles
A-135	U04	**An Automated Search for Almost Dark Galaxies in the Sloan Digital Sky Survey** Pranav Sivakumar; Advisor(s): Don York
B-101	B01	**Structural Insights Into the Functions of Microtubule and Microtubule-Associated Proteins** Daisy Bugarin, Gina Jiang; Advisor(s): Ao Ma, Ken Tsui, Xinge Wang
B-110	A09	**In Vivo Identification of Tumor Cells in the Sentinel Lymph Node** Wasan Kumar; Advisor(s): Chengyue Li, Kenneth Tichauer
B-115	B06	**A Low Cost Efficient Electroencephalography Recording System to Determine the Correlation between Mental Visualization and Relaxation** Meghana Kamineni; Advisor(s): David Mogul
B-116	C34	**Visualizing Bacterial Alarmone Induction and Antibiotic Survival in *Bacillius subtilis*.** David Ying; Advisor(s): Kachun Danny Fung, Jue (Jade) Wang
B-125 Tellabs	C06	**Competitive Exclusion Between *Echinacea angustifolia* and *Echinacea purpurea*** Nina Denne; Advisor(s): Stuart Wagenius
B-131 Grainger	C08	**Investigating B Cell Responses in Food Allergic Children** Catherine Drake; Advisor(s): Kris Erickson, Kathryn Hulse, Anne-Marie Singh
B-133	R13	**Quench Degradation Limits and Mechanisms of High Current Density Ag/Bi-2223 Superconducting Tapes** Jason Wu; Advisor(s): Tengming Shen
B-206 Lect. Hall	F02	**Neural Networks and Machine Learning Applied to Classification of Cancer** Sachin Govind; Advisor(s): Namrata Pandya

10:15 - 10:30

Room	ID	
A-113	R884	**Analyzing Different Categories of Stars and Star-like Objects Within the Dark Energy Survey's Camera System**

Jack Mueller; Advisor(s): Douglas Tucker

A-115 F01 **User Defined Motion Counting**
Michael Dow, Samuel Zelman; Advisor(s): Mark Albert

A-117 V01 **Daughters of Eve: Social Behaviors of Women in the Old Testament and Their Role in the Story of God's Divine Plan**
Kadyn Geier; Advisor(s): Michael Hancock

A-119 J13 **Novel Organic Light-Emitting Diode Materials Testing Method**
Nathaniel Rabideau; Advisor(s): John Thurmond

A-121 Q12 **Nerve Terminal Degeneration in Painful Diabetic Neuropathy**
Cindy Ho; Advisor(s): Nirupa Jayaraj, Daniela Menichella, Richard Miller

A-123 I05 **Determining the Efficiency of Retention Initiatives for At-Risk Students in a Higher Educational Institution**
Kameda Mallory, Jeanette Suarez; Advisor(s): Adrienne Coleman, Omar Headen

A-129 J03 **Quantifying Excitement Using Rollercoasters**
Spencer Andrews; Advisor(s): Eric Hawker

A-131 T04 **The Effects of Attending a Residential Summer Camp on Youth Between the Ages of 5 and 18**
Tess Mangan; Advisor(s): David Evenson

A-133 Q28 **The Effects of Antipsychotics on the Integrity of Thalamic Connectivity in Schizophrenia Patients**
Braxton Schuldt; Advisor(s): Anna Varentsova, Lei Wang

A-133 Q843 **Hippocampal Functional Connectivity in Breast Cancer Patients with CRCI**
Khusbu Patel; Advisor(s): Alexandra Apple, Lei Wang

B-101 C04 **Inhibition of the Activity of Enzyme A in Rat Cardiomyocytes**
Jyotsna Bitra, Binita Gupta; Advisor(s): William Marszalec, J. Andrew Wasserstrom

B-108 T05 **Genuine and Non-Genuine Smiles in Married Couples: Associations with Well-Being**
Samantha Murphy; Advisor(s): Claudia Haase, Taylor Shelton, Ryan Svoboda, Sara Thomas

B-110 A02 **Purification and Crystallization of Bacterial Direct Oxygen Sensor Phosphodiesterase PAS Domain**
Hannah Cavagnetto; Advisor(s): Xiaojing Yang, Xiaoli Zeng

B-115 B02 **Creating a Micropipette System to Measure T Cell Binding Kinetics**
Jason Chen; Advisor(s): Jun Huang, Jake Skarzynski

B-116 C25 **The Relationship between Protein Centrality and Essentiality in *Saccharomyces cerevisiae***
Yugan Sakthi; Advisor(s): Manyuan Long, Wenyu Zhang

B-125 Tellabs E09 **Determination of Estrogen Metabolites by HPLC-ECD at Boron-Doped Diamond and Nitrogen-Incorporated Tetrahedral Amorphous Carbon Thin Film Electrodes**
Joy Qiu; Advisor(s): Greg Swain

B-131 Grainger C14 **Effect of Fasting and Deoxycholic Acid Feeding in Xbp1-Knockout and Xbp1-Flox Control Mice**
Sweta Kotha; Advisor(s): Richard Green

B-133 R08 **Modeling and Simulation of Radiation Doses and Nuclide Distributions in the Mu2e Experimental Hall with MARS15**
Tianyuan Lu; Advisor(s): Vitaly Pronskikh

B-206 Lect. Hall U839 **Measurements and Comparisons of Diffuse Interstellar Bands around the MBM12 Interstellar Cloud**
Melanie Hess; Advisor(s): Don York

A-135 F03 **Creating an Immersive Virtual Reality Representation of the Illinois Mathematics and Science Academy for use in the Oculus Rift, a Virtual Reality Head Mounted Display**
Addison Herr; Advisor(s): Britta McKenna

10:40 - 10:55

Room	ID	
A-113	C15	**Characterizing the Host Immunologic Response to a Pouchitis-Associated Strain of *Bacteroides fragilis*** Katrina Kuhn; Advisor(s): Eugene Chang, Emma Liechty
A-115	F07	**Optimizing Femtocell Bandwidth Allocation for Cellular Service Providers** Alcaeus Lam; Advisor(s): Randall Berry
A-117	K02	**The Hiroshima Survivor's Tale in Manga, Memoirs, and Anime** Angelina Liao; Advisor(s): Michael Hancock
A-119	B09	**Novel Nano-ceramic Coating On Polymethyl Methacrylate Denture Base Material** Caitlin O'Callaghan; Advisor(s): Su Huang, Christos Takoudis
A-121	P08	**Structural Considerations for Novel Small Molecule Agonists at the CXCR4 Chemokine Receptor** Cindy Ho, Jessica Phung; Advisor(s): Brittany Hopkins, Richard Miller
A-123	I02	**An Exploration of the Factors that Motivate Gifted and Talented Latino Males and Females to Engage in Science, Technology, Engineering and Mathematics.** Xiomara Cardona, Elysia Sawyers; Advisor(s): Adrienne Coleman
A-129	J05	**Can Small Unmanned Aircraft Undertake Complex Tasks Efficiently?** Kevin Chen, Malik Roberson, Christopher Rogers; Advisor(s): Jim Gerry
A-131	S05	**The Effect of Visual and Auditory Reaction and Memorization Based Tasks on Temporal Judgement** Ryan Johnson; Advisor(s): David Evenson
A-133	Q01	**Better Understanding the Anatomical Changes of Spiny Projection Neurons in Parkinson's Disease Through 3D Reconstruction** Jason Barraza; Advisor(s): Savio Chan, Harry Xenias
A-135	U03	**Using Globular Clusters as Tracers of Dark Matter in the Virgo Cluster Dwarf Elliptical Galaxies** Milutin Perovic, Karolina Podsada; Advisor(s): Brooke Schmidt
B-101	A06	**Comparison of Proteins from Cocaine Addicted and Control Mouse Brains using Proteomic Techniques** Shin Imai; Advisor(s): Peter Yau
B-108	T02	**Shinto and Japanese Youth Today**

Gabriel Jankowski; Advisor(s): Jonathan Besancon

B-110	A11	**Amount of Five Oil Dispersant Ingredients that Remain in Water After Use and Their Toxicity to Cell Culture at Such Concentrations** Jair Powell; Advisor(s): Anita White
B-115	E10	**A Comparison of Two Blood Collection Methods for Monitoring Immunosuppressant Drugs in Transplant Patients** Lily Anne TranCat; Advisor(s): Shannon Haymond, Faye Vicente
B-116	C01	**Lysine Metabolism is a New Tumor Suppressor Pathway in Breast Cancer that is Deregulated by Obesity** Eve Adami; Advisor(s): David Crowe
B-125 Tellabs	B05	**Computational Analysis of Spatial Organization of Chromosomes** Lindy Hong, Michelle Zhu; Advisor(s): Gamze Gursoy, Jie Liang
B-131 Grainger	C11	**The Role of Autophagy in HSV-Mediated Cell to Cell Fusion** Herschel Gupta, Yeeun Paik; Advisor(s): Dinesh Jaishankar, Shrey Patel, Deepak Shukla
B-133	R01	**Medium Correction for Proton Final State Interaction for Lower Simulation Deviation** Kyle Bachinski; Advisor(s): Minerba Betancourt
B-206 Lect. Hall	C867	**Factors Affecting the Transformation of 76R Variety Rio-Grande Tomatoes to Induce Expression of HopZ3 Effector Protein** Vadini Agrawal; Advisor(s): Joanna Jelenska

11:05 - 11:20

Room	ID	
A-113	A12	**Biochemical Analysis of Ketamine Metabolites Using Liquid Chromatography-Mass Spectrometry** Malavika Ramnath; Advisor(s): Eugene Chang, Kyle Dolan
A-115	F08	**The Impact of Experts and Error in Observation on Informational Cascades** Rohit Mittapalli; Advisor(s): Randall Berry
A-117	K03	**Tropes and Trends** Samuel Okoli; Advisor(s): Tracy Townsend
A-119	E04	**Surface Functionalization of Polydimethylsiloxane Using Titanium Oxide Atomic Layer Deposition** Ashu Gupta; Advisor(s): Arghya Bishal, Christos Takoudis
A-121	P05	**What is the Role of *Clostridium difficile* Carriage in Inflammatory Bowel Disease?** Alexander Gonsalves; Advisor(s): Dejan Micic, David Rubin
A-129	J01	**Designing a Dual Air and Water Purifier** Niharika Agrawal; Advisor(s): Brendan Casey
A-131	S07	**Frequency of Marijuana Use and its Impact on Skill Development and Academic Achievement in Homeless Youth Populations** Jaszmine Simmons; Advisor(s): Scott Hunter
A-133	Q36	**Cellular Pallidostriatal Connectivity Within a Parkinson's Disease Model** Neha Verma; Advisor(s): Savio Chan, Harry Xenias

A-135	U02	**The Efficiency of the Large Synoptic Survey Telescope for Finding Planet Nine-Like Objects** Varun Iyer, Nicholas Michuda; Advisor(s): Mark Subbarao
B-101	A05	**Characterization of the Cyanobacteria *Anabaena* sp. PCC 7120 and iPC** Johnathan Guo, Tea Ryza; Advisor(s): Robert Haselkorn, Amin Nasser
B-108	Q804	**The Effects of Chronic Alcohol Exposure and Histone Deacetylase Inhibition on GABA-A Receptor Subunit Expression in the Rat Cortex** Rajangad Gurtatta; Advisor(s): Subhash Pandey, Tara Teppen
B-110	A01	**Creation of a PAX3 with a FLAG Tag Tool** Allison Bai; Advisor(s): Deborah Lang, Sixia Xiao
B-115	Q20	**Effects of Home-Based Progressive Resistance Training on the Body Composition of Older Adults with Advanced Multiple Sclerosis** Irisa Myint; Advisor(s): Lara Pilutti
B-116	F817	**Image Recognition and Tracking for Use in Augmented Reality Applications** Sean Ngo; Advisor(s): Benjamin Carls
B-125 Tellabs	C28	**Role of N-cadherin Adhesion Mediated Signaling in Regulating Stability of VE-cadherin Adhesions and Permeability Endothelial Barrier Function** Mitchell Sun; Advisor(s): Yulia Komarova, Kevin Kruse, Asrar Malik
B-131 Grainger	C35	**Identification of Hox Regulatory Domains for Appendage Diversity and Fin-to-Limb Transition (using Transgenic Zebrafish)** Mickinney Zhang; Advisor(s): Tetsuya Nakamura, Neil Shubin
B-133	R02	**Understanding the Analysis of Ultrasonic Propagation in Ablative Materials** Felicia Chen; Advisor(s): Carol Vorres, Donald Yuhas
B-206 Lect. Hall	R910	**Field-Programmable-Gate-Array Implemented on Time-to-Digital Converter: Improving its Resolution** Soomin Park; Advisor(s): Jin-Yuan Wu

12:45 - 1:00

Room	ID	
A-113	C22	**Regulation of Mitochondria and Mitochondrial Oxygen Species by TGF-β** Malavika Ramnath; Advisor(s): Jun Wei
A-115	C02	**Leukocyte Telomere Length and Risk of Mortality: A Systematic Review** Ayan Agarwal, Sahiti Pidaparti; Advisor(s): Brandon Pierce
A-117	N01	**The Influence of Daoist Principles on Acupuncture and Herbal Remedies, Techniques of Traditional Chinese Medicine** Amy Liu; Advisor(s): Robert Kiely
A-119	S03	**Creating Deeper Engagement in Serious Video Games** Madison Dong; Advisor(s): Patrick Jagoda, Ashlyn Sparrow
A-121	R10	**Improvements in Sensitivity and Background Modeling in WH→ℓνbb Matrix Element Analysis** George Moe, Nicholas Nusgart; Advisor(s): Ryuji Yamada
A-123	Q05	**Manganese and Zinc Alzheimer's Disease Diagnostic Probe** Esther Chung; Advisor(s): William Klein, Kirsten Viola
A-131	S08	**Monogenic Diabetes and its Cognitive Difficulties Concerning Executive**

		Function Alexa Tyszka; Advisor(s): Megan Scott
A-133	Q06	**Morphological Properties of Diseased Astrocytes in the Hippocampus and Globus Pallidus** Divya Dureja; Advisor(s): Savio Chan
A-135	D04	**A Case Study: Calculation of Total Addressable Market and Client-Side Economic Advantage of an On-Demand, Temporary Staffing Agency's (Shiftgig) Food Service Sector** Braden Saltus; Advisor(s): Jade Martin
B-101	L02	**Assessing the Effects of Anthropogenic and Biogenic Ligands on Mercury Bioavailability** Katherine Su; Advisor(s): Jean-Francois Gaillard, Sara Thomas
B-108	P07	**The Effectiveness of Preventative Shoulder Exercise Programs in High School Softball and Baseball Athletes** Paxton Greco; Advisor(s): Brian Kosan
B-110	F11	**Risk Maximization of Metal Futures through the Usage of Derivative Strategies** Anmol Nigam; Advisor(s): Marc De Muart, Adrian Jaronczyk
B-115	Q23	**Creating Three-Dimensional Neuron Tracts Through Diffusion Tensor Imaging Applied To Post-Ischemic Stroke Patients** Tim Pan; Advisor(s): Jun Yao
B-116	Q17	**Comparing the Sequence and Protein Structure Characteristics of Wild Type Copper-Zinc Superoxide Dismutase and Several Mutant Genotypes Commonly Associated with ALS** Wincy Faith Mejias; Advisor(s): Sarah Oleary
B-125 Tellabs	J06	**Newly Built vs Renovated: Achieving Leadership in Energy and Environmental Design Certification Through the most Cost-Effective Method** Stoyan Georgiev; Advisor(s): Joy Meek
B-131 Grainger	C18	**The Role of DNA Methylation in Different Subtypes of Glioblastoma** Jaeyoung Oh; Advisor(s): Shi-Yuan Cheng, Rajendra Pangeni
B-133	Q35	**Death of Subthalamic Nucleus Neurons due to Mitochondrial Oxidative Stress in Huntington's Disease Mouse Models** Srivarun Tummarakota; Advisor(s): Mark Bevan
B-206 Lect. Hall	C997	**The Effect of Antibiotics on Gastrointestinal Motility and Gut Microbiota** Catherine Chen; Advisor(s): Eugene Chang, Ketrija Touw

1:10 - 1:25

Room	ID	
A-113	C16	**Assessing the Viability of an Isolated Aquatic Ecosystem via Offseason Sampling** Julien Mathie; Advisor(s): Crystal Randall
A-115	C21	**Telomere Length Versus Cotinine, Cadmium, and Lead Exposure** Sahiti Pidaparti; Advisor(s): Brandon Pierce

A-117 N02 **The Destroyer of Worlds: An Understanding of Nuclear Strategy in the Twentieth Century**
Luke Morrical; Advisor(s): Lee Eysturlid

A-119 S01 **The Effect of Perspective Taking on Moral and Religious Convictions**
Baylee Blackburn; Advisor(s): Allison Mueller, Linda Skitka

A-121 R05 **Search for the Standard Model Higgs Boson in Associated *WH* Channels Resulting in $b\bar{b}$ Decay in DØ Data Using Matrix Element Analysis**
Alexander Gonsalves, William Tong; Advisor(s): Ryuji Yamada

A-123 Q07 **Understanding the Chicken Embryo Model for Alzheimer's Disease-Related Research**
Nathan Errampalli, Michael Qian; Advisor(s): William Klein, Kirsten Viola

A-129 R958 **Bayesian Statistics and Estimating Stellar Masses in the Blind Cosmology Challenge and the Dark Energy Survey**
John DeMastri; Advisor(s): James Annis

A-131 S10 **The Relationship Between Parent Praise, Math Anxiety, and Students' Theories of Intelligence**
Amy Yu; Advisor(s): Sian Beilock, Lori Petersen, Marjorie Schaeffer

A-133 Q18 **The Analysis of Parkinson's Disease in Mice as Seen Through Astrocyte Morphology**
Sruti Mohan; Advisor(s): Savio Chan

A-135 D01 **Using Demographical Information to Predict Work Performance Among Shiftgig, Inc. Employees: A Case Study of Temporary On-Demand Staffing**
Jiabao Li; Advisor(s): Jade Martin

B-101 L01 **Effects of Sand Filters in Wastewater Treatment Plants on Microplastic Output**
Morgan Phillips; Advisor(s): Catherine O'Reilly, William Perry

B-108 P01 **Determining the Effectiveness of Low-Dose Computerized Tomography Screenings in Detecting Early Stage Lung Cancer**
Rakesh Chatrath; Advisor(s): Rachel Logan

B-110 F17 **Designing a Website for Off the Shelf Data Acquisition Systems to Improve Their Accessibility**
Brian Yu; Advisor(s): Ryan Rivera, Lorenzo Uplegger

B-115 Q29 **Hand Movements and Hand Postures Encoded in the Brain**
Anna Shabayev; Advisor(s): Sliman Bensmaia

B-116 Q16 **Ion Channels and Action Potentials in Primary Vestibular Neurons: Impact of Damage and Regeneration in the Vestibular Epithelium**
Jessica Lee; Advisor(s): Ruth Anne Eatock, Antonia Gonzalez Garrido

B-125 Tellabs J04 **Measuring Circulation Control Wings of an Unmanned Aerial Vehicle**
Joshua Burke; Advisor(s): David Williams

B-131 Grainger C26 **The Effects of Ethanol on the Behavioral and Developmental Aspects of *Drosophila melanogaster***
Gissel Salas, Kaitlyn Schmieder; Advisor(s): Vandana Chinwalla

B-133 Q27 **Classifying Cortical Areas and Neurons Involved in Proprioception**
Grace Ryan; Advisor(s): Sliman Bensmaia, James Goodman

B-206 G953 **Comparing Biodiversity of Silurian Reefs in Illinois and Wisconsin Using**

Lect. Hall		**Museum Collections and Unbiased Bulk Samples** Walker Weyland; Advisor(s): Paul Mayer

1:35 - 1:50

Room	ID	
A-113	C17	**Characterization of Chlorella Algae Virus PVCV-1 in Western Suburban Freshwater Bodies** Stefanie Ochoa, Kyle Parker; Advisor(s): Crystal Randall
A-115	C29	**The Protein Expression of CAV-1, COL1A2, and THBS2 proteins in the CaCo2 cell line.** Nitya Talasila; Advisor(s): Joel Pekow
A-117	I03	**Effects of Instruction in Advanced Planning on Computational Problem Solving in a Group Environment** Adam Grobman; Advisor(s): Alice Bennett, Meridith Bruozas, Emily Cantu, John Domyancich
A-119	S06	**The Effects of Physical Activity on Linguistic Memorization** Linnea Lee-Brown; Advisor(s): David Lundgren, Jay Thomas
A-121	R07	**A Comprehensive Look at Nucleon Decay Modes for the DUNE Experiment** Lisa Lin; Advisor(s): Maury Goodman
A-123	Q02	**Development of an Antibody-Targeted PET Probe for Early Diagnostic Imaging of Alzheimer's Disease** Adrian Bebenek; Advisor(s): Erika Cline, William Klein, Kirsten Viola
A-129	C12	**Analysis of High Throughput Gene Array Data Identifies Common Cellular Pathway to Treat Hearing Loss** Krishi Korrapati; Advisor(s): Debashree Mukherjea
A-131	T07	**Perceptions and Effects of Science and Math Gender Stereotypes Upon Illinois Mathematics and Science Academy Students and Parents** Amy Yu; Advisor(s): Leah Kind
A-133	Q10	**High-frequency Brain Activity Supports Architectonic Parcellation of Cortex** Alexis Giff; Advisor(s): V. Leo Towle
A-135	F05	**Testing and Optimizing Trading Speed Using Lower-Level Embedding on Time Series Analysis Functions** Joseph Hutter; Advisor(s): Maxwell Rhee
B-101	M02	**Analysis of Rachmaninoff’s String Quartets and its Application to Reconstruction** Isabella Spinelli; Advisor(s): Peter Dong
B-108	P02	**Exploration of Drug Encapsulation and Delivery Using Toroidal-Spiral Particles** Roy Chiu; Advisor(s): Paola Leon Plata, Ying Liu
B-110	Q22	**The Efficacy of Neurofeedback when Applied to Post-Concussion Syndrome** Joseph Palakeel; Advisor(s): Lori Russell-Chapin
B-115	Q04	**Effect of Outside Stimuli During Sleep Stages** Gloria Choi, Kirstin Johnson; Advisor(s): Moran Cerf

B-116 Q30 **Inhibiting Epigenetic Histone Methylation Within Pediatric Brainstem Glioma via PRC2 Methyltransferase**
Aadit Shah; Advisor(s): Rintaro Hashizume, Quanhong Grace Ma

B-125 Tellabs J819 **Characterizing Icephobic Properties of Superhydrophobic Polypropylene Manufactured Using a Hot Emboss Method**
Evan Sun; Advisor(s): Michelle Khine

B-131 Grainger C27 **Effect of Hormones on Breast Cancer Cell Line Enhancers**
Whitney Sloneker; Advisor(s): Michael Bolt, Heather Scott, Kevin White

B-133 R04 **The Effect of Media on Heat Distribution by 1860 Nanometer Wavelength Infrared Radiation**
Kyle Brennan Feliciano; Advisor(s): Claus-Peter Richter, Xiaodong Tan

B-206 Lect. Hall G855 **Inferences of Subglacial Processes Under the West Antarctic Ice Sheet From Grain Surface Textures**
Aspen Wheeler; Advisor(s): Ross Powell, Rebecca Puttkammer

2:00 - 2:15

Room ID

A-113 A10 **Genetic Modification of Yeast Cell MATa in Order to Express α-factor**
Amy Liu; Advisor(s): Ping Wei

A-115 C30 **Expression of Focal Adhesion Proteins in Ulcerative Colitis Associated Neoplasia**
Nitya Talasila; Advisor(s): Joel Pekow

A-117 I01 **Effects of Agent-Based Modeling on Comprehension of the Macro and Micro Levels in the Natural World**
Anna Barannikova; Advisor(s): Alice Bennett, Meridith Bruozas, Emily Cantu, John Domyancich

A-119 S04 **Cross-cultural Differences in Personality among Ethnicities in the United States and Races Worldwide**
Samhita Inampudi; Advisor(s): William Revelle

A-121 R09 **Analysis of Neutrino Events From the NUMI Beamline With NOvA Near Detector**
Liam McParland; Advisor(s): Zelimir Djurcic, Maury Goodman, Guang Yang

A-123 Q25 **Identifying Toxic Amyloid-Beta Oligomers Species (AβOs) in Alzheimer's disease**
Shrey Patel; Advisor(s): Erika Cline, William Klein, Kirsten Viola

A-129 C13 **Molecular Mechanisms of Cancer Stem Cell Creation via High Nitric Oxide Adaptation**
Krishi Korrapati, Niresh Kuganeswaran, Thomas Wan; Advisor(s): James Radosevich

A-131 S02 **The Effect of Social Anxiety on Acute Responses to the Drug MDMA (Ecstasy)**
Kasey Cervantes; Advisor(s): Kasey Van Hedger, Harriet de Wit

A-133 Q26 **An Electrocorticographic Study of Embodied Cognition in the Human Brain**
Kate Pauss; Advisor(s): V. Leo Towle

A-135 H03 **Determining the Effectiveness of Dividend Change as an Indicator of Price**

		Movement David Xu; Advisor(s): Maxwell Rhee
B-101	M01	**Absolute And Relative Pitch: Factors Into The Origin And Acquisition** Austin Choi, Alexander Hughes; Advisor(s): Emily Sites
B-108	P10	**Levels of Transforming Growth Factor Beta and Programmed Cell Death 1 in Normal and Cancerous Pancreatic Cells** Sneh Patel; Advisor(s): Paul Grippo
B-131 Grainger	C32	**Mechanisms of Host Viral Interactions Leading to Loss of Oral Tolerance in Celiac Disease Patients** Bingtao Xiang; Advisor(s): Romain Bouziat, Reinhard Hinterleitner, Bana Jabri
B-133	R06	**Decoherence and Dephasing Rates of the Fluxonium Qubit Under the Influence of Charge Noise** Aakash Lakshmanan; Advisor(s): Jens Koch, David Schuster
B-206 Lect. Hall	F06	**Artificial Intelligence: Prospects, Pathways, Realities** Timur Javid, Tara Parkman, Nathaniel Smith; Advisor(s): Mike Ososky

Biochemistry

Creation of a PAX3 with a FLAG Tag Tool

Presenter(s)
Allison Bai, Illinois Mathematics and Science Academy

Advisor(s)
Deborah Lang, University of Chicago
Sixia Xiao, University of Chicago

The PAX gene makes proteins that bind to certain segments of DNA controlling the activity of that gene. The transcription factor PAX3 over-expresses in melanoma cell lines, affecting the development of melanocytes. The question remains then how phosphorylation of the PAX3 protein affects the stability of the PAX3 protein level. To answer this, the half-life of the PAX3 level must be examined. This project entails creating a tool for adding PAX3 with a FLAG tag which can be used in the future to examine the half-life of the PAX3 protein. PAX3 cDNA is amplified via PCR before being cut and then ligated with a cut portion of pcDNA-5'UT-FLAG vector to form a recombinant plasmid. Specifically, PCR and restriction enzyme digestion, ligation, transformation, and amplification form the recombinant plasmid. We check the accuracy by isolating the plasmid and performing diagnostics. If the project is successful and a tool has successfully been created, the isolated DNA may be sent to sequencing to do a final check on accuracy and the tool can be used for future projects. In the grand scheme of things, introducing a mutation to the epitopes that PAX3 is phosporylated to lets us see how phosphorylation affects turnover rate.

Purification and Crystallization of Bacterial Direct Oxygen Sensor Phosphodiesterase PAS Domain

Presenter(s)
Hannah Cavagnetto, Illinois Mathematics and Science Academy

Advisor(s)
Xiaojing Yang, University of Illinois at Chicago
Xiaoli Zeng, University of Illinois at Chicago

All living organisms have biological sensors that receive signals and regulate cell functions in the presence of oxygen. One of these particular sensor proteins, Direct Oxygen Sensor Phosphodiesterase (DosP) from *E.coli*, works with a partner protein to regulate the presence of cyclic-di-GMP, an important dinucleotide second messenger. In this investigation, the oxygen sensing module of DosP, referred to as DosP 382, was examined by means of protein purification and X-ray crystallography. Purification experiments were conducted by amplification of the sequence of DosP 382, insertion into an expression vector, transformation into an *E.coli* culture, extraction and elution. Crystallization experiments were set up with purified DosP 382 and observed under a microscope. Preliminary results have shown successful protein purification, however the outcomes from crystallization experiments have failed to produce any protein crystals. Further investigation of DosP 382 may reveal greater intricacies of its conformational changes in response to oxygen sensing, as well as a better understanding of certain bacterial cell processes.

The Effect of Novel, Small-Molecule Drugs as Agonists or Antagonists on G-Protein Coupled Receptors

Presenter(s)
Tiffany Ding, Illinois Mathematics and Science Academy
Susriya Gangireddy, Illinois Mathematics and Science Academy

Advisor(s)
Brittany Hopkins, Northwestern University
Richard Miller, Northwestern University

G-Protein Coupled Receptors are seven-transmembrane receptors known to be the target receptors of one-third of all prescribed medicines, which demonstrates their importance in the pharmaceutical and pharmacological context. When activated, these receptors signal through stereotyped intracellular signaling pathways, demonstrating the ligands' effects. We used the Tango assay which relies on a modified beta-arrestin recruitment signaling pathway, ours specifically targeting the dopamine (D2) receptor to activate this pathway. In the five-day assay, we primarily completed the fourth day, consisting of injecting novel, small-molecule drugs designed to interact with the CXCR4 receptor on HTLA cells. The assay allows for downstream signaling of luciferase transcription, which indicates the efficacy of the drug as either a D2 agonist or antagonist. We injected quinpirole, a D2 selective agonist, onto the cells as a control for other injected drugs for the agonist screen. For the antagonist screen, we injected quinpirole in combination with other drugs to determine those drugs' effects in blocking quinpirole activity. Preliminary results suggest that the majority of tested drugs do not act as agonists nor antagonists for the D2 receptor. These results are not unexpected as the drugs were designed to target the CXCR4 receptor, showing their clinical possibilities. However, the observed specificity of the drugs for the CXCR4 receptor compared to the D2 receptor are encouraging.

The Inhibition of Thioredoxin Glutathione Reductase in *Schistosoma mansoni*

Presenter(s)
Ethan Fisher, Illinois Mathematics and Science Academy

Advisor(s)
David Williams, Rush University Medical Center

Schistosoma mansoni is a parasitic flatworm that is a causative agent of the disease schistosomiasis. Schistosomiasis plagues many third-world countries and is considered by the CDC to be a neglected tropical disease. Currently there is only one treatment: praziquantel. Praziquantel has many limitations, which necessitates discovery of a new treatment. The enzyme thioredoxin glutathione reductase (TGR) has been identified as vital to worm survival and been identified as a potential drug target. A screen of 350,000 compounds found 10,000 that inhibited TGR, and of these 2,000 were screened against thioredoxin reductase, glutathione reductase, and mammalian cells. Following up on this study, 42 compounds were obtained and screened using a TGR-enzyme assay. Of these 42, 5 were found to have a half maximal inhibitory concentration (IC50) lower than 10 micromolar (μM), the threshold set for a compound to be suitable for drug development. These five were sent to other labs for further study. In a second follow-up study an additional five compounds that were obtained and screened using the same assay; three of these were found to have an IC50 of less than 10 μM. Other work being done on these compounds includes testing for activity against live worms and structural studies to identify the binding site of the inhibitors.

Characterization of the Cyanobacteria *Anabaena* sp. PCC 7120 and iPC

Presenter(s)
Johnathan Guo, Illinois Mathematics and Science Academy
Tea Ryza, Illinois Mathematics and Science Academy

Advisor(s)
Robert Haselkorn, University of Chicago
Amin Nasser, University of Chicago

Cyanobacteria are gram-negative prokaryotes that perform oxygenic photosynthesis by fixing carbon dioxide to produce oxygen. Multiple species, such as *Anabaena* sp. PCC 7120, of cyanobacteria are also capable of fixing N_2 when nitrogen sources in the environment are scarce. Around 10% of the vegetative cells of the filamentous cyanobacteria *Anabaena* sp. PCC 7120 differentiate into heterocysts, cells that specialize in fixing nitrogen, in response to lack of nitrogen sources. Phycobilisomes are protein complexes composed of phycobiliproteins that catch sunlight to use in oxygenic photosynthesis and exist within the thylakoid membranes of vegetative cells. The phycobiliproteins absorb light and are composed of an α and β subunit. We removed the α and β subunit of phycocyanin, one of the phycobilproteins, to create iPC, a mutated strain of Anabaena. The wild type is an unaltered sample of Anabaena and was used as a comparison against iPC. Cells of both were grown in medium with and without a nitrogen source in order to force heterocysts to form. We found differences in the growth pattern and the size of the phycobilisomes within the cells. We determined that the average distance between thylakoid membranes in thw wild type is 61.1nm (±11.7 SD) while the average distance in iPC was 37.1 nm (±9.7 SD). We also found that that the lack of phycobilisome in iPC had an effect on the growth of filaments.

Comparison of Proteins from Cocaine Addicted and Control Mouse Brains using Proteomic Techniques

Presenter(s)
Shin Imai, Illinois Mathematics and Science Academy

Advisor(s)
Peter Yau, University of Illinois at Urbana-Champaign

Little is known about the molecular mechanisms involved in cocaine addiction. An understanding of the mechanism at the level of protein expression would be potentially useful for coming up with a treatment. This study analyzed the proteins from brains of cocaine treated (dose of 20 milligrams per kilogram of body weight) and control (treated with saline) BALB/cByJ mice using a proteomics based approach. The proteins were digested with trypsin and analyzed using Liquid Chromatography - Tandem Mass Spectrometry (LC-MS/MS) followed by identification and quantitation using the MASCOT protein database search engine. The proteins were then functionally classified using PANTHER. The cocaine treated mouse brain showed a significant increase in energy, metabolic and transport related proteins consistent with increased cell activity. Also, a protein, myelin basic protein (MBP), was found to be increased in the cocaine treated brain similar to a peptidomics study by Rhodes and Sweedler (2015) performed on the same brains that looked at neuropeptides that were derived from MBP that are involved in the reward pathway that is implicated in the addiction process. This implies that the mechanism of cocaine's effects is at the level of protein expression rather than at the processing step of the protein to neuropeptides.

Understanding the Role of RB-Binding Protein KDM5A in Cancer Cell Proliferation

Presenter(s)
Divya Jasthi, Illinois Mathematics and Science Academy
Emma Mattson, Illinois Mathematics and Science Academy

Advisor(s)
Elizaveta Benevolenskaya, University of Illinois at Chicago

The retinoblastoma protein (pRB) is a key regulating protein in the cell cycle, which often interacts with the lysine (K)-specific demethylase 5A (KDM5A). While pRB has been shown to play a significant role in the processes of cell differentiation and metabolism, the role of KDM5A in these cellular processes is not fully known. Our investigation focused on clarifying the role of KDM5A in a non-small cell lung cancer line under different concentrations of erlotinib, a common chemotherapy drug, by examining the cell cycle and cell proliferation using the Celigo Imaging Cytometer. Cell cycle analysis revealed that there was a greater number of cells with *KDM5A* knocked down in the G2/M phase of the cell cycle when compared to the control, while there were fewer cells with overexpression of *KDM5A* in G2/M phase when compared to its respective control. Results from cell proliferation data showed that cells with knock down of *KDM5A* had decreased cell proliferation compared to their control at a drug concentration of 0.01 micromolar. Consistent with this result, cells with overexpression of *KDM5A* compared to their control did not decrease in proliferation. These findings establish that KDM5A is a potential therapeutic target for cancer treatment.

Investigation on the Decomposition of Sugar Substitutes in Simulated Blood

Presenter(s)
Priyankka Krishnan, Illinois Mathematics and Science Academy

Advisor(s)
Sowmya Anjur, Illinois Mathematics and Science Academy

In recent years several arguments have been raised as to whether sugar substitutes help or harm us. This SIR investigation is focused on researching the effects of sugar substitutes in simulated blood. This was completed through both a literature search and lab experimentation. Simulated blood and amylase (0.1% solution in buffer) were used in the lab investigation, amylase represents the salivary amylase that breaks down food when ingested. Sugar and sugar substitutes were added to the simulated blood in the recommended serving sizes. The amylase solution would be allowed to react with the simulated blood-sugar substitute mix, and glucose strips would be used to determine if any glucose was present. The results indicated that there was little to no glucose found in the sugar substitutes. The only substitutes where glucose was detected were aspartame and stevia. The literature search showed that the sugar substitutes broke down into glucose in simulated blood, but not in the body. To conclude, aspartame might increase blood glucose levels in humans when used as directed. Further research may be necessary to conclude whether aspartame is harmful or not.

In Vivo Identification of Tumor Cells in the Sentinel Lymph Node

Presenter(s)
Wasan Kumar, Illinois Mathematics and Science Academy

Advisor(s)
Chengyue Li, Illinois Institute of Technology
Kenneth Tichauer, Illinois Institute of Technology

The purpose of this investigation was to determine if the PAISLY (Paired-agent imaging of sentinel lymph nodes) was an effective method to non-invasively detect the presence of tumor cells in the sentinel lymph node. In this investigation, human breast cancer cells were grown in female nude mice, until the tumor cells metastasized into the lymphatic system. Fluorescent anti-EGFR antibodies were then injected into the mice, and the uptake of this imaging agent in the sentinel lymph node was imaged using the custom ARTEMIS Scanner for the next 3 hours using 10 minute intervals. The process was repeated using a paired imaging agent instead of the anti-EGFR antibodies. There were also mice who were injected with untargeted imaging agent and scanned for the same time. There was no correlation between level of fluorescence in the lymph nodes and the number of cancer cells present in the lymph node when using the anti-EGFR. When compared to the control, the two had very similar patterns of uptake and retention. The PAISLY method however was accurately able to detect fewer than 200 cancer cells in the sentinel lymph node, making it extremely accurate.

Genetic Modification of Yeast Cell MATa in Order to Express α-factor

Presenter(s)
Amy Liu, Illinois Mathematics and Science Academy

Advisor(s)
Ping Wei, Peking University

Yeast, or *Saccaromyces cerevisiae*, can exist as MATa haploid cells, which secretes the mating pheromone a-factor, MATα haploid cells, which secretes the mating pheromone α-factor, or MATa/MATα diploid cells. MAT represents a locus that determines mating type. Several studies have shown that the mating pheromones a- factor and α-factor are functionally interchangeable. This investigation sought to determine whether MATa could be genetically modified using an integrated plasmid with a constant promoter to express α-factor. The gene that expresses α-factor was isolated in the MATα yeast cell, cut, and transferred using the integrated expression plasmid to a MATa yeast cell. The results show that α-factor can be expressed in MATa yeast cells, but at a slower rate and at a smaller amount than α-factor in MATα cells. This leads to another interesting question about the molecular mechanism underlying the difference in secretion dynamics of the same pheromone, α-factor, in the two different types of MAT yeast cells.

Amount of Five Oil Dispersant Ingredients that Remain in Water After Use and Their Toxicity to Cell Culture at Such Concentrations

Presenter(s)
Jair Powell, Illinois Mathematics and Science Academy

Advisor(s)
Anita White, Illinois Mathematics and Science Academy

Oil dispersants are among the most common methods of oil spill cleanup yet they are not strictly regulated. A list of some ingredients, without concentrations, has only recently been released making testing on these ingredients crucial to leaning oil dispersant's effect on ecosystems. We used a Michigan Center Foundation-7 (MCF-7) immortal cell line to test the toxicity of five ingredients of oil dispersants. These were used at a concentration that was likely to remain in the water, which we found by adding each to a set volume of water to determine their solubilities. While tetradecane does have harmful effects, it is insoluble in water, as it would not dissolve at even a 0.1% solution. Dioctylsulfosuccinate and di(propylene glycol)butylether were minimally soluble in water meaning not enough of either will be left in the environment to cause much harm. 2-Butoxy ethanol and 1-methoxy-2-propanol were very soluble in water up to the common 25% oil dispersant concentration meaning their effect will be visible throughout an ecosystem. These results help show that the toxicity of an oil dispersant ingredient to cell culture is dependent on its solubility. The more soluble ingredients were present in higher concentrations so their effect was more prevalent.

Biochemical Analysis of Ketamine Metabolites Using Liquid Chromatography-Mass Spectrometry

Presenter(s)
Malavika Ramnath, Illinois Mathematics and Science Academy

Advisor(s)
Eugene Chang, University of Chicago
Kyle Dolan, University of Chicago

In order to determine if drug metabolism is affected by a change in diet, urine samples from ketamine and saline treated mice were collected in order to determine the rate at which ketamine metabolized into norketamine. We wanted to look at the effects of dietary fat on constitutive androstane receptor-regulated (CAR) drug metabolism, since CAR has been found to be an anti-obesity nuclear receptor. We observed the differences in the rate of ketamine metabolism between mice fed an 18% milk-fat (MF) diet and mice fed a low-fat (LF) diet. Mouse urine samples were extracted using solid phase extraction columns and analyzed using a liquid chromatography- tandem mass spectrometry machine. We determined the limit of detection and the limit of quantification and used an internal standard to detect ketamine and norketamine in mouse urine. After 300 minutes, the average amount of norketamine and ketamine in the sample of mice fed the LF diet was lower than the mice fed the MF diet. This could indicate that the mice on the LF diet metabolized the ketamine and norketamine more efficiently by a slight margin. However, our sample size was too small to accurately report any statistical significance.

Manipulating Expression of LP502, PcyA, and Ho1 with pET28b and PETDuet Vectors in Chemically Competent *Escherichia coli*

Presenter(s)
Taylor Reyes, Illinois Mathematics and Science Academy
Nicole Tartaglia, Illinois Mathematics and Science Academy

Advisor(s)
Don Dosch, Illinois Mathematics and Science Academy
C. Robyn Fischer, Illinois Mathematics and Science Academy

When combined, the proteins Ho1, PcyA, and LP502 make up the light- harvesting complex, or phycobilisome (PCB), of cyanobacteria. These complexes are primarily responsible for the light absorption that takes place in photosystem II of photosynthesis. Expression vectors pET28b- and pETDuet code specifically for the LP502 protein and the Ho1 and PcyA proteins. By inserting the photosystem into *Escherichia coli*, we limit the number of outside factors that affect the light absorption. The goal of this study is to transform *E. coli* with vectors pETDuet and pET28b- in order to generate the three aforementioned proteins. These plasmids can be transformed individually into *E. coli*, but when attempting to insert them both into the bacteria at the same time, the transformation efficiency decreases drastically. The plasmids we used in this investigation were clones sent from our collaboration partners at RDFZ. By manipulating how the bacteria is transformed we are able to observe how the expression of the PCB is affected. Engineering the expression of these proteins in *E. coli* connects to research in the advancement of production efficiency and effectiveness of various biomaterials, especially biofuel.

Bioengineering

Structural Insights Into the Functions of Microtubule and Microtubule-Associated Proteins

Presenter(s)
Daisy Bugarin, Illinois Mathematics and Science Academy
Gina Jiang, Illinois Mathematics and Science Academy

Advisor(s)
Ao Ma, University of Illinois at Chicago
Ken Tsui, University of Illinois at Chicago
Xinge Wang, University of Illinois at Chicago

Microtubules (MTs) are polymers of tubulin that exhibit highly dynamic instability and play a critical role in the eukaryotic cell cycle. MT dynamic instability, which is the fluctuation between growth and shrinkage of MT ends, allows cells to undergo constant, rapid structural reorganization to perform various cell functions. MT plus-end tracking proteins (+TIPs) are a type of microtubule- associated protein (MAP) that modulates MT dynamics and link cellular components to the MT tip. Members of one class of +TIPs are known as the end-binding (EB) proteins, which play a significant role in the protein-protein interaction dynamic network. In order to understand how EB tubulin complex affects MT function, we've pieced together information from various scholarly articles. Furthermore, by using the digital visualization software, Chimera, to visualize these structures, we have been better able to understand how the structure of tubulin changes. Our investigation into MT promotes more understanding about the relationship between subunit structure to MT dynamic instability. As a result, we have learned how different conformations of tubulin dimers change at MT plus end, how EBs bind to specific conformation of tubulins and specific part of MT only and how these bindings might affect tubulin conformation changes during MT growth phase and affect dynamic instability.

Creating a Micropipette System to Measure T Cell Binding Kinetics

Presenter(s)
Jason Chen, Illinois Mathematics and Science Academy

Advisor(s)
Jun Huang, University of Chicago
Jake Skarzynski, University of Chicago

The human adaptive immune system relies on T cells, lymphocytes which recognize pathogens through antigen receptors on their surfaces. To initialize the immune response, T cell receptors (TCRs) bind to pMHC complexes, consisting of the antigenic peptides of a pathogen and the major histocompatibility complex (MHC) of an antigen presenting cell. The binding process triggers the beginning of the adaptive immune response as cytokines are released and other leukocytes are activated. The specificity of this binding mechanism is an area of special interest, because a specific TCR can only recognize a very small subset of antigenic peptides and thus pMHC complexes. In particular, TCRs must have the capability to search for a corresponding pMHC complex at a very rapid rate. In this investigation, the binding kinetics of the TCR-pMHC interaction are studied using an experimental micropipette system, based on similar experiments by Chesla et al. The micropipette system is constructed, which can be used to measure the adhesion and association/disassociation behavior through an adhesion frequency assay or a thermal fluctuation assay, using a biomembrane force probe. This data can then be used to directly calculate the 2D binding kinetics of the TCR-pMHC interaction. This investigation is still waiting on final results.

Activity Monitoring and Fall Detection Using Smart Phones in Individuals With Neurological Problems

Presenter(s)
Mateusz Cikowski, Illinois Mathematics and Science Academy

Advisor(s)
Arun Jayaraman, Rehabilitation Institute of Chicago
Luka Lonini, Rehabilitation Institute of Chicago
Krishna Mummidisetty, Rehabilitation Institute of Chicago

This study focused on comparing three different leg braces that assist people with neurological disabilities namely micro-processor controlled knee-ankle-foot orthosis (C-Brace), stance-control knee- ankle-foot orthosis (SCO), and conventional knee-ankle-foot orthosis (KAFO). Each participant in the study wore accelerometer sensors along with a brace and was asked to perform activities of daily living (sitting, standing, climbing stairs, etc.) and simulated falls (in healthy participants and amputees) in a lab setting and at home. The data from the accelerometer sensors will be used to implement activity recognition using a smart phone (app in production) that has similar sensors. This application is useful in mining information related to a patient's community mobility and interactions to create specific rehabilitation plans.

Determining Colorectal Carcinoma Treatment Effectiveness Using a Fractional Order Calculus (FROC) Model

Presenter(s)
Nicholas Damen, Illinois Mathematics and Science Academy

Advisor(s)
Frederick Damen, University of Illinois at Chicago
Xiaohong Joe Zhou, University of Illinois at Chicago

Diffusion Weighted Magnetic Resonance Imaging observes the diffusion of water through tissue. Diffusion of water attenuates the signal received. The purpose of this study was to determine if the Fractional Order Calculus (FROC) model can be used to determine if the treatment of colorectal cancer patients is effective over the duration of radiation therapy. Sixty-eight patient datasets were collected and analyzed. Regions of interests (ROI) were drawn over colorectal tumors. The variables D0, beta, and mu describe properties of tumor tissue, and were used to determine if the treatment was effective over the duration of radiation therapy. A Mann-Whitney U- test was used to analyze the ROI information. The difference in the parameter values between the initial time point and each of the two following time points was not statically significant ($P > 0.05$). The FROC model was not able to determine if colorectal cancer treatment was effective.

Computational Analysis of Spatial Organization of Chromosomes

Presenter(s)
Lindy Hong, Illinois Mathematics and Science Academy
Michelle Zhu, Illinois Mathematics and Science Academy

Advisor(s)
Gamze Gursoy, University of Illinois at Chicago
Jie Liang, University of Illinois at Chicago

Understanding the spatial organization of genome is key to gaining insights into nuclear events that cause diseases such as cancer. Experimental techniques such as chromosome conformation capture and its derivatives (3C/4C/5C and Hi-C) provide a wealth of information on organization of genome in the nucleus by quantifying the frequency of DNA interactions between restriction enzyme fragments in a population of cells. By the analysis of the outcome of these techniques, one can compare the specific gene interactions in different cell types such as cancer cell vs. normal cells. Unfortunately, current computational analysis techniques suffer from the biases in the experiments that substantially affect the understanding of the experimental data, including the distance between restriction sites. Here, we investigated how these biases affect the identification of important chromatin interactions by calculating the distribution of restriction enzyme sites in the genome. We further used the available software to detect the topologically associated domains of chromosome 19 and showed how identification of these domains depends on the quality and quantity of the experimental data. These results will help to improve the analysis of current chromosome conformation capture data and correct discovery of gene interactions that are important for cellular functions.

A Low Cost Efficient Electroencephalography Recording System to Determine the Correlation between Mental Visualization and Relaxation

Presenter(s)
Meghana Kamineni, Illinois Mathematics and Science Academy

Advisor(s)
David Mogul, Illinois Institute of Technology

As relaxation techniques have surged in popularity, many scientific studies have researched the efficiency of these methods, including mental visualization. However, mental visualization has not received much scrutiny from the scientific community. In this study, a program was designed to determine the relationship between mental visualization and relaxation. The program inputs electroencephalography (EEG) signals from the brain, plots them in real time on a scrolling graph, performs live data analysis, and gives live audio feedback to the user. In the future, this interface can be used to test the effects of both mental visualization and live audio feedback on relaxation, which is measured by determining the power of frequency bands of the inputted signals. In the second part of this study, EEG signals were collected from the scalps of numerous subjects during three minutes of relaxation with no specified method and three minutes of relaxation while mentally visualizing a beach and listening to ocean sounds.

Endothelial Focal Adhesion Kinase (FAK) and Macrophage Polarization

Presenter(s)
Devdhi Kasana, Illinois Mathematics and Science Academy

Advisor(s)
Dolly Mehta, University of Illinois at Chicago
Pascal Yazbeck, University of Illinois at Chicago

Endothelial cells (ECs) are responsible for recruiting immune cells during times of injury or pathogenesis. Among the immune cells they recruit are macrophages, cells responsible for the endocytosis of unwanted materials in the body. There are two macrophage phenotypes: M1, which is pro-inflammatory, and M2, which is anti-inflammatory. The macrophages polarize from monocytes into one of these two types based on environmental stimuli. Since ECs secrete many signals and are responsible for monocyte recruitment, we wondered if ECs had a role in the polarization of macrophages. We silenced focal adhesion kinase in both C57BL6/J mice and ECs. We took the media in which these altered cells were grown and applied it to naïve macrophages. We then compared the results to those from cells treated with lipopolysaccharides and interleukin-4, whose polarizing effects are known. We found that the macrophages polarized towards an elongated phenotype. We conclude that through the media, the transfected ECs polarized the macrophages using a secreted cytokine/chemokine to combat basal inflammation, a hallmark of focal adhesion kinase deletion. Future research may be done to see whether these elongated macrophages act as lids on open junctions to stabilize the integrity of the endothelium using co-culture of endothelial cells and macrophages.

The Construction of a Forearm Interface with a Wrist Brace for the Barrett Medical Proficio Robot

Presenter(s)
Benjamin Maher, Illinois Mathematics and Science Academy

Advisor(s)
James Patton, Rehabilitation Institute of Chicago

Barrett Medical Inc.'s Proficio rehabilitation robot has the ability to improve the lives of many stroke patients with impaired upper extremity function through techniques such as error augmentation and negative viscosity. However, the current forearm segment of the Proficio robot prevents some stroke patients with weak grip from using it and inhibits natural arm movement. In this project, we constructed a forearm interface for the Proficio robot in an attempt to combat these shortcomings. We tried to make the interface as comfortable for the user as possible and lightweight to enable more realistic arm movement. This resulted in an interface with a carbon fiber tube mounted to the Proficio which extends to a wrist brace to control the robot rather than a handle. The wrist brace is attached to a nylon screw which allows more flexibility for the user's arm movement. In future development, the design of the interface could be improved to make it more streamlined and polished, with only one piece connecting the carbon fiber tube and the wrist brace.

Novel Nano-ceramic Coating On Polymethyl Methacrylate Denture Base Material

Presenter(s)
Caitlin O'Callaghan, Illinois Mathematics and Science Academy

Advisor(s)
Su Huang, University of Illinois at Chicago
Christos Takoudis, University of Illinois at Chicago

Many dental appliances are made from the polymer polymethyl methacrylate (PMMA); however, PMMA has a relatively soft surface that is susceptible to scratches. Bacteria enter the grooves and cultivate, increasing the risk of infection for the user. To prevent this, the PMMA is strengthened by the application of TiO_2, which is deposited by Atomic Layer Deposition (ALD). Before deposition, we wish to increase the wettability of PMMA so that there is a stronger bond between the PMMA and TiO_2. In this investigation we tested the use of oxygen plasma treatment as a precursor to ALD. Various durations of plasma treatment and thickness of PMMA samples were tested in search of the best variables to increase wettability. To measure wettability, the water contact angle (WCA) of the samples was found before and after treatment. Results show that 45 seconds of oxygen plasma treatment resulted in a 74° to 39° decrease in WCA. Surface thickness had no effect on the water contact angle because the PMMA sample was at a millimeter level instead of a nanometer level. We did notice some fluctuation in the percent decrease in WCA. In the future we wish to further investigate surface roughness of the PMMA as it is known to have an effect on wettability.

The Cytotoxic Effect of Melittin and TsAP 2 on pBR322 Vector DNA

Presenter(s)
Shivani Senguttuvan, Illinois Mathematics and Science Academy

Advisor(s)
Santosh Misra, Carle Biomedical Research Center
Dipanjan Pan, University of Illinois at Urbana-Champaign

The instability of genomic deoxyribonucleic acid (DNA) plays an integral role in carcinogenesis and metastasis by causing mutations that regulate cell division and expression. Degrading the genomic DNA that governs the cell cycle will downregulate both proliferation and differentiation. In an attempt to discover therapeutic agents that would distort the molecular structure of DNA, this investigation uncovered medicinal effects of the cytotoxic and amphipathic peptides, melittin and TsAP 2, on pBR322 Vector DNA. Gel electrophoresis and ultraviolet imaging allowed us to determine the optimal concentration range of melittin and tityusserrulatus antimicrobial peptide (TsAP 2) needed to distort the charge of DNA. In each trial, the ratio of DNA to peptide assorted from 1:0.25 to 1:2.5, respectively. Preliminary gel images suggest that as the peptide concentration increased, the amount of unbound DNA decreased. Specifically, melittin is able to bind and distort DNA at a concentration of 25 micromolar (μM) while TsAP 2 is able to do so at a concentration of 150 μM. I speculated that the peptides caused long- range electrostatic interactions in the backbone of DNA, causing the helix to condense and collapse. I concluded that melittin and TsAP 2 are potent distorters of DNA.

Microfluidic Oxygen Control: Effect of Microfluidic Device Geometry on Oxygen Gradient Stabilization

Presenter(s)
Deepshika Sudhakar, Illinois Mathematics and Science Academy

Advisor(s)
Dave Eddington, University of Illinois at Chicago

Air pollution contributes to more than 62,000 lung cancer deaths worldwide and an additional 712,000 cardiac and respiratory diseases per year. To raise public awareness of the hazards, the Environmental Protection Agency is working to make air sensors, which detect more than 180 hazardous air pollutants, available for the public to observe the air pollutants and safety risks of the air we breathe. Currently, since air sensors cost thousands of dollars, it is only available for the government. However, we can create a cheaper, smaller microfluidic air sensor to raise public awareness of air pollution. To do so, we are identifying which microfluidic device geometries allow the most oxygen molecules to pass quickly through the polydimethylosiloxane (PDMS) membrane by flowing oxygen and nitrogen molecules into different microfluidic devices. The results demonstrate that device 150528A and device D150126A12J, both devices with smaller channel lengths, displayed the quickest diffusion rate of oxygen through the PDMS. This demonstrates that as the channel length decreases, the diffusion rate increases, and thus, devices with shorter channel lengths will provide the most accurate and efficientdetection of the air pollution.

Drosophila Bazooka Gene in Asymmetrical Division and Stem Cell Differentiation

Presenter(s)
Deepshika Sudhakar, Illinois Mathematics and Science Academy

Advisor(s)
Jun Cheng, University of Illinois at Chicago

Stem cell asymmetric division is necessary for cyst stem cells (CySC) to produce self-renewed and differentiated cells at a 1:1 ratio around the stem cell niche, also known as hub cells. It is extremely important that this ratio is maintained because tumorigenesis can occur if too many self-renewed cells are produced while germ cell depletion and infertility can occur in the presence of too many differentiated cells. Recent studies show that CySC require mitotic spindle reorientation to maintain asymmetrical division. Drosophila testis were dissected and imaged after the green fluorescence protein (GFP) was engineered inside CySCs. The mitotic spindles were examined and analyzed using time lapse imaging techniques. This study indicates that the Bazooka gene is related to CySC spindle reorientation by determining the polarity of stem cells during mitosis, allowing self-renewed cells to attach to the hub at the tip of the testis while differentiated cells travel toward the center of the testis, and this suggests that the Bazooka gene interacts with Par 3, Par 6 and aPKC complexes in CySC cells to affect cellular polarity. This research can further be used to understand how to maintain asymmetrical division in human cancer cells, which can eventually suppress tumor growth.

Evaluating Spatiotemporal Gait Parameters and Subject Daily Mobility in Chronic Stroke Patients after High-Dosage Exoskeleton Training Program

Presenter(s)
Heena Srivastava, Illinois Mathematics and Science Academy

Advisor(s)
Arun Jayaraman, Rehabilitation Institute of Chicago

The “Ekso Bionics” exoskeleton is a powered external orthotic device which provides assistance for lower extremity movement in individuals with neuromuscular disorders. This exoskeleton technology is currently under clinical investigation for its use in mobility training during stroke rehabilitation. In my project, we used the Actigraph wearable sensor and GAITRite Gait tracking system to evaluate changes in daily stepping and walking/gait parameters during and following exoskeleton training in chronic stroke patients (ages 18-85). In tracking of daily mobility of subjects, results demonstrate a significant increase in the number of step counts, cadence (steps per minute), and energy expenditure (kilocalories) during therapy sessions than during non-therapy sessions. GAITRite analysis show changes in spatial (length) asymmetries in Self-Selected Velocity (SSV) and Fast Velocity (FV) trials as well as temporal (time) asymmetries in Fast Velocity trials. They also indicate noticeable trend towards perfect symmetry = 1.00 (Spatial SSV decreased by 0.3863, Spatial FV decreased by 0.4547, Temporal SSV decreased by 0.2277). Overall, the results indicate improvements in subject’s endurance, cardiovascular strength, walking velocity and balance among many other outcomes as a result of the exoskeleton training program. However, the results are considered inconclusive as the study is ongoing.

Biology

Lysine Metabolism is a New Tumor Suppressor Pathway in Breast Cancer that is Deregulated by Obesity

Presenter(s)
Eve Adami, Illinois Mathematics and Science Academy

Advisor(s)
David Crowe, University of Illinois at Chicago

Obesity (excess fat) is a cause of breast cancer, but reasons for this are not understood. Peroxisome proliferator- activated receptor gamma (PPARɣ) is responsible for fat cell differentiation and is activated by fatty acids stored in fat cells. PPARɣ prevents breast cancer in humans. We hypothesized that excess fatty acids may reverse PPARɣ function to tumor promotion. To test this hypothesis, we deleted the PPARɣ gene in mammary epithelium of normal and obese mice. Decreased PPARɣ expression in obese mice increases tumor latency and depletes tumorigenic progenitor cells. These cells slowly digest their mitochondria by the process of autophagy. To understand this, we determined changes in gene expression in obese PPARɣ null mammary tumors. Gene expression analysis showed a 16-fold increase in 2-aminoadipate semialdehyde synthase, an enzyme involved in lysine catabolism. PPARɣ suppressed expression of this enzyme, which may reduce cellular acetoacetate concentration (the end product of lysine catabolism). Human breast cancer lines that over expressed the synthase or were exposed to increased acetoacetate concentrations showed reduced proliferation and autophagy similar to that observed in mammary tumors. We conclude that obesity changes PPARɣ function from tumor suppressor to tumor promoter by inhibiting lysine catabolism, intracellular acetoacetate levels, and autophagy.

Leukocyte Telomere Length and Risk of Mortality: A Systematic Review

Presenter(s)
Ayan Agarwal, Illinois Mathematics and Science Academy
Sahiti Pidaparti, Illinois Mathematics and Science Academy

Advisor(s)
Brandon Pierce, University of Chicago

The purpose of our investigation was to conduct a literature review of available studies that look at leukocyte telomere length and compare it to overall risk mortality. Leukocyte telomere length has been connected to aging and age related diseases. Our study compiled data from many studies to see if there were significant results to report. The different studies we chose were both proscriptive and retrospective that reported the relationship between leukocyte telomere length and overall mortality. The eight studies involved 90,612 individuals in which 13,892 individuals died. The pooled relative risks were adjusted to the shortest tertile and tested for heterogeneity. There was moderate heterogeneity between the studies. The pooled relative risk for all-cause mortality in individuals with the shortest third versus longest third of telomere length showed high association (RR=1.38). The studies exhibited low to moderate heterogeneity (I2=35.18%). Observational data showed that telomere length has an inverse relationship with mortality in about 90,612 individual. However, additional research is needed to get more absolute results.

Inhibition of the Activity of Enzyme A in Rat Cardiomyocytes

Presenter(s)
Jyotsna Bitra, Illinois Mathematics and Science Academy
Binita Gupta, Illinois Mathematics and Science Academy

Advisor(s)
William Marszalec, Northwestern University
J. Andrew Wasserstrom, Northwestern University

Heart failure, a chronic condition caused by the gradual degradation of the heart muscle over time, is one of the leading causes of death in America. Despite its prevalence, a cure has not been discovered, though palliative measures may be taken. It is speculated that heart failure is caused by the deterioration and loss of t-tubules in cardiomyocytes, which results from the increasing activity of enzyme A. We seek to develop a drug that will prevent the activation of the enzyme A, which will protect t-tubules. Inositol monophosphate (IP1)- specific enzyme-linked immunosorbent assays were performed to test the drug's effectiveness. The levels of IP-1, the enzymatic metabolite of enzyme A's activity, were measured when the mouse HL-1 cardiac cells were activated with endothelin and measured again after treated with the experimental compound. Images of the treated and untreated cells under a confocal microscope were analyzed to detect the level of deterioration and reparation of the t-tubules. Among the sixteen initial experimental compounds considered for testing, compounds 2 and 9 have shown 50% inhibition of the endothelin response at low concentrations, indicating definite potential to be developed into a medicinal drug.

Competitive Exclusion Between *Echinacea angustifolia* and *Echinacea purpurea*

Presenter(s)
Nina Denne, Illinois Mathematics and Science Academy

Advisor(s)
Stuart Wagenius, Chicago Botanic Garden

The potential impacts of future invasive species in habitat restorations and preservations can be better understood through examining the effects of a non-native species in a remnant prairie plant community. This study will accomplish this through testing the competitive exclusion principle, creating an environment where *Echinacea purpurea* and *Echinacea angustifolia* , a non- native species and a native species, are competing directly for resources, and will measure the height of the seedlings of these two species when they are grown together. Over the course of the investigation, *E. angustifolia* and *E. purpurea* seedlings were planted in three levels of treatment: individual *E. angustifolia* seedlings, individual *E. purpurea* seedlings, and *E. purpurea* and *E. angustifolia* . There were also varying density levels of these species. Based on preliminary data, *E. purpurea* seems to grow shorter in mixed treatments, while *E. angustifolia* seems to grow taller in mixed treatments. Currently, 259 total seedlings across 189 pots are being measured in order to gather more data, 206 of which are *E. angustifolia* and 53 of which are *E. purpurea* . This study seeks to demonstrate the competitive exclusion principle between *E. angustifolia and E. purpurea* , which will provide insight into their behavior in other competitive settings.

Investigating Nanoluciferase as a Potential Proteome Stress Sensor

Presenter(s)
Heidi Dong, Illinois Mathematics and Science Academy
Sarah Xu, Illinois Mathematics and Science Academy

Advisor(s)
Sue Fox, Northwestern University
Richard Morimoto, Northwestern University
Anan Yu, Northwestern University

Firefly luciferase (Fluc) is a well-documented proteome stress sensor. Its misfolding upon cellular stress leads to aggregation and loss of enzymatic activity, which can be assayed by oxidizing luciferin, producing bioluminescence. However, Fluc is large (63 kilodaltons) and dependent on adenosine triphosphate (ATP) for activity. Since stresses to the cell can affect ATP production, Fluc activity is not solely dependent on its proper folding. We examined a luciferase synthesized from deep sea shrimp, nanoluciferase (NanoLuc); smaller (19 kDa), more luminescent than Fluc, and ATP- independent, to determine if it can accurately detect changes in chaperone mediated protein folding upon stress. We used four forms of NanoLuc: wild type, 8M, R116N, and 8M+R116N, with each mutation structurally destabilizing the protein. We expressed the proteins in human neuroblastoma HTB11 cells to examine whether NanoLuc can detect acute stress. We also purified the NanoLuc proteins expressed in Escherichia coli (E. coli) in order to determine if it is in vitro refolding dependent on the 70 kDa heat shock cognate protein (Hsc70). Our preliminary results show that two-hour heat stress led to aggregation of the NanoLuc protein in the cytosol of the cell, suggesting that NanoLuc could behave like a proteome stress sensor.

Investigating B Cell Responses in Food Allergic Children

Presenter(s)
Catherine Drake, Illinois Mathematics and Science Academy

Advisor(s)
Kris Erickson, Northwestern University
Kathryn Hulse, Northwestern University
Anne-Marie Singh, Northwestern University

It is estimated that 8% of US children have food allergies. Despite the high prevalence and risk associated with food allergy, the mechanisms that drive this disease are unclear. B cells play many important roles in all allergic diseases; however, the role of B cells in food allergy has not been studied. We sought to determine whether B cell function was different between children with and without food allergy. Blood was drawn from children with (n=4) and without (n=4) food allergy, and peripheral blood mononuclear cells (PBMCs) were isolated using ficoll centrifugation. PBMCs were left unstimulated, or stimulated to induce production of IgG or IgE for 5 days and then assessed by flow cytometry to identify the effect of stimulation. Interestingly, we did not find any differences in B cell subsets between the two groups at baseline. However, IgE-promoting conditions tended to induce increased B cell frequencies only in samples from food allergic children; likely due to an increase in memory B cells. These data suggest that B cells from food allergic children may be more easily stimulated by IgE-promoting factors, and ongoing studies are aimed at further elucidating the differences in B cell responses between these two groups.

The Effect of Different Concentrations of Camptothecin on the Apoptosis of MCF-7, U937, and CEM Cancer Cells

Presenter(s)
Sarah Eaton, Illinois Mathematics and Science Academy
Jin Komerska, Illinois Mathematics and Science Academy

Advisor(s)
Don Dosch, Illinois Mathematics and Science Academy

Camptothecin has been found to inhibit topoisomerase 1, which is essential for DNA replication. With a decreased amount of topoisomerase 1, there is an excess of reversible cleaving complexes which initiates apoptosis. Through microscope observation of camptothecin treated cells, concentrations of camptothecin were narrowed down in order to determine a range of 0.2 micromolar (uM) to 0.8 uM to use when running enzyme-linked immunosorbent assay (ELISA) tests. The ELISA test indicates the level of cleaved caspase 3, which is present in higher amounts when apoptosis has occurred, indicating that a camptothecin concentration has affected the cancer cells. The ELISA tests were run with camptothecin concentrations in the previously determined range, and the results provide a starting point for further research into investigating if camptothecin is a viable option for cancer treatment.

Modeling Ability of Herpes Simplex Virus 1 to Induce Cell-to-Cell Fusion

Presenter(s)
Angad Garg, Illinois Mathematics and Science Academy

Advisor(s)
Dinesh Jaishankar, University of Illinois at Chicago
Deepak Shukla, University of Illinois at Chicago

Herpes simplex virus type-1 is estimated to be present in around 90% of humans. Although most cases of HSV-1 are latent, the virus still poses a threat, especially to patients with a weak immune system. Once the virus enters a cell and replicates itself using cell machinery, HSV-1 can induce cell-to-cell fusion and form syncytia. The four glycoproteins responsible for syncytia are the same as the 4 necessary for viral entry: gB, gD, and the gH-gL heterodimer. These syncytia are harmful to the body, and they provide some refuge for the virus, protecting it from immune functions. We used CHO-K1 cells, though they are not human, because of their quick reproduction and receptiveness to transfection, a crucial process for this experiment. After transfecting the cells with the viral glycoproteins and a few other essential plasmids, using a Split Luciferase Assay, the presence of syncytia was quantitatively measured. The equation for the curve that best fit the data is $y = 14.941e^{0.3308x}$ where x represents time and y represents Luciferase activity. The experiment was run without glycoprotein gB, and the data was found to be negligible, reaffirming the finding that the four aforementioned glycoproteins are all crucial to syncytia formation.

The Role of Autophagy in HSV-Mediated Cell to Cell Fusion

Presenter(s)
Herschel Gupta, Illinois Mathematics and Science Academy
Yeeun Paik, Illinois Mathematics and Science Academy

Advisor(s)
Dinesh Jaishankar, University of Illinois at Chicago
Shrey Patel, University of Illinois at Chicago
Deepak Shukla, University of Illinois at Chicago

Herpes simplex virus type-1 (HSV-1) is a widely prevalent virus and 67% of the world's population is latently infected by the virus. One of the ways through which HSV-1 can spread is cell-to- cell fusion of infected and uninfected cells mediated by viral envelop glycoproteins. So far, there has been no cure against HSV-1 infection or its spread. Previous studies in our lab suggest that autophagy, a constructive degradative process that promotes cellular homeostasis, has important roles in several steps of HSV-1 lifecycle. However, it is unclear whether autophagy can influence virus-mediated plasma membrane fusion. Therefore, the aim of this study was to determine if autophagy has an effect on cell-to-cell fusion. For our studies a virus-free cell fusion assay was used. In this surrogate assay, the membrane fusion was mediated by expressing four viral glycoproteins, called gB, gD and gH-gL, in cells that mimic a viral infection. Pharmacological inducers and inhibitors of autophagy were administered to vary the levels of autophagy in virus-like cells that tend to fuse with neighboring cells. Our results show that suppressing or inducing autophagy by pharmacological drugs heavily alters the ability of cells to fuse. The suppressor of autophagy reduced the amount of basal cell-to-cell fusion while the inducer increased the amount of cell-to-cell fusion. Thus, our results suggest that autophagy has a significant role in HSV-1 membrane fusion and viral spread pathway.

Analysis of High Throughput Gene Array Data Identifies Common Cellular Pathway to Treat Hearing Loss

Presenter(s)
Krishi Korrapati, Illinois Mathematics and Science Academy

Advisor(s)
Debashree Mukherjea, University of Illinois at Springfield

Hearing loss (ototoxicity) is a global phenomenon. Noise induced hearing loss is one of the most common causes. Chemotherapeutic agents such as cisplatin, used in the treatment of solid tumors, also contribute to ototoxicity. We hypothesized that both cisplatin and noise trauma initiate similar stress signaling cascades in the cochlea. The goal of this study was to analyze high throughput gene array data from rat cochleae to determine commonly dysregulated genes in noise and cisplatin induced ototoxicity. Affymetrix expression consoles were used to analyze the genes and the DAVID (the Database for Annotation, Visualization and Integrated Discovery) software was used to generate signaling pathways. Genes from cellular calcium signaling pathways were upregulated under both stress conditions. To validate the calcium signaling pathway, in vitro calcium imaging studies were performed with cultured cochlear hair cells exposed to hydrogen peroxide (H2O2) to mimic the effects of noise and cisplatin in these cultures. H2O2 produced a significant increase in calcium uptake through the transient receptor potential vanilloid 1 (TRPV1) channel, which are present in these cells. Thus, we have identified a common cochlear stress protein (TRPV1) activated by cochlear trauma which could serve as a target for drugs to treat hearing loss.

Molecular Mechanisms of Cancer Stem Cell Creation via High Nitric Oxide Adaptation

Presenter(s)
Krishi Korrapati, Illinois Mathematics and Science Academy
Niresh Kuganeswaran, Illinois Mathematics and Science Academy
Thomas Wan, Illinois Mathematics and Science Academy

Advisor(s)
James Radosevich, University of Illinois at Chicago

For some time, it has been known tumors exhibit morphological and functional heterogeneity. Multiple theories have been proposed to address the cause of this, the most accepted of which is the hierarchy model, which states that biologically distinct cell classes compose tumors and only one has the ability to initiate tumor growth: the cancer stem cell (CSC) class. Today, however, the origin of these CSCs is unknown and under active research. One hypothesis has been that CSCs are actually results of the adaptation of cancer cells to nitric oxide in high amounts (HNO). We replicated this adaptive process, exposing five adenocarcinoma (AC) and five squamous cell carcinoma (SCC) cell lines to HNO levels. Using genechip analysis, we observed the changes in gene expression in the cancers from this adaptation process. With various bioinformatic tools, we determined which genes were commonly up and down-regulated across the ACs, the SCCs, and both the ACs and SCCs. The significant down-regulation of pyruvate dehydrogenase across all cell lines suggests that HNO- adapted cells go through a nonstandard pathway of cellular respiration. Furthermore, HNO-adapted SCCs displayed increased ribosomal production and genomic instability typical of CSCs. Our results clearly support the idea that CSCs are created from HNO- adaptation.

Effect of Fasting and Deoxycholic Acid Feeding in Xbp1-Knockout and Xbp1-Flox Control Mice

Presenter(s)
Sweta Kotha, Illinois Mathematics and Science Academy

Advisor(s)
Richard Green, Northwestern University

The unfolded protein response (UPR) is a protective response which helps the cell adapt to intracellular stressors. Recent data indicates that the UPR affects hepatic lipid and glucose metabolism. This study analyzes how the individual and combined effects of bile acid feeding followed by fasting or non-fasting periods affect phosphorylated inositol requiring enzyme 1 alpha (IRE1α), a UPR protein. Cre+ X-box binding protein 1 (Xbp1) knock-out mice (lacking hepatic Xbp1) and Cre- mice (containing hepatic Xbp1) were either fed chow or 0.3% deoxycholic acid (a bile salt) for three days. After feeding, the mice were either left non-fasted or were fasted for 4 hours before sacrifice. Western blots indicate that phosphorylated- IRE1α is prominent in 4 hours fasted DCA-fed Cre+ mice and 4 hours fasted chow-fed Cre+ mice, which may be due to loss of suppression by XBP1 in knockout mice. Further testing will examine how IRE1α alters with different fasting periods in chow and DCA-fed mice. Additionally, XBP1 will be studied to analyze its interaction with its upstream target, IRE1α. By studying mechanisms of the UPR through fasting and feeding contexts, critical information can be formulated about UPR proteins' role in bile acid and lipid regulation.

Characterizing the Host Immunologic Response to a Pouchitis-Associated Strain of *Bacteroides fragilis*

Presenter(s)
Katrina Kuhn, Illinois Mathematics and Science Academy

Advisor(s)
Eugene Chang, University of Chicago
Emma Liechty, University of Chicago

Ulcerative colitis (UC) is an inflammatory bowel disease that affects the colonic mucosa. One of the treatments for UC is a surgical procedure that involves creating an ileal pouch from the large intestine that is called ileal pouch anal-anastomosis (IPAA). In some cases this ileal pouch becomes inflamed: a condition called pouchitis. Pouchitis is hypothesized to occur in genetically susceptible individuals from an abnormal immune response to mucosal microbiota. In a longitudinal study of pouch microbial communities from 22 IPAA patients, bacteria in the genus Bacteroides were found in greater abundance during episodes of pouchitis. We isolated *Bacteroides fragilis* from pouchitis patients and evaluated the contribution of these bacteria to development of colitis in two gnotobiotic mouse models, the IL10 knockout and dextran sodium sulfate (DSS) models. It was found that monoassociation with pouchitis-associated *B. fragilis* does not promote colitis in the IL10 gnotobiotic mouse in comparison to a reference strain of *B. fragilis* and that pouchitis-associated *B. fragilis* attenuates DSS colitis in the gnotobiotic mouse.

Assessing the Viability of an Isolated Aquatic Ecosystem via Offseason Sampling

Presenter(s)
Julien Mathie, Illinois Mathematics and Science Academy

Advisor(s)
Crystal Randall, Illinois Mathematics and Science Academy

Small freshwater ecosystems are highly sensitive to pollution and are dependent on reliable influxes of nutrients. Run off from surrounding roads and fields delivers chlorides, nitrates, and sulfates to these ecosystems, which particularly affect indigenous macroinvertebrates during development. We collected water samples to determine chloride, sulfate, and nitrate concentration, as well as conductivity and dissolved oxygen content to assess the overall health and long-term sustainability of No Pond, a small freshwater body on the Illinois Math and Science Academy campus. Here we report dissolved oxygen levels above 5.4 mg/L, the minimum for proper development of several keystone species recommended by the EPA, to a depth of 3 meters. The presence of pollution- and oxygen-sensitive macroinvertebrate species further suggests a healthy, strong environment going into and exiting the winter season. Our findings therefore suggest that No Pond can support life at many tropic levels and maintain a balanced and diverse ecosystem.

Characterization of Chlorella Algae Virus PVCV-1 in Western Suburban Freshwater Bodies

Presenter(s)
Stefanie Ochoa, Illinois Mathematics and Science Academy
Kyle Parker, Illinois Mathematics and Science Academy

Advisor(s)
Crystal Randall, Illinois Mathematics and Science Academy

The eukaryotic green algae strain Chlorella NC64A and its corresponding Chlorella virus PBCV-1 are both commonly found in North American freshwater bodies. In this investigation, we tested the abundance of the PBCV-1 virus within the freshwater lake "No-Pond" located behind IMSA's campus. For this investigation, we collected water from "No-Pond" and filtered it so that only virus particles would remain. Afterwards, we grew subcultures of our original NC64A algae strain on slants of Modified Bold's Basal Medium under a UV light. After successful growth in the slants, we moved the algae to liquid cultures. Finally, by combining our filtered pond water with the algae and liquid media, we performed plaque assays to assess the abundance of the virus. Preliminary results suggest that the virus may not be very abundant within "No-Pond"; however, more plaque assays will be done in the future to confirm this. Final results will be presented. The study of eukaryotic green algae and their viruses is becoming increasingly important as algae is a strong candidate for a future resource of food and biofuel.

The Role of DNA Methylation in Different Subtypes of Glioblastoma

Presenter(s)
Jaeyoung Oh, Illinois Mathematics and Science Academy

Advisor(s)
Shi-Yuan Cheng, Northwestern University
Rajendra Pangeni, Northwestern University

DNA methylation, a mechanism that regulates gene expression, is associated with various cancers including glioblastoma (GBM). The purpose of this investigation was to investigate the role of DNA methylation in GBM stem cell (GSC) subtypes including mainly proneural (PN) and mesenchymal (MES). We carried out 450K methylation array on the GSCs to obtain levels of methylation and used gene expression data sets to obtain gene expression. We compared and found corresponding methylation and gene expression to identify candidate genes and validated the gene expression through quantitative reverse transcription polymerase chain reaction and Western blot. Out of the candidate genes, further work was done to specific genes due to their dysregulated methylation in MES and non-methylation in PN which corresponded to the high level of gene expression in PN and low level of gene expression in MES. The results suggested that DNA methylation does play a role in PN and MES GSCs phenotypes and their tumorigenic properties. This investigation could possibly help further in understanding DNA methylation associated with phenotypes of malignant GBMs and lead to more specific therapeutic targets.

Regulation of Genes Involved in Lipid Absorption by Bacterial Conditioned Media

Presenter(s)
Grace Park, Illinois Mathematics and Science Academy

Advisor(s)
Eugene Chang, University of Chicago
Kristina Martinez, University of Chicago

Microbial dysbiosis; triggered by diet, environment, and host genetics; is associated with extra-intestinal disorders. Preliminary data showed that high fat diets significantly increased the abundance of the family Clostridiaceae in the small intestine and that diet-mediated dysbiosis drives lipid absorption in the small intestine causing increased adiposity. Therefore, it was hypothesized that *Clostridium scindens* would directly impact expression of fatty acid transporters or processing enzymes and enteroendrocrine hormones. To test this hypothesis, ileal enteroids were treated with conditioned media (CM) from *C. scindens* for 24 and 48 hours and mRNA levels of target genes including cluster of differentiation *(cd)36,* cholescystokinin, secretin, monoacylglyceride transferase *(Mogat2),* and peroxisome proliferator activated receptor gamma *(pparg2)* were measured. CM from *Allobaculum e14* and *Lactobacillus johnsonii* were used as controls. *C. scindens* and *L. johnsonii CM* media increased *cd36* expression at 48 hours, but not significantly. *L. johnsonii* CM significantly decreased *mogat2* expression at 24 and 48 hours compared to control media. Other genes measured were not significantly altered by CM. These results suggest interaction between bacterial CM and small intestinal gene expression. However, the importance of these changes on lipid absorption and transport requires further experimentation.

Cognitive Dysfunction in the Hemodialysis Population

Presenter(s)
Sneha Pathuri, Illinois Mathematics and Science Academy

Advisor(s)
Kenneth Wilund, University of Illinois at Urbana-Champaign

Patients with end stage renal diseases requiring hemodialysis treatment experience cognitive impairment due to a variety of risk factors. Many risk factors come from Chronic Kidney Disease (CKD) and dialysis itself. The purpose of this study was to assess changes in cognitive functioning in maintenance hemodialysis (MHD) patients during a hemodialysis (HD) session. MHD patients (n=21) were recruited from dialysis clinics. Cognitive function was measured using a battery of tests from the CogState and Count Battle programs at 15 minutes, 1 hour, and 3 hours into a HD treatment. In addition, quality of life and depression questionnaires, heart rate, and blood pressure data was collected for comparison. Significant declines were seen in cognitive domains. Long term memory declined over the course of a dialysis session ($p < 0.05$). A trend toward significance was seen in working memory. In addition, questionnaires evaluating quality of life and depression were correlated with measures of cognitive function. These findings suggest that cognitive impairment in hemodialysis patients is most likely due to a variety of cerebrovascular problems caused by CKD and the hemodialysis process itself. Further studies are needed to determine if other domains are also affected and to determine the primary mechanisms behind these cognitive issues.

Telomere Length Versus Cotinine, Cadmium, and Lead Exposure

Presenter(s)
Sahiti Pidaparti, Illinois Mathematics and Science Academy

Advisor(s)
Brandon Pierce, University of Chicago

The purpose of this investigation was to compare leukocyte telomere length with cotinine, cadmium, and lead exposure in the US population. Telomere length has been shown to negatively correlate with biological aging and it has been shown as a marker for many age related disease. Leukocyte telomere length has been connected with many dietary conditions, including the exposure of different metals. All data was analyzed using the program R to model a linear regression. This study, using the data from the National Health and Nutrition Examination Survey from the years 2001 – 2002, found a linear fit between mean telomere length and the before mentioned metal exposure. This was adjusted for age, and sex. Telomere length was found to be negatively correlated with cotinine (p-value: 0.7795) and cadmium (p-values: 0.586) and positively correlated with lead (p-value: 0.1103), but the results were not significant.

Regulation of Mitochondria and Mitochondrial Oxygen Species by TGF-β

Presenter(s)
Malavika Ramnath, Illinois Mathematics and Science Academy

Advisor(s)
Jun Wei, Northwestern University

In patients with fibrosis, the imbalance of the manifestation of reactive oxygen species (ROS) and the body's detoxifying abilities results in oxidative stress in the cytoplasm and mitochondria. Increased production of ROS can stimulate extracellular matrix synthesis, leading to persistent fibrosis. To determine how the addition of TGF-β affects mitochondria ROS production, RNA was isolated from human foreskin fibroblasts and quantitative polymerase chain reaction was used to examine changes in the levels of mRNA in the mitochondria and nucleus after the application of TGF-β. Western blot technique determined TGF-β's effect on SIRT3, a post-transcriptional modifier that plays a key role in mitochondria ROS production, and Ac-MnSOD2, an enzyme that clears ROS; the levels of SIRT3 expression were relatively similar in the TGF-β-treated cells and the control group; however, Ac-MnSOD2 expression levels were elevated slightly in the TGF-β treated sample as compared to the control, suggesting reduced SIRT3 activities. Apigenin, a natural plant product and a SIRT3 activator, possesses the ability to reduce TGF-β-induced collagen and α-smooth muscle actin expression. TGF-β can induce mitochondrial complex III ROS generation, which promotes TGF-β mediated expression of fibrosis genes. Targeting mitochondria ROS production by activating SIRT3 may have clinical potential in fibrosis therapy.

Investigating Factors Involved In Nassau Grouper Spawning Aggregation Dynamics In The Bahamas

Presenter(s)
Jennifer Rosauer, Illinois Mathematics and Science Academy

Advisor(s)
Kristine Stump, Shedd Aquarium

In The Bahamas, Nassau Grouper, a top predator, are at a critical stage in their long term survival. Years of overfishing at spawning aggregations have caused an enormous decrease in their population, causing them to be listed as endangered and the Bahamas National Trust to enlist the help of biologists for research. The main focus of my research was to add temperature and light intensity readings to each tracking of a Nassau Grouper, so that the data could be graphically examined for significant trends. Each fish that was tagged had every one of its motions reviewed and graphed against depth, light, and temperature. The average temperature when the fish moving was 80.1373 degrees Fahrenheit. Light was not found to be a significant factor in the movements to or within aggregations. The depth of the Nassau Grouper in the water was found to be significantly higher during spawning hours than non-spawning hours. This pattern cannot be found in the graphs of individual fish, but the technology can pick up the pattern across all fish. These findings are important for implementing regulations on fishermen during the grouper's mating season that protect both Nassau Grouper and the fishermen.

The Relationship between Protein Centrality and Essentiality in *Saccharomyces cerevisiae*

Presenter(s)
Yugan Sakthi, Illinois Mathematics and Science Academy

Advisor(s)
Manyuan Long, University of Chicago
Wenyu Zhang, University of Chicago

With the recent shift in molecular biology to the study of proteins not as individual elements but as nodes in a larger network, the question arises of the impact of a central protein or gene in these networks. Previous studies have suggested that highly-connected proteins play a more important role in organism fitness. In this investigation, I examined the most highly connected proteins in the *Saccharomyces cerevisiae* protein network to determine these relationships. I used a variety of data analysis and mapping tools, such as Microsoft Excel, Python, and R, to filter through hundreds of thousands of protein-protein interactions, map these into genetic, physical, and combined networks, and analyze all of the nodes in these networks. The results showed that more essential proteins tend to be more highly connected within the interaction network; furthermore, they showed that older genes tended to have a higher chance of being essential, as well as being more central to the network. These results were especially clear in the physical protein interaction dataset, where a few genes such as YDR172W and YIL021W contained over 300 interactions. However, there were a few anomalies in the data, especially in the genetic network, which warrant more accurate testing in the future.

The Effects of Ethanol on the Behavioral and Developmental Aspects of *Drosophila melanogaster*

Presenter(s)
Gissel Salas, Illinois Mathematics and Science Academy
Kaitlyn Schmieder, Illinois Mathematics and Science Academy

Advisor(s)
Vandana Chinwalla, Illinois Mathematics and Science Academy

Prenatal exposure to ethanol has been known to cause irreversible neurobehavioral abnormalities, developmental delay, and hindrances in growth. Fetal alcohol syndrome (FAS) is known to be the primary cause of mental retardation in the United States. *Drosophila,* the fruit fly, show comparable signs of intoxication and behavioral stimulation to that of mammals and has been used as a model organism. Our study focused on various olfactory and instinctual tests including larvae learning training, adult T-maze testing, and negative geotaxis. These assays tested the memory and learning capabilities of larvae and adults that had been exposed to 5% ethanol compared to those of a control group. Although we did not collect data on the fertility of flies, we have observed reduced fertility in those flies raised on ethanol. Preliminary results indicate that the flies have learned with the t-maze and larvae training, but there is no significant difference between the test and control groups. As approximately one to three babies per one thousand births in the United States are affected by FAS, the need to understand the behavioral, learning and developmental effects of this disease is imperative.

Effect of Hormones on Breast Cancer Cell Line Enhancers

Presenter(s)
Whitney Sloneker, Illinois Mathematics and Science Academy

Advisor(s)
Michael Bolt, University of Chicago
Heather Scott, University of Chicago
Kevin White, University of Chicago

Breast cancer pervades society, so its cell lines are studied to find therapies. Hormones and enhancer regions play a central role in messenger ribonucleic acid (mRNA) levels of genes, so observing them can help develop new therapies. We use a luminal A breast cancer cell line model, MCF-7, to determine the effect of different hormones on gene expression. Hormone effect on gene expression within cell lines needed to be determined by Quantitative Polymerase Chain Reaction (qPCR), a process that determines the expression levels of ribonucleic acids of specific gene targets. Preliminary results suggest each MCF-7 ligand used (E2, Dexamethasone, GW0742, AM580, T3, and Rosiglitazone) showed hormone specific effects in gene expression. T3 and ROSI both primarily up-regulate their targets, while the remaining hormones are more of a mix of up and down regulated genes. However, future studies will have to confirm this using mRNA sequencing to determine the genome-wide transcription effects of these hormone. CapStarr-seq (self-transcribing active regulatory region sequencing) will be used to determine enhancers involved. By studying the interactions of hormones on MCF-7, we hope to further understand cell line interactions in breast cancer for greater therapeutic options in patients and understand this form of breast cancer better.

Role of N-cadherin Adhesion Mediated Signaling in Regulating Stability of VE-cadherin Adhesions and Permeability Endothelial Barrier Function

Presenter(s)
Mitchell Sun, Illinois Mathematics and Science Academy

Advisor(s)
Yulia Komarova, University of Illinois at Chicago
Kevin Kruse, University of Illinois at Chicago
Asrar Malik, University of Illinois at Chicago

The endothelial monolayer lining the vascular system maintains tissue-fluid homeostasis through selective permeability. This permeability is a result of inter-endothelial junctions such as adherens junctions (AJs), which provide a physical attachment of endothelial cells by extracellular Vascular-Endothelial (VE)-cadherin adhesion. Stability of AJs is regulated by anchorage of VE-cadherin complexes of associated alpha-, beta-, and p120-catenins to the actin cytoskeleton in the Rho GTPase-dependent manner. Neural (N)-cadherin form adhesion between endothelial and mural cells. Recent studies suggest that N-cadherin might also regulate endothelial barrier permeability. However, the complete mechanism of N-cadherin and VE-cadherin cross-interactions remains unknown. Data from the lab suggest that N-cadherin might control activity of RhoGTPases at AJs. Rho GTPases are molecular switches cycling between GTP- and GDP-bound states. This process is activated and inhibited by guanine-nucleotide exchange factors (GEFs) and GTPase-activating proteins. Trio is a RhoGEF consisting of two GEF domains. GEF1 activates Rac1 and RhoG while GEF2 activates RhoA. Trio needs Neuron Navigator (NAV)1 to activate Rac1. In this study, we investigated effect of NAV1 and N-cadherin signaling on recruitment of VE-cadherin to AJs. Our data show that both proteins are required for stabilization of VE-cadherin adhesion and restricting permeability.

The Protein Expression of CAV-1, COL1A2, and THBS2 proteins in the CaCo2 cell line.

Presenter(s)
Nitya Talasila, Illinois Mathematics and Science Academy

Advisor(s)
Joel Pekow, University of Chicago

Patients with Inflammatory Bowel Disease, which includes Crohn's disease and ulcerative colitis (UC), are at a significantly higher risk than the general population for development of colon cancer. In preliminary studies, we identified down regulation of microRNA (miRNA), 4728-3p, in non-dysplastic mucosa from UC patients harboring a neoplastic lesion. Bioinformatics analysis suggests that this miRNA regulates three proteins also increased in patients with neoplasia in UC, and are vital to the interaction between cells and the extracellular environment. This investigation was performed to view caveolin 1, collagen, and thrombospondin 2 protein expression in the colon cancer cell line CaCo2, which is a human colorectal adenocarcinoma cell line. Before transfecting miRNA in CaCo2 cells, we measured baseline expression of the three proteins. Since the miRNA is predicted to down-regulate the proteins, high baseline expression is needed to demonstrate a difference. After culturing the CaCo2 cell line and running Western blots, it was concluded that the COL1A2 and THBS2 proteins were expressed, although CAV1 had low expression. Therefore, in subsequent experiments, we will use CaCo2 cells to examine the impact of the miRNA on COL1A2 and THBS2, and an alternative cell line to study the effects of miR-4728-3p on CAV1 expression.

Expression of Focal Adhesion Proteins in Ulcerative Colitis Associated Neoplasia

Presenter(s)
Nitya Talasila, Illinois Mathematics and Science Academy

Advisor(s)
Joel Pekow, University of Chicago

Colorectal neoplasia is the abnormal growth of tissue in the colon, encompassing dysplasia as well as colorectal cancer cancer. Patients with inflammatory bowel disease have chronic inflammation in their colon. It is thought that the chronic inflammation places them at increased risk for colorectal neoplasia, whereby the colonic lining changes from at risk mucosa with chronic inflammation to dysplasia and ultimately cancer. In previous studies, several genes involved in focal adhesion were demonstrated to be increased in normal appearing colonic mucosa of patients who had colorectal neoplasia This experiment was performed to confirm the expression of focal adhesion proteins in inflammatory bowel disease (IBD) associated neoplasia. We evaluated proteins thrombospondin 2, caveolin 1, and collagen in IBD associated neoplasia by immunohistochemistry (IHC). Conditions for the IHC process, including antigen retrieval methodology and primary antibody dilution, were optimized in normal control tissues. We used different tissue samples such as Ulcerative Colitis (UC) cancer, Diverticulosis Control, Sporadic Cancer, and Active UC from patients to stain for all three focal adhesion proteins. These studies demonstrated that all three proteins were expressed on different levels in IBD associated neoplasia. Therefore, we will investigate mechanisms of up-regulation of these protein in chronic inflammation and cancer in later studies.

TIM4 detection in Hepatic Stellate Cells

Presenter(s)
Akshay Verma, Illinois Mathematics and Science Academy

Advisor(s)
Xiao Wang, Northwestern University

HSC (hepatic stellate cell) activation has emerged as a key player in liver injury and fibrosis development. However, the molecules and signal pathways involved in liver fibrosis are unclear. The aim of this study is to identify the molecule related to HSC phagocytosis and activation. TIM4 is a cell receptor used by activated T-cells and could potentially be a mediator for HSC phagocytosis. We determined TIM4 RNA expression by real-time PCR (polymerase chain reaction) and protein level by western blot, respectively. We found that both TIM4 RNA and protein are expressed at low levels, suggesting that TIM4 may not play a major role. It would be interesting to explore if inflammation or other stress can induce TIM4 expression in HSCs and if the increase in TIM4 can be attributed to HSC activation in liver diseases. Identifying such a biomarker would have potential for clinical use.

Mechanisms of Host Viral Interactions Leading to Loss of Oral Tolerance in Celiac Disease Patients

Presenter(s)
Bingtao Xiang, Illinois Mathematics and Science Academy

Advisor(s)
Romain Bouziat, University of Chicago
Reinhard Hinterleitner, University of Chicago
Bana Jabri, University of Chicago

Celiac disease is a complex autoimmune disorder induced by the ingestion of gluten that causes inflammation and mucosal damage in the small intestine due to a loss of tolerance to gluten. Past studies have suggested that virus infections play a role in the development of celiac disease. In this investigation, we aimed to study how infection by reovirus T1L affects the gene expression of IL-27 and IL-12, important for oral tolerance, in type-1 interferon knockout mice and interferon regulatory factor 1 (IRF1) knockout mice. Through real time polymerase chain reaction (qPCR) and flow cytometry (FACS staining), we gathered results showing that IRF1 KO mice had no significant increase in gene expression of IL-27 or IL-12 when infected by T1L, indicating that removal of the IRF1 gene can restore oral tolerance. Looking forward, we will continue studying the mechanisms that lead to oral tolerance by looking at other genes such as IL-12 and BATF3 expressed in certain dendritic cell subsets important to maintain oral tolerance.

The Effects of Different Compounds on PLCβ-1 Activity in HL-1 Cells

Presenter(s)
Andy Xu, Illinois Mathematics and Science Academy

Advisor(s)
Gary Aistrup, Northwestern University
William Marszalec, Northwestern University
J. Andrew Wasserstrom, Northwestern University

In hearts, the T-tubules allow calcium ions to enter the organ, which will then initiate a pathway that allows the heart to contract. Studies have shown that over time, T-tubules will lose their structure, leading to less efficient contraction and eventual heart failure. One protein that causes this is phospholipase Cβ-1 (PLCβ-1), which, when activated, cleaves and deactivates phosphatidylinositol 4,5-bisphosphate (PIP2), a protein that supports the stability of T-tubules. Eighteen different chemical compounds were previously determined to be able to theoretically prevent PLCβ-1 from binding to its receptor, protecting T-tubules from remodeling. Our investigation treated HL-1 cells, a type of tumor cell isolated from mouse hearts, with the compounds in order to see which ones were able to lower the activity of PLCβ-1.

Visualizing Bacterial Alarmone Induction and Antibiotic Survival in *Bacillius subtilis*.

Presenter(s)
David Ying, Illinois Mathematics and Science Academy

Advisor(s)
Kachun Danny Fung, University of Wisconsin at Madison
Jue (Jade) Wang, University of Wisconsin at Madison

Guanosine penta/tetraphosphate ((p)ppGpp) plays an influential role in the stress response exhibited by bacteria cells. Not only does it prevent the production of GTP, but it also helps to prevent cellular death. ppGpp induction is found under the presence of amino acid starvation and also inhibits GTP biosynthesis enzymes. Furthermore, there is a direct correlation between cell death and the dysregulation of GTP caused by a lack of ppGpp. The work of this study aimed to identify the effects of ppGpp induction on *Bacillus subtilis* under the stress of antibiotics such as vancomycin, trimethoprim, and carbenicillin. Killing curves were run to identify the effects of vancomycin on ppGpp induction. Single cell time-lapse microscopy analysis and mCherry reporters were used to identify cells that were spontaneously induced by ppGpp. Transposon sequencing was used to identify genes that were necessary in the induction of ppGpp. The results of this study found that spontaneous induction of ppGpp is common and that it does indeed hinder cell processes, including cell growth. In addition, the ppGpp is useful in preventing cell death and is a significant portion in the survival of *B. subtilis* through external stressors.

Identification of Hox Regulatory Domains for Appendage Diversity and Fin-to-Limb Transition (using Transgenic Zebrafish)

Presenter(s)
Mickinney Zhang, Illinois Mathematics and Science Academy

Advisor(s)
Tetsuya Nakamura, University of Chicago
Neil Shubin, University of Chicago

To reveal the molecular mechanisms of appendage diversity and the fin-to-limb transition, I am identifying the regulatory domain of Hox expression in skate fin development. Hox genes are essential to organismal development but the genetic loci responsible for Hox expressions shifts remain elusive. Potential enhancer sites in the skate genome were identified using Assay for Transposase-Accessible Chromatin (ATAC) sequencing, cloned into the Green Fluorescent Protein (GFP) reporter vector and then injected into single-cell eggs of wild type zebrafish. To determine whether these enhancers were successfully integrated into the zebrafish genome, we used a polymerase chain reaction (PCR) to identify the presence of the GFP gene. In those that the PCR deemed GFP positive, second generation transgenic egg cells were examined for GFP fluorescence concentrated in the fin region. So far, I identified one transgenic fish; it showed GFP fluorescence in the hindbrain region. But I have yet to find transgenic fish showing fluorescence in the pectoral fin. I continue to identify transgenic fish by PCR and confirm localization of the GFP signal. Identifying these enhancers is not only indispensable in the study of ancient evolutionary mechanisms but also for the regulation of organ structure in regenerative biology and study of congenital diseases.

Factors Affecting the Transformation of 76R Variety Rio-Grande Tomatoes to Induce Expression of HopZ3 Effector Protein

Presenter(s)
Vadini Agrawal, Illinois Mathematics and Science Academy

Advisor(s)
Joanna Jelenska, University of Chicago

In order to study the plant immune system for benefits in crop production, a protocol was developed to effectively transform the 76R variety Rio-Grande tomato to express the HopZ3 effector protein which is found in *Pseudomonas syringae*, a bacteria which is pathogenic to plants. Cotyledons from the 76R variety were infected with *Agrobacteria* to insert HopZ3 bacterial genes into plant cells, and these cotyledons were placed in media with a selection agent and hormones to induce callous growth, plantlet growth, shoot growth, and root growth until only transformed cells remain. In the most successful test thus far, cotyledons have successfully been transformed, but do not survive in the media used for more than 4-5 weeks, and different *Agrobacteria* strains and hormone concentrations are being tested. If successful, the tomato plant would express the HopZ3 protein which would be further studied for its role in immune system pathways in the tomato plant cell.

The Effect of Antibiotics on Gastrointestinal Motility and Gut Microbiota

Presenter(s)
Catherine Chen, Illinois Mathematics and Science Academy

Advisor(s)
Eugene Chang, University of Chicago
Ketrija Touw, University of Chicago

Antibiotics are widely used to treat infectious diseases caused by pathogenic bacteria in many disease states. While eliminating pathogens, antibiotics also affect gut commensal bacteria composition, leading to long-lasting gastrointestinal (GI) symptoms associated with GI motility problems. In this study, the mechanism by which the broad-spectrum antibiotic cefoperazone, gram-positive specific antibiotic vancomycin, and gram-negative specific antibiotic neomycin affect GI motility and gut microbial composition was examined. To assess alterations in the host after antibiotic treatment, whole gut transit time was measured by gavaging and tracing charcoal dye. Significantly delayed GI transit time in antibiotic-treated mice was observed, especially in the cefoperazone test group. Bacterial community structure in cecal contents was analyzed by 16S rRNA analysis. Results showed a significant decrease in Bacteroidetes and increase in Firmicutes in cefoperazone-treated and neomycin-treated mice. There was also a significant increase in Proteobacteria in vancomycin-treated mice. Using gas chromatography–mass spectrometry, short chain fatty acids levels were measured to be lower in antibiotic-treated mice. Overall, these results suggest that antibiotic use leads to delayed GI transit time possibly due to alterations in microbial community and metabolic profile. These findings could be beneficial for alleviating symptoms with antibiotic usage.

Business

Using Demographical Information to Predict Work Performance Among Shiftgig, Inc. Employees: A Case Study of Temporary On-Demand Staffing

Presenter(s)
Jiabao Li, Illinois Mathematics and Science Academy

Advisor(s)
Jade Martin, Shift Gig Inc

Shiftgig, Inc., a technology company founded in 2012, has created a mobile platform to remedy the high turnover experienced in the service industry by acquiring a workforce that is deployable at moment's notice. The platform acts as a medium between the workforce and the employer. The greatest challenge Shiftgig experiences is achieving a balance between these two users. This case study addressed this issue by breaking it into two parts: quantifying market demand and the availability of the targeted supply. Prior to this study, a survey was conducted to understand the varying interests among Shiftgig's demographical workforce. This study used the survey results to understand how Shiftgig can estimate the size of the workforce needed to optimize the shift fill rate. The survey suggests that there are significant differences in job preferences among genders and age groups. Preliminary data also shows that Shiftgig would need to spend approximately $1.38 million to recruit a workforce capable of generating the revenue necessary to meet its 2016 goals. An outcome of this investigation is the potential to create forecasting models which could show the anticipated workforce population for 2016 by using data from 2015.

Could Helpful Short-Term Rental Platforms be Negatively Affecting the Housing Market?

Presenter(s)
Julian Litvak, Illinois Mathematics and Science Academy

Advisor(s)
Liad Wagman, Illinois Institute of Technology

Short term rental platforms such as Airbnb provide cost efficient rooms for tourists. However, it also can cause housing prices to fluctuate, making it hard for some areas to retain local residents. In order to evaluate Airbnb's effect on the housing market, we collected data from different towns on Anna Maria Island, Florida. The three towns we evaluated were: Anna Maria, Holmes Beach and Bradenton Beach. Anna Maria and Bradenton Beach had zoning laws that allowed residents to use Airbnb, while Holmes Beach prohibited its use. We recorded the data we found on the average price of houses using the houses parcel ID in Excel and then evaluated in Stata. By comparing the most recent average price of houses and the second most recent average price of houses in the two areas, we could judge the net increase of prices in those areas. The city of Anna Maria, which allowed Airbnb, had nearly double the net increase in home prices than Holmes Beach, which did not allow Airbnb, supporting the hypothesis that Airbnb raises housing prices.

Using Big Data Analytics to Determine the Most Significant Attributes That Affect the Chances of Getting a Loan Approved

Presenter(s)
Jonathan Liu, Illinois Mathematics and Science Academy

Advisor(s)
Charles Downing, Northern Illinois University

Hundreds of loan applications are being submitted in every state. Massachusetts is no exception. The purpose of this investigation is to find out what are the main attributes that increase or decrease the chance of a particular loan application to get approved in Massachusetts. After getting access to all of the loan data available in that state in 2010, courtesy to EMC Corporation, a logistic regression was ran on that dataset. Not surprisingly, it was found that having a higher annual income and median family income and asking for a lower loan amount both significantly increased one’s chance of getting a particular loan approved. It was also found that having the lender in the first lien position provided a much higher chance of approval than having the lender be in the subordinate lien position. The type and purpose of a particular loan requested also played a crucial role in the probability of one getting a loan approved. Lastly, race was found to play a minor, but significant role as it was also discovered that African Americans, Hispanics/Latinos, Asians, Hawaiians/ Pacific Islanders, Alaskan Natives/American Indians all had slightly lower chances of approval than Whites had.

A Case Study: Calculation of Total Addressable Market and Client-Side Economic Advantage of an On-Demand, Temporary Staffing Agency's (Shiftgig) Food Service Sector

Presenter(s)
Braden Saltus, Illinois Mathematics and Science Academy

Advisor(s)
Jade Martin, Shift Gig Inc

Total addressable market refers to the percentage of a demographical population that could benefit from services offered by an entity. For the purpose of this study, total addressable market refers to the food service part-time worker demographic within cities which Shiftgig services. Economic advantage refers to the added value provided to the consumer resulting from using one service provider rather than another. This study aims to quantify these metrics conveniently and understandably. Total available/addressable market was calculated by dividing total hours worked (by Shiftgig-staffed workers) by total hours worked by the demographic. Economic advantage was calculated by taking all expenses of hiring a part-time worker and his or her hourly costs of employment (FUTA, etc.) compared to the costs of ordering a part-time worker through Shiftgig and hourly billing costs of this service. Results of total addressable market shows a current market occupancy of 0.11%. Results of economic advantage show the average breakeven point of economic advantage being 22 hours (hiring and ordering a worker for a 22 hour period has equal economic viability). Total market occupancy tracking enables the potential of new branches of a company to be approximated. Additionally, economic advantage analysis enables new consideration in revenue maximization.

Chemistry

Synthesis of Organic Conducting Dendrimers

Presenter(s)
Jake Bail, Illinois Mathematics and Science Academy
Tavis Reed, Illinois Mathematics and Science Academy
Patrick Swearingen, Illinois Mathematics and Science Academy

Advisor(s)
John Thurmond, Illinois Mathematics and Science Academy

The creation of plastics revolutionized how we built materials, allowing them to be easily created for a low cost, and have a wide variety of forms and structural properties. Likewise, the successful creation of an organic conducting material would revolutionize the electronics industry. Dendrimers are complex polymers that take multiple synthetic steps to create, however, they allow for greater control of their conductive and other structural properties. Dendrimers possess 3D structure, making them of interest for the creation of an organic conducting material. This experiment explored the synthesis of organic conducting dendrimers by seeking to improve upon a previously characterized structure. The structure contains a 1,3,5-triazine center with p-phenylenediamine attached. Attached to the p-phenylenediamine are anilines, attached through a nitrogen- nitrogen double bond. To explore this synthesis process, the previously created dendrimers were synthesized, and aspects of the synthesis were changed to create novel divergent dendrimers. These aspects include changing the functional groups and bond locations. The properties and the conductivity of the material was not yet tested, however four generations of the dendrimer, as well as a divergent generation were accurately synthesized. Based on these results, further research on this method of synthesizing an organic conducting dendrimer must be explored.

Optimal concentrations of Ethanol and Isopropanol for the dissolution of PMMA

Presenter(s)
Maya Costales, Illinois Mathematics and Science Academy

Advisor(s)
Leonidas Ocola, Argonne National Laboratory

Last year we studied the effectiveness of Alcohol/Water mixtures in dissolving PMMA. PMMA is a commonly used resist in electron beam lithography. Ethanol/Water mixtures in a 4:1 volume ratio developed PMMA such that they could replace mixtures of Methyl(isobutylketone) and Isopropanol. Raman spectroscopy revealed that Ethanol/Water mixtures in a 4:1 ratio and IPA/Water mixtures in a 3:1 ratio have different vibrations than those of pure Ethanol, IPA, and water. Our study this year will discuss the characteristics of Ethanol/Water and Isopropanol/Water solutions with dissolved Poly(methylmethracrylate). A fixed amount of 12,000 molecular weight PMMA was dissolved into a series of these Alcohol/Water mixtures and analyzed under a Raman spectroscope. The vibrations of PMMA molecule and alcohol and water molecule interactions can be observed through the Raman spectroscope. IPA/Water mixtures with PMMA have significant fluorescence not observed in Ethanol/Water mixtures with PMMA. Thermogravimetric analysis was used to determine if the interactions between the alcohols, water, and PMMA affected the rate at which mass was lost. Thermogravimetric analysis measures the weight of a sample as organics are decomposed with increasing temperatures.

Surface Functionalization of Polydimethylsiloxane Using Titanium Oxide Atomic Layer Deposition

Presenter(s)
Ashu Gupta, Illinois Mathematics and Science Academy

Advisor(s)
Arghya Bishal, University of Illinois at Chicago
Christos Takoudis, University of Illinois at Chicago

Polymers have potential in the medical field to be used for microfluidic devices and composite implant materials for tissue engineering. However, using polymers in the medical field has drawbacks; microbes can grow wherever there is moisture, heat and food, causing bacterial infection or biofilm formation. We hypothesized that the functionality of polymers could be increased by coating polymer with an antibacterial titanium oxide layer through Atomic Layer Deposition (ALD), which deposits thin films layer-by- layer onto a substrate and offers precise control over thickness. The water contact angles of samples of Polydimethylsiloxane (PDMS) were measured using a contact angle goniometer. The samples were pre- treated with oxygen plasma treatment at 60 seconds, and then coated with TiO_2 at 60°C using ALD. Preliminary results suggest that samples pre-treated with oxygen plasma and coated with TiO_2 showed significantly lower levels of hydrophobicity. Microorganism adhesion tests were performed using *Escherichia coli* bacteria in order to determine the antibacterial levels of the samples. We concluded that samples pre-treated with oxygen plasma and coated with TiO_2 were able to eliminate a greater amount of *E. coli* bacteria compared to untreated samples.

Modifying Clay-Based Germicidal Filters to Remove Harmful Metal Ions from Water

Presenter(s)
Ethan Heidrich, Illinois Mathematics and Science Academy

Advisor(s)
Mark Carlson, Illinois Mathematics and Science Academy

Clay filters treated with silver nanoparticles have shown strong germicidal activity. However, other toxins in water include heavy metal ions from agricultural runoff. This investigation deals with possible amendments to the clay filter, allowing it to not only kill bacteria but also remove heavy metal ions from water. Copper, a common heavy metal in fungicides, was used in this investigation. Absorbance was measured in the visible range for three different copper solutions (CuSO4, CuCl2 and Cu(NO3)2). The solutions were funneled through three different mineral compounds (activated carbon, bentonite and zeolite) that have shown promise in previous studies. The absorbance data were used to determine the reduction in concentration. Various amounts of these compounds were used. Activated carbon and bentonite did not lower copper levels. Zeolite significantly reduced the concentration (26% less absorbance) of Cu(NO3)2 consistently, but its effect on the others remains unclear. Further testing is ongoing to confirm and extend the zeolite results. One extension includes baking zeolite into the clay filter. Zeolite is the most promising of the tested compounds so far, but further testing is needed to ensure that its effect is a result of the copper and not the nitrate counter ion.

An Exploratory Synthesis of a Chemical Group Common to Several Novel Biflavonoid Molecules

Presenter(s)
Joseph Jagusah, Illinois Mathematics and Science Academy

Advisor(s)
John Thurmond, Illinois Mathematics and Science Academy

In 2014, a biochemical assay of the Kenyan plant Ochna Holtzii Gilg led to the discovery of eight new molecules containing a flavonoid group. In this investigation, we are synthesizing a group containing a bicyclic ring, which was common to the compounds isolated in the 2014 assay. We intend to study the anti-microbial activity of the group compared to structurally similar molecules, to study the usefulness of this chemical in a targeted in vivo role. In this investigation, we attempted two synthesis routes for flavonoid-like compounds. In the first route, we attempted a synthesis based on acid cyclization, and in the second, we used various aldehydes and an acetophenone to synthesize the three-ring flavonoid base group, using several reactions to demonstrate the versatility of our process. In the first synthesis route, chromatography techniques were used extensively in the purification of intermediate products. Additional analogs were synthesized via a second synthetic sequence. Findings regarding the second synthesis route will be presented at IMSAloquium.

Synthesizing Conjugated Polymers that can Better Detect Nitroaromatic Compounds

Presenter(s)
Theodora Khan, Illinois Mathematics and Science Academy
Corona Tsai, Illinois Mathematics and Science Academy

Advisor(s)
John Thurmond, Illinois Mathematics and Science Academy

Conjugated polymers are organic macromolecules containing alternating double and single bonds. In recent years, conjugated polymers have attracted considerable attention as chemosensory devices to detect nitroaromatic compounds, that are found in explosives. The goal of our research is to synthesize a conjugated polymer that will detect nitroaromatic compounds and improve the efficiency in the polymer's detection abilities. We began by synthesizing 9,10-adduct anthracene derivative that will be coupled with 1,4-diethynyl-2,5- didodecyloxybenzene to form our conjugated target polymer. Synthesizing new conjugated polymers that better detects these nitroaromatic compounds can improve the efficiency of explosives detection.

Variations on the Phenyl Groups of Bis-4-(N-carbazolyl)phenylphosphine Oxide for Host Layer of Blue Organic Light-Emitting Diodes

Presenter(s)
Kyle Anthony Leano, Illinois Mathematics and Science Academy

Advisor(s)
John Thurmond, Illinois Mathematics and Science Academy

Organic Light-Emitting Diodes (OLEDs) are more efficient versions of the common Light-Emitting Diodes (LEDs), but are difficult to mass produce. Another problem with OLEDs is that blue OLEDs are not as efficient as other colors, making them unreliable. One way to combat this issue is through the use of host layers in these devices to increase the efficiency of the transfer of electron to electron holes. Finding such a host layer for blue OLEDs would cause more consistency, reliability, and efficiency in blue OLEDs, making OLEDs in general more accessible and usable for commercial and industrial purposes. We synthesized the base structure of the host layer using a vacuum to control pressure and purified between steps using column chromatography, nitrogen flushing, and gravity filtration. Once the base layer was synthesized, naphthalene, phenanthrene, and 3,5- diphenylbenzoic acid were added as new groups to replace the phenyl in the original bis-4-(N-carbazolyl)phenylphosphine oxide. These host layers will be tested against one another for efficiency. As of yet, no testing of efficiency has been conducted. Results will be presented at IMSALoquium.

Determination of Estrogen Metabolites by HPLC-ECD at Boron-Doped Diamond and Nitrogen-Incorporated Tetrahedral Amorphous Carbon Thin Film Electrodes

Presenter(s)
Joy Qiu, Illinois Mathematics and Science Academy

Advisor(s)
Greg Swain, Michigan State University

The detection of pharmaceutical compounds, pollutants, and biological molecules plays a critical role in industrial analysis and water quality regulation. In particular, the effective determination of estrogen metabolites, a class of endocrine- disrupting compounds and potential urinary predictors of breast cancer, has great medical and environmental significance. High performance liquid chromatography with electrochemical detection (HPLC-ECD), a method which utilizes the relative polarities and electrochemical properties of the desired compounds, has before been employed for this purpose. In this study, we comparatively evaluated boron-doped diamond (BDD) and nitrogen-incorporated tetrahedral amorphous carbon (ta-C:N) thin film electrodes, two novel materials which exhibit higher stability and versatility in comparison to other commonly used carbon materials, for use in the electrochemical detection of estriol, estradiol, and estrone. From a series of experiments, various figures of merit (quantitative indicators of performance, stability, utility, etc.) were determined for each electrode. In particular, the background and noise currents, optimum detection potential, short-term response variability, linear dynamic range, and detection limits for estriol, estradiol, and estrone at BDD and ta-C:N electrodes were calculated. Results indicate that ta-C:N, a more cost-efficient material, is equally as effective as BDD for the determination of the estrogen metabolites by HPLC-ECD.

A Comparison of Two Blood Collection Methods for Monitoring Immunosuppressant Drugs in Transplant Patients

Presenter(s)
Lily Anne TranCat, Illinois Mathematics and Science Academy

Advisor(s)
Shannon Haymond, Ann & Robert H. Lurie Children’s Hospital of Chicago
Faye Vicente, Ann & Robert H. Lurie Children’s Hospital of Chicago

After surgery, transplant patients are required to take immunosuppressant drugs for the rest of their lives. Too much or too little of these drugs impact their health. Therefore, drug concentrations are routinely monitored in their blood collected by the standard venipuncture method. This study compares and contrasts venipuncture to a minimally invasive, microsampling collection method, namely the Mitra device. Adult transplant patient blood was collected using both approaches, prepared and analyzed for immunosuppressant drug concentrations using a liquid-chromatography mass spectrometry based testing method. Although using the Mitra device has positive outcomes including smaller sample size and ease of patient use, preliminary results suggest that using the device will be much more costly and time consuming to process in the laboratory than the current clinical method. Some reasons for this include using fresh blood while performing more steps with the Mitra. Also, the lab workflow is currently designed around the use of vacutainer tubes, so this device will not be consistent with the other tests run in the lab. With this information, the current blood collection method for immunosuppressant drug monitoring may be kept for some time until a new alternative comes along.

Computer Science

User Defined Motion Counting

Presenter(s)
Michael Dow, Illinois Mathematics and Science Academy
Samuel Zelman, Illinois Mathematics and Science Academy

Advisor(s)
Mark Albert, Loyola University

Already there is a large consumer market on devices that track steps and other standard measures. However, there are many more movements that can be quantified by wearable devices. This can be particularly useful to motivate a physical therapy patient's compliance. This system was designed to be flexible enough to handle multiple movements of exercise. Wearable devices with accelerometers were attached to a participant's body to track repetitions during exercise. Eighteen participants completed a series of 10 exercises (arm circles, bicep curls, bridges, crunches, elbow extensions, leg lifts, lunges, push ups, squats, and upper trunk rotations), twice each, for 30 seconds. Three analysis techniques were used to count the repetitions: threshold crossing, threshold crossing with a low-pass filter, and a Fourier transform with a low-pass filter. Preliminary results indicate that some exercises like arm circles and pushups are tracked well by most analysis methods, while less periodic, irregular motions like upper trunk rotations, are more difficult to track. The methods that used low-pass filtering performed reasonably well. This indicates that our system is capable of tracking a large number of activities, even ones for which it was not originally designed.

Neural Networks and Machine Learning Applied to Classification of Cancer

Presenter(s)
Sachin Govind, Illinois Mathematics and Science Academy

Advisor(s)
Namrata Pandya, Illinois Mathematics and Science Academy

Using genome data to predict cancer type is an increasingly relevant practice as it provides a direct, non-invasive strategy to analyze genetic predisposition to malignant cancer types. More specifically, analysis of gene expression data across the genome can provide insight into the underlying gene interactions that propel the progression of tumors. A database containing expression levels for 16,063 genes was split into disjoint training and testing sets; these were subjected to a variety of machine learning methods and statistical analyses, including multinomial logistic regression across cancer phenotypes, k-means clustering analysis, optimization of a predictive support vector machine, and rooted random forest sampling with hidden neural networks. A predictive network was created via these models and was applied to the testing dataset. Primary results indicate a surprising ability of these algorithms to accurately classify cancers. Accuracy of these methods ranged as high as 98.8% with sparse misclassification. Furthermore, an analysis was conducted to determine the genes with the most potential to indicate tumor location as well as the corresponding probabilities for tumorigenic mutations. The results of this investigation demonstrate that machine learning algorithms with random sampling of genes can serve as extraordinarily accurate methods to classify and predict resultant cancers.

Creating an Immersive Virtual Reality Representation of the Illinois Mathematics and Science Academy for use in the Oculus Rift, a Virtual Reality Head Mounted Display

Presenter(s)
Addison Herr, Illinois Mathematics and Science Academy

Advisor(s)
Britta McKenna, Illinois Mathematics and Science Academy

Previous studies have indicated the potential of head-mounted displays such as the Oculus Rift for use as education tools, due to increased immersion and perception of realism within virtual settings compared to standard digital displays such as computer monitors and TVs. 3-dimensional models of architecturally significant areas in the Academy building were modeled using Blender and Google Sketchup, two architectural visualization programs. These areas were programmed into a cohesive walking tour of the building with the development engines Unity and Unreal Engine. A software development kit (SDK) for the second iteration of the developer-only Oculus Rift was used to incorporate head positional tracking, head rotation, and 3-dimensional graphics. We plan on utilizing this demo for outreach purposes by taking the software and the Oculus Rift to under-resourced schools and libraries for students who are unable to visit the Academy in person. We will simultaneously display IMSA to prospective students through an immersive, cutting-edge medium, as well as show some of the technological opportunities available at the Academy such as Virtual Reality. The utility of this program will be assessed with a short survey that users will fill out immediately after the conclusion of their experience within the VR IMSA demo.

Improving Wearable Activity Sensors using Hidden Markov Models for Outpatient Physical-Therapy Applications

Presenter(s)
Cameron Hudgins, Illinois Mathematics and Science Academy
Mark Rogers, Illinois Mathematics and Science Academy

Advisor(s)
Mark Albert, Loyola University
Jessie Pichleap, Loyola University

The purpose of this investigation is to improve the accuracy of the software used in recognizing patient activities in physical therapy in order to allow for the collection of objective and continuous activity data in a manner which is convenient for the subject. Patients' activities are traditionally predicted simply using static classifiers such as Support Vector Machines (SVMs). Studies have shown the static classifiers are prone to mistakes which an additional model can correct, a Hidden Markov Model (HMM). In our experiments, the accuracy of the activity recognition software was determined using data containing patient's movements-such as walking, running, sitting, etc. Our results have confirmed this hypothesis, with an increase to 86% accuracy with the HMM vs. 84% accuracy without. Due to the success of the model, doctors will be able to access unbiased and continuous data regarding how patients go about their prescribed activities without having to meet with them regularly or rely on inaccurate patient reports. By using HMMs to correct mistakes made by static classifiers analyzing activity recognition data doctors will have more accurate profiles of patients' activities as well as the patient's reactions to treatments while increasing their comfort and freedom.

Testing and Optimizing Trading Speed Using Lower-Level Embedding on Time Series Analysis Functions

Presenter(s)
Joseph Hutter, Illinois Mathematics and Science Academy

Advisor(s)
Maxwell Rhee, TransMarket Group

Lower-level languages perform computations much faster than higher- level languages, because they use code closer to machine code, whereas the latter abstracts away that convoluted code for read- and write-ability. Novice programmers with small data can take this for granted, but trading firms that analyze huge amounts and know that speed is money can not. The goal of this project is to evaluate the run-time reduction effect of C embedding on Python and R. To do this, four computationally heavy time series manipulation functions were chosen to implement in R and Python, both pure and embedded. After writing and running the code that implements the functions, C embedding significantly improved computational speed in both languages in different ratios, dependent on the algorithmic complexity of the code. This supports the traditional implementation by trading firms of lower-level embedding and compromise of readability for speed, even as all language speeds improve with regular updates.

Artificial Intelligence: Prospects, Pathways, Realities

Presenter(s)
Timur Javid, Illinois Mathematics and Science Academy
Tara Parkman, Illinois Mathematics and Science Academy
Nathaniel Smith, Illinois Mathematics and Science Academy

Advisor(s)
Mike Ososky, Applied Computer Technology

The specter of Artificial Intelligence (AI) looms before us, continuously growing in power, soon to match, and then exceed human capabilities. To explore this, we read and discussed books by experts, and learned about the exponential nature of technological progress and the difficulties of halting or even slowing it. Technological improvements trend towards an autonomous AI capable of replicating, if not exceeding human thought and interaction, a complex adaptive system with an input stream, isomorphic model of reality and output mechanism, fully capable of passing the Turing Test. How a system is organized is a key determinant of the processes it can perform, so achieving processes such as intelligence and self- awareness requires suitably organized systems in proper environments, one such system being the brain currently reading this. AI will use advances in evolutionary algorithms, recursion, machine learning and self-organizing computational networks to develop the complex organization necessary for advanced cognitive functioning. These systems are evolving, and it is up to us to learn as much as we can about them.

Optimizing Femtocell Bandwidth Allocation for Cellular Service Providers

Presenter(s)
Alcaeus Lam, Illinois Mathematics and Science Academy

Advisor(s)
Randall Berry, Northwestern University

Femtocells, a type of small cellular tower, are becoming more commonly used by wireless service providers for their benefits over the traditional macrocells such as better data rates and indoor coverage. However, due to the limited range of femtocells, service providers must accommodate for users of both types of towers, resulting in a need for optimized bandwidth allocation. In order to study this optimization, a computer software package called Octave is used to model the bandwidth for femtocells and macrocells. The model takes into consideration various parameters such as a user's data rate and the provider's revenue to determine the ideal allocation. After completing a base model, an initial run was verified with another scientific journal to ensure its accuracy by testing a predetermined set of parameters. From this preliminary model, certain parameters including the utility a user receives from a given amount of data and total bandwidth were altered to further investigate certain conditions. Through testing these parameters, patterns were identified of how each parameter effects a service provider's allocation. These findings will be presented at IMSAloquium. Overall, these results will help define the optimal bandwidth allocation between femtocells and macrocells for cellular service providers.

The Impact of Experts and Error in Observation on Informational Cascades

Presenter(s)
Rohit Mittapalli, Illinois Mathematics and Science Academy

Advisor(s)
Randall Berry, Northwestern University

Models are often used to analyze observational learning. Many of which study a decision making process in which Bayesian agents make binary decisions based upon observations of previous agents. These observations may mislead an agent from their initial decision causing what is known as an Informational Cascade. Formally, an Information Cascade refers to a time in which every subsequent agent relinquishes their own private information and follows the previous agents. The model discussed in this investigation explores the effect of a more educated population, called experts, and error in an agent's observation, defined as noise. Specifically, our main focus was studying the probability that agent's would cascade correctly. The investigation showed a non-monotonic relationship between the probability of a correct cascade and noise. This relationship was also characterized by spikes, later explained throughout the investigation. The relationship between expert concentration and the probability of a correct cascade also showed a non-monotonic relationship. Overall, we presented a new model studying informational cascades with respect to noise and expert concentration. With this, we disproved the notion that a lower noise and higher expert concentration increases the probability of a correct cascade.

MARTHA Speaks: Implementing Theory of Mind for More Intuitive Communicative Acts

Presenter(s)
George Moe, Illinois Mathematics and Science Academy

Advisor(s)
Piotr Gmytrasiewicz, University of Illinois at Chicago

The theory of mind is an important human capability that allows us to understand and predict the goals, intents, and beliefs of other individuals. We present an approach to designing intelligent communicative agents based on modeling theories of mind. This can be tricky because other agents may also have their own theories of mind of the first agent, meaning that these mental models are naturally nested in layers. So, to look for intuitive communicative acts, we recursively apply a planning algorithm in each of these nested layers, looking for possible plans of action as well as their hypothetical consequences, which include the reactions of other agents; we propose that truly intelligent communicative acts are the ones which produce a state of maximum decision theoretic utility according to the entire theory of mind. We implement these ideas using Java and OpenCyc in an attempt to create an assistive AI we call MARTHA. We demonstrate MARTHA's capabilities with two motivating examples: helping the user buy a sandwich and helping the user search for an activity. We see that, in addition to being a personal assistant, MARTHA can be extended to other assistive fields, such as finance, research, and government.

Risk Maximization of Metal Futures through the Usage of Derivative Strategies

Presenter(s)
Anmol Nigam, Illinois Mathematics and Science Academy

Advisor(s)
Marc De Muart, TransMarket Group LLC
Adrian Jaronczyk, TransMarket Group, LLC

When using financial instruments, traders look for the best possible methods for maximizing the risk they undertake. Many different strategies have been developed to accomplish this goal. This project focuses on a single strategy, the calendar spread, analyzing which types of calendar spreads maximize risk and reward for over 500 contracts on a three year period. Financial tools such as Bloomberg Terminal and Transmarket Group's Modeling Tools were used to model each of these strategies and implementation was done with Visual Basic for Applications, in conjunction with Python and Microsoft Excel. After modeling the different types of calendar spreads for 6 different metals, a best model was determined that matched the performance of the market itself best, looking at the volatility and rate of return as these are the primary factors that determine the viability of a trading strategy. Further back-testing of the model over a different time horizon may change this conclusion, as a different market environment will yield different results. In conclusion, there is no real best type of spread, but certain types of spreads are more suitable for certain investors.

Analysis of the Accuracy of Color Filter Arrays by Color Sets and Arrangement in Digital Images

Presenter(s)
Abigail Paul, Illinois Mathematics and Science Academy

Advisor(s)
Phadmakar Patankar, Illinois Mathematics and Science Academy

Photography has largely gone digital, and these images are developing to become more realistic reflections of their subjects. By analyzing the digitizing process of creating colored images from the color filter array layered image sensor, the most accurate method of extrapolating color can be examined. By coding arrays to mimic the information collected from an image sensor with a color filter array, and testing the accuracy of images by comparing percent change in pixel value, the accuracy of each array was tested. Results show that color filter arrays that sample red, green, and blue are more accurate in lower light settings with the average color value of the picture to be below 127.5 while color filter arrays that sample cyan, yellow, and magenta are more accurate above. Furthermore the arrangement pattern of the color filter array determines the accuracy of a photo, with the more accurate arrangement a rigid pattern that alternates colors. These make digital photos faithful to their real life subjects.

Comparing Efficiency of the Minimax Algorithm to Alternatives

Presenter(s)
Samuel Rousser, Illinois Mathematics and Science Academy
Andriy Sheptunov, Illinois Mathematics and Science Academy

Advisor(s)
Phadmakar Patankar, Illinois Mathematics and Science Academy

Digital technology has become increasingly important in our lives. While many programs have a set capability, we have begun using machines that learn using adaptive algorithms, allowing computers to imitate the flexibility of the human brain, reacting quicker and more effectively. This investigation could provide rationale for alternatives to brute force algorithms. We started by coding a connect four game in Java, implementing a brute force algorithm called Minimax, and developed a version that used limited resources as a foundation for our AI (artificial intelligence). Our data analysis compares the win-loss ratio of the AI to the hypothetical perfect record of Minimax. Preliminary testing suggests that Minimax is far less efficient than AI alternatives; Minimax was unable to calculate a single move in fourteen hours, while the AI takes significantly less time. One of our alternatives to brute force is an algorithm that uses large quantities of random sampling to determine the most effective turn, rather than simulating all possible combinations; This algorithm is slower than one that makes random moves, but more effective. The improved performance demonstrated by our AI could show alternatives to brute force algorithms in real world applications, trading calculation time and effectiveness for increased efficiency.

MARTHA Speaks: Implementing Artificial Intelligence and the Theory of Mind for Intuitive and Inferential Communicative Acts Involving Deeply Nested Layers of Rationality

Presenter(s)
Pranav Upadhyayula, Illinois Mathematics and Science Academy

Advisor(s)
Piotr Gmytrasiewicz, University of Illinois at Chicago

The theory of mind is, perhaps, one of the most important psychological constructs in humans today, as it allows us to record, understand, and predict the desires, intentions, beliefs, and goals, of other individuals or agents. The purpose of this project was to implement an assistive agent that we call MARTHA, or the Mental-state Aware Real-time Thinking Assistant, in order to simulate various deeply nested layers of user and self-induced thought. This assistive Artificial Intelligence agent is able to process a combination of social norms/implications and user motivations in order to provide the user with an optimal course of action. The action with the greatest utility is the one that is selected. In order to determine the most intuitive communicative acts, I implemented a recursive searching algorithm for each nested layer of thought that determined all possible plans of action and their hypothetical consequences. The general scenario involved the interaction between two cars or people. I implemented four practical applications of this scenario, and the most useful response was provided by MARTHA 100% of the time. These results are a positive indication of the wide range of pragmatic situations in which MARTHA could be extremely useful.

ChiQat-Tutor: A Natural Language Processing Component That Uses Artificial Intelligence to Interpret and Answer Student Queries

Presenter(s)
Sushil Upadhyayula, Illinois Mathematics and Science Academy

Advisor(s)
Barbara Di Eugenio, University of Illinois at Chicago

Intelligent Tutoring Systems are computer systems that are designed to provide users with customized or immediate instruction without the use of a human teacher. An example of this is ChiQat-Tutor, which is a system designed to teach students basic Computer Science concepts. The purpose of this research was to develop and evaluate a component of ChiQat-Tutor that interprets and answers students' questions regarding the concepts that the system teaches. My component uses Artificial Intelligence software that analyzes a user's query and code to generate an appropriate and accurate response. In order to create this component, I first analyzed data from student-tutor dialogues that had been collected earlier to understand the types of questions students ask when learning Computer Science. I then created a keyword-based system, programmed in Java that interprets and answers students' queries by analyzing their code and query in order to select and return the best possible response to their question. After creating this component, I conducted an evaluation of it. Per the results, 79.2% of the time, the question-answering component of ChiQat answered the user's question in an appropriate and accurate manner. Thus, I can conclude that using a keyword-based, Artificially Intelligent question-answering system can provide both apt and precise responses to student inquiries, moving Intelligent Tutoring Systems one step closer to simulating a live student-to-tutor experience.

Using the Monte Carlo Localization Algorithm to Allow for Effective Indoor Navigation

Presenter(s)
Melissa Wen, Illinois Mathematics and Science Academy

Advisor(s)
Phadmakar Patankar, Illinois Mathematics and Science Academy

The Global Positioning System (GPS)is the most widely used navigation system to help travelers get from one place to another. However, because the system requires satellite signals to obtain an object's location and subsequently give it direction, it doesn't work well for indoor navigation. In this investigation, the goal was to create a way to localize an object indoors and allow it to navigate through an indoor setting with the same ease as using a GPS outdoors. Using Java, we constructed a system that would localize a robot through the Monte Carlo Localization algorithm and navigate to another location using a map of the indoor area. Preliminary results suggest that indoor navigation using the algorithm is plausible but that the effectiveness of navigation may be hindered by some issues regarding external forces, calibration, and timeliness in getting to its destination. These issues are currently being looked into. Though this navigation system is not yet effective, this investigation has shown that this sort of system is plausible and can have huge implications regarding helping those disabled navigate indoors more easily and allowing navigation and localization through building with complex interiors to be a little bit easier.

Designing a Website for Off the Shelf Data Acquisition Systems to Improve Their Accessibility

Presenter(s)
Brian Yu, Illinois Mathematics and Science Academy

Advisor(s)
Ryan Rivera, Fermi National Accelerator Laboratory
Lorenzo Uplegger, Fermi National Accelerator Laboratory

Many present day research facilities use data acquisition systems to collect data for experiments. However, data acquisition systems are difficult to find and get outdated frequently, resulting into high expenses. Our objective is to design a website for these systems to make them more readily available to the public. We used many different programming languages including HTML, CSS, JavaScript, and PHP to design the website. It allows the consumer to find many different components of the systems, such as the amount of memory or type of memory needed, and also specifics about the price. Our website is still in progress. We added a library for the website to view the systems and added a section where a person can request their device's specific needs. I'm also currently adding a model viewer so consumers can see how the object works by the use of squares that are generated, demonstrating how the data acquisition systems work. As a result, while we haven't finished coding the website to work perfectly, we created a website that functions for our set task, to develop a way to make Data Acquisition Systems more readily available for everyone.

Image Recognition and Tracking for Use in Augmented Reality Applications

Presenter(s)
Sean Ngo, Illinois Mathematics and Science Academy

Advisor(s)
Benjamin Carls, Fermi National Accelerator Laboratory

Image recognition software attempts to identify similar or identical images by searching for and matching visual features of two sampled images. However, one issue when it comes to image processing is accounting for inconsistencies in viewing conditions. This investigation explored varying factors that could impact the effectiveness of the image recognition and tracking software, Vuforia, in the game engine Unity. The performance and reliability of detection and tracking of Different image targets for Vuforia were tested. Images that were rich in detail with complex features provided better tracking and detection than simpler images. Complex images can include images of the Chicago skyline and simple images could range from a bare, empty wall to a bookshelf with bland or similarly colored books. Both insufficient and excessive lighting caused image detection to fail to some extent. Images with repeating parts or patterns would fail to be tracked effectively, as the software would have trouble determining the position of the image. Today's image recognition software still has much to expand on regarding accuracy, efficiency, and flexibility, but image recognition is still able to track an image successfully. Even in largely varying environments, images are still able to be recognized by computer software.

Earth Science

Inferences of Subglacial Processes Under the West Antarctic Ice Sheet From Grain Surface Textures

Presenter(s)
Aspen Wheeler, Illinois Mathematics and Science Academy

Advisor(s)
Ross Powell, Northern Illinois University
Rebecca Puttkammer, Northern Illinois University

Subglacial sediment transport under Whillans Ice Stream in West Antarctica is inferred using samples collected from Subglacial Lake Whillans (SLW) and two sites at a location called "UpB". The surface features on quartz grains between 125 and 1000 micrometers were described using a Scanning Electron Microscope. *Mahaney's Atlas of Sand Grain Surface Textures and Applications* (2002) was used to uniformly and unbiasedly categorize surface features from SLW and UpB, for different grain sizes and depths in cores collected from subglacial till. Data showed three groups that can be used to delineate phases of the subglacial sediment. Phase one is shown by features indicating surface weathering formed while grains were in their original rock outcrop. Phase two is features overprinted on phase one, which indicate glacial transport within subglacial till due to the high frequency of glacial transport features. The final phase is younger weathering features that overprint the glacial transport features such as etching and precipitation features attributed to microbiologically-mediated chemical changes. This supports the view that subglacial transport occurs in till rather than in the waters that fill and drain SLW. Furthermore, microbial activity detected in SLW sediment and waters is likely to be pervasive up-stream from the lake.

Comparing Biodiversity of Silurian Reefs in Illinois and Wisconsin Using Museum Collections and Unbiased Bulk Samples

Presenter(s)
Walker Weyland, Illinois Mathematics and Science Academy

Advisor(s)
Paul Mayer, The Field museum of natural history

Silurian (Wenlock) fossil reefs from the Racine Formation in Illinois measure over 100 meters tall and draping flanks beds extend over a mile. Biodiversity studies of reefs in Southeastern Wisconsin reveal complex, diverse communities with over 191 species. We hypothesized that the larger reefs reflect a more optimal environment and may have had higher diversity than reefs in Wisconsin. We compared diversity between the reefs using, identified fossils from the Field Museum, which were collected in Herscer, Romeo, Thornton, Bridgeport, and Hawthorn. Then we compared the results with those from Watkin's (1997) counts, collected from Horlick, Ives, Franklin, and Francy quarries. We also collected an unbiased bulk sample from Thornton quarry and compared it to unbiased samples from Wisconsin. We found that the unbiased samples had greater differences than the museum collections when compared. The most variable group are echinoderms, In Watkin's bulk sample data, Echinoderms ranged from 0-22% of the Fauna, in the ours they accounted for 55% of the fauna. Selected samples also showed large amounts of variation in reef composition. This could be due to museum bias for larger specimens, each locality could represent different reef communities, or because Watkin's had a larger sample size.

Economics

The Study of Bandwidth Allocation and Price Point on Revenue in Hetergeneous Networks

Presenter(s)
Rohit Mittapalli, Illinois Mathematics and Science Academy

Advisor(s)
Randall Berry, Northwestern University

In order to satisfy the popularity of internet-connected devices and the demands for faster speeds, network companies have moved towards heterogeneous networks. Cellular providers have a limited bandwidth and must allocate it across its different cell types in order to best optimize revenue. We used MatLab to create a model which optimizes bandwidth allocation across a heterogeneous network consisting of both femtocells and macrocells. With the model we input utility- functions describing a user's willingness to pay for a given rate. The computational model justifies other similar mathematical based models. This permits us, to in the future, test other more complicated utility functions with greater ease. Using the model, we can also extrapolate patterns in reference to the some of the model's parameters. For example, we plan to examine the relationship between max revenue and bandwidth allocation with the density of users of both cell types. By assuming a pre-existing macrocell network and assigning a constant installation cost for femtocells, we plan to use the model to determine the optimal number of femtocells for a network.

The Effectiveness of Super Bowl Advertisements on the Sales of Major Car Manufacturing Companies

Presenter(s)
Ravali Thimmapuram, Illinois Mathematics and Science Academy

Advisor(s)
Pradeep Chintagunta, University of Chicago

Every year, car manufacturing companies spend millions of dollars advertising their products during one of the most watched television events of the year, the National Football League's Super Bowl. In addition, millions of Americans are more interested in watching these famous advertisements rather than the outcome of the game. Because of the large sums of money being spent on these advertisements, this investigation looks at the effectiveness of Super Bowl Advertisements on the sales of car manufacturing companies in order to determine whether these companies are spending their money advertising justifiably. By using regression models, we determined how correlated Super Bowl Ads are to the sales of the car manufacturing companies. Results will be presented.

Determining the Effectiveness of Dividend Change as an Indicator of Price Movement

Presenter(s)
David Xu, Illinois Mathematics and Science Academy

Advisor(s)
Maxwell Rhee, TransMarket Group

Identifying factors that affect the price movements of a stock comprises the core of strategy development. Earnings surprise, price to earnings to growth, and return on equity are some of the more common factors. Dividend change, however, has had mixed results. Some researchers have concluded that dividends have no influence on prices while others have identified a direct causation. This paper examines the effects that dividend changes have on a company stock price, measured in terms of abnormal returns up to sixty days after the dividend announcement. To do so, we conducted a multiple-factor linear regression of dividend events against its respective company size, value, and expected return. This regression would eliminate variation in price movements related to the company itself, thus removing noise that may compound the effects of the dividend event. Current theories such as the Dividend Signaling and Free-Cash-Flow hypotheses predict that an increase (decrease) in dividend payout will result in a positive (negative) price movement. However, our results had shown no significant stock price movements resulting from dividend changes.

Education

Effects of Agent-Based Modeling on Comprehension of the Macro and Micro Levels in the Natural World

Presenter(s)
Anna Barannikova, Illinois Mathematics and Science Academy

Advisor(s)
Alice Bennett, Argonne National Laboratory
Meridith Bruozas, Argonne National Laboratory
Emily Cantu, Argonne National Laboratory
John Domyancich, Argonne National Laboratory

Micro and macro relationships are found at every ecological, biological, and social level. Understanding these relationships is imperative not only in science, affecting how hypotheses and solutions are made, but also in everyday life. This investigation determined if using Agent-Based Modeling (ABM), a computer modeling style that focuses on the individual, affected comprehension of the macro and micro levels. By building two separate curriculums modeling the spread of infectious diseases, one including ABM and one without, 58 students were tested on their knowledge of the macro and micro levels both before and after the curriculum was implemented using surveys. The results from this testing showed that both curriculums significantly increased the comprehension of the macro and micro levels for the control (p=2.99E-9) and the experimental (p=1.11E-10) groups. However, comparing all the data groups, consisting of pre/post surveys in the experimental and control groups, using a Tukey test, determined that the difference between the means of the scores was nonsignificant. Overall, the addition of ABM neither hinders nor assists in the comprehension of macro and micro levels. In addition, the percent of students with misconceptions of the macro level decreased post experiment by 64.4%.

An Exploration of the Factors that Motivate Gifted and Talented Latino Males and Females to Engage in Science, Technology, Engineering and Mathematics.

Presenter(s)
Xiomara Cardona, Illinois Mathematics and Science Academy
Elysia Sawyers, Illinois Mathematics and Science Academy

Advisor(s)
Adrienne Coleman, Illinois Mathematics and Science Academy

This study looked at the motivational factors of gifted and talented Latino males and females, who are enrolled in the Illinois Mathematics and Science Academy (IMSA), involved in Science, Technology, Engineering, and Mathematics education (STEM). The study explores the reasons behind IMSA's Latino students being involved and engaged in STEM. Since there are not many Latinos engaged in STEM, this SIR explores the Latinos who are and why. Seven focus groups were conducted that targeted this demographic using a qualitative research, case study approach. The focus groups were digitally recorded and the information was transcribed and analyzed. The information was analyzed to search for common themes, patterns, and trends. The trends that emerged within the data were financial security in the future and giving back to the community/family. These trends are some of the main contributors that explain the motivation behind these students interest in pursuing STEM. The study explores potential reasons why there is a gap in Latino males and females involvement in STEM. This study can be used to inform programs/services designed to get more Latinos in STEM. A recommendation for future studies would be to explore ways in which the gap in STEM can be closed.

Effects of Instruction in Advanced Planning on Computational Problem Solving in a Group Environment

Presenter(s)
Adam Grobman, Illinois Mathematics and Science Academy

Advisor(s)
Alice Bennett, Argonne National Laboratory
Meridith Bruozas, Argonne National Laboratory
Emily Cantu, Argonne National Laboratory
John Domyancich, Argonne National Laboratory

An increase in computer science careers will require workers to solve problems with advanced technology; even jobs outside this domain will depend on basic understanding of computer power. However, teaching the skills needed for proficiency has proved difficult. To combat this, we designed and implemented a Scratch-based computational thinking program that culminated in a group problem solving activity. We then added a lesson into the program that focused on planning methods—goal setting, action planning, and division of labor. Students ($N = 54$) completed surveys before and after the learning experience to measure whether explicitly teaching planning strategies assists in computational problem solving. The mean perceived validities of solutions for control and experimental groups were not significantly different ($p = 0.917$). Mean student understanding of their group's solution was lower in the experimental group compared to the control group ($p = 0.047$). The mean number of students who used planning techniques was not significantly different between the two groups ($p = 0.268$; $p = 0.594$; $p = 0.180$). Positive correlations exist between goal setting or division of labor and perceived validity of solution ($p = 0.027$; $p = 0.040$). These data indicate that setting goals and dividing labor may assist in solving computational problems, but explicitly teaching such strategies does not change the frequency of their use.

An Examination of The Correlation of a Child's Background to Their Enjoyment and Outlook on Science As Well as if it Changes Over Time

Presenter(s)
Isabel Lee, Illinois Mathematics and Science Academy

Advisor(s)
Bryan Wunar, Museum of Science and Industry

Although the population of America (and more specifically Chicago) is incredibly diverse, we are far from having equal representation and diversity in Science, Technology, Engineering, and Math (STEM) fields. Furthermore, research suggests that enthusiasm in science is more likely to lead to a STEM related college degree than top performance on science tests. My investigation researched how a child's race, gender, and background can influence their opinion and enthusiasm on science. The subjects, mostly kids aged 3-15, were participating in a science exploration program and subject to two surveys given out two days apart. They responded to questions inquiring about their dream job, how they feel about science, and who they think science is for. After analyzing their data, the results suggest many children are capable and open- minded, as well as have the equal enthusiasm for learning science regardless of race, age, or gender. Although I am not able to extrapolate this data to the future to see what these kids become, these results may help us understand the general state of kids today and exactly what changes between their opinions in childhood and their actual jobs in adulthood.

Determining the Efficiency of Retention Initiatives for At-Risk Students in a Higher Educational Institution

Presenter(s)
Kameda Mallory, Illinois Mathematics and Science Academy
Jeanette Suarez, Illinois Mathematics and Science Academy

Advisor(s)
Adrienne Coleman, Illinois Mathematics and Science Academy
Omar Headen, Chicago State University

Tutoring and academic advising serve important roles in determining the academic achievement of at-risk students in a post-secondary learning institution. This study was conducted at a small university in Chicago with undergraduate students who are considered to be a part of at-risk populations including ethnic minorities, students with disabilities, students of low socioeconomic status, probationary students, or are otherwise academically disadvantaged in a post- secondary learning institution. Factors of academic achievement such as course grades, students' self-reflection of study habits, and exam scores were examined to determine the effectiveness of the Learning Assistance Center. Utilizing a mixed methodology approach with both qualitative and quantitative components, student surveys were developed to evaluate the goals and practices of the tutoring center. This investigation included several questions such as, how frequently the student visits the tutoring center, and how has it affected their course grades, exam grades, and the students' ability to complete coursework, in order to examine the effect of tutoring service initiatives on students' academic achievement. The results of this investigation will be presented during IMSAloquium.

Engineering

Designing a Dual Air and Water Purifier

Presenter(s)
Niharika Agrawal, Illinois Mathematics and Science Academy

Advisor(s)
Brendan Casey, Fermi National Accelerator Laboratory

Air pollution is a mixture of solid particles and gases in the air, causing air toxins, which are pollutants known or suspected of causing health issues. Water pollution is a mixture of particles not meant to be in water, leading to the water becoming toxic to drink. Some common air pollutants are ozone, carbon monoxide, and nitrogen dioxide. My goal was to design a machine that would filter out one of these pollutants from the air to purify water. Ozone, the pollutant I chose, is known to be a powerful water purifier as one molecule of ozone is composed of three oxygen atoms. After weeks of research, I decided to use ozone's higher density compared to the other gases in the atmosphere as a way to filter it out using a cyclone filter, which is the design I have completed. Preliminary results using an ozone generator and sensor have cemented the fact that ozone does not immediately recombine into the oxygen, which shows that our project is indeed applicable. Other testing is still being done.

Development of a Transportation Network Analysis Algorithm to Assess System Resilience

Presenter(s)
Michael Alexandrovich, Illinois Mathematics and Science Academy

Advisor(s)
Megan Clifford, Argonne National Laboratory
Casey Trail, Argonne National Laboratory
Thomas Wall, Argonne National Laboratory

Roads accommodate a large portion of the movement of people and goods across transportation systems, but are vulnerable to man-made and natural disasters. To minimize the impacts of potential disruptions on the road network's users, network resilience, the ability to resist, react, and adapt to disruptions must be improved. Investing into the network is critical to improving resilience, but requires a systematic analysis, such as computerized network analysis, to identify and prioritize the most critical infrastructure system components for investment. In this study, we develop a network routing approach that uses the shortest path algorithm to connect randomly selected origin points to a destination and ranks sections of the paths by usage level, which correlates to potential impact on network resilience. We then apply this method to a transportation system case study in Ogden, Utah, and show that the method can prioritize critical transportation network components. This method helps identify critical infrastructure in a time-efficient manner, and can be systematically applied to networks that vary in size and complexity. By identifying critical transportation network infrastructure, experts can receive information to be used for improving system resilience in planning for the future.

Quantifying Excitement Using Rollercoasters

Presenter(s)
Spencer Andrews, Illinois Mathematics and Science Academy

Advisor(s)
Eric Hawker, Illinois Mathematics and Science Academy

Rollercoasters are a definitive means for stimulating excitement, and, thus, a great medium to use for determining a quantifiable value for excitement. This value has not been previously quantified in this manner. To do this, I compiled a collection of data on five aspects of four rollercoasters at Universal Studios in Orlando. I then compared the data with the relative popularity of the roller coasters. I derived a 5 sets of constants based on the popularity of each individual coaster. I then averaged these values and came to 5 general constants that can be applied to rollercoasters within Universal. From these, I determined that speed and length positively affect live time, while height, drop, and number of inversions negatively affect them. I also took a broader look at the popularity of these specific aspects of rollercoasters as a function of their first operating date. I calculated the percent difference of the aspect of the rollercoaster relative to Cedar Point's Blue Streak, which had the earliest first operating date I could find. This was different for number of inversions, for which I used Cedar Point's Corkscrew. I determined that height, drop, length, and speed have been increasing over time, with height increasing at the fastest rate, while the number of inversions have been decreasing. Based on my assumptions, I have determined that these aspects do quantifiably affect the excitement of rollercoasters.

Measuring Circulation Control Wings of an Unmanned Aerial Vehicle

Presenter(s)
Joshua Burke, Illinois Mathematics and Science Academy

Advisor(s)
David Williams, Illinois Institute of Technology

The "ICE-101/SACCON" unmanned aerial vehicle was developed by David Williams as an unmanned flying wing aircraft that uses an innovative aileron called a circulation control wing. The wing uses air blown over a rounded surface to maintain control without flaps. The 1 to 37 scale three dimensionally printed model used in this investigation has also been tested at the Air Force Academy. In this investigation, a calibration between supply pressure and mass flow rate through each of the four control points was measured using a commercial flowmeter and a needle valve regulator with pressure sensors. The mass flow rates were examined over a pressure range of 14.7 to 61.7 pounds per square inch absolute. Performance between control points was determined to be relatively uniform. Data was collected over six trials for each of the four control points. A distribution of mass flow rates for all four control points with a confidence interval of 95 percent over a range of supply pressures was obtained. Finally the flow coefficients of the control points, values important in industry, were calculated.

Can Small Unmanned Aircraft Undertake Complex Tasks Efficiently?

Presenter(s)
Kevin Chen, Illinois Mathematics and Science Academy
Malik Roberson, Illinois Mathematics and Science Academy
Christopher Rogers, Illinois Mathematics and Science Academy

Advisor(s)
Jim Gerry, Illinois Mathematics and Science Academy

As we investigated last year, the benefits of unmanned aerial vehicles (UAVs) can be massive. While organizations such as the military utilize them rather extensively, UAVs can also improve the lives for the general public from lowering taxes to potentially saving lives. The aircraft tested last year was fully capable of carrying a modest payload of a camera and live video feed equipment. To further investigate their capabilities, we used the well known design as a basis and attempted to optimize it, mainly by modifying the wing. Instead of folding and gluing foam sheets, which can only approximate a wing shape, we switched to a foam block which we cut with a hot wire. That can create a very accurate shape. We then mounted a simple camera on board and ran several test flights to help evaluate the airflow characteristics of the new wing in various phases of flight, i.e., stall or cruise. Even though we are still testing the efficiency of the plane, the preliminary flight results have been promising and it seems that our current model is more efficient compared to last year's model.

Newly Built vs Renovated: Achieving Leadership in Energy and Environmental Design Certification Through the most Cost-Effective Method

Presenter(s)
Stoyan Georgiev, Illinois Mathematics and Science Academy

Advisor(s)
Joy Meek, Wheeler Kearns Architects

The Leadership in Energy and Environmental Design (LEED) program is a worldwide program that certifies buildings for their incorporation of energy-efficient design strategies and practices to improve the energy use and waste of buildings. In this investigation, we focus on the LEED certification process for residential homes, and the cost implications to meet this certification. We looked at the requirements to meet a certain level of certification, the process of submitting the building for inspection, and the different levels of certification that can be achieved. We then calculated the costs of all materials and aspects that go towards renovating an existing residential building and compared that to the costs towards building a new LEED certified building. Preliminary results showed that, depending on the size of the building and the state of the existing home, it is generally less expensive to construct a new home to achieve certification; this is being confirmed. We predict that this is due to the constraints of the existing conditions, systems, fixtures and appliances that can be replaced without completely gutting the home. These results could be beneficial to future home owners when weighing their options for a new energy efficient home.

Designing a Water Purifier Using Shortwave Ultraviolet Light

Presenter(s)
Rebecca Lisk, Illinois Mathematics and Science Academy

Advisor(s)
Mark Carlson, Illinois Mathematics and Science Academy

Despite the existing methods of water purification, over 1.1 billion people do not have access to potable water. The purpose of this investigation was to design an ultraviolet light filter that produces 40 liters of water per day at a 99.9% kill rate, uses minimal power, costs less than $20, and is simple to operate. The initial design involved a siphon that transferred water into a light exposure chamber and killed more than 99.99% of Escherichia coli. However, this filter was difficult to operate, so a second prototype was built. Instead of a traditional siphon, a partial vacuum inside the exposure chamber draws contaminated water from a reservoir. This design was tested with various flow rates and tubing sizes to maximize the kill rate while maintaining a large output of clean water. The prototype, when run at 40 L/day, kills at least 99.7% of bacteria and has a power draw of 0.9 Watts. Future steps include confirming results, further increasing kill rate, and minimizing cost and power draw. The effect of nucleotide excision repair, the process in which damaged DNA is removed, will also be explored to determine the purifier's long-term efficiency.

Connecting a Spectrometer to a High Power Telescope in Order to Gather Light From Stars

Presenter(s)
Jeremy Mateja, Illinois Mathematics and Science Academy

Advisor(s)
Eric Hawker, Illinois Mathematics and Science Academy

The purpose of this investigation was to design a way to connect an Ocean Optics Red Tide USB650 spectrometer to a 12 inch Meade LX200GPS Schmidt-Cassegrain telescope, so that astronomical spectra could be gathered. The other purpose was to show that with relatively simple equipment, most schools that have a telescope can do this. First, in order to accomplish this, the location of the focal point of the telescope was found. Finding the focal point involved many measurements and computations, most of which was done on Microsoft Excel. A flashlight was used as the object of an optical system, and it was tested at various distances to acquire the image distance for the focal point calculations. Once the focal point was found, the optical fiber was attached and connected to the spectrometer. It was first tested with regular light sources such as neon, hydrogen, and argon. The spectrometer was able to read the neon and hydrogen, but the argon was too faint to be detected. This shows that any school with a telescope and solid state spectrometer can connect the two to take spectroscopic data of astronomical objects.

Creating a Second, Chemical Stage for Germicidal, Ceramic Filters

Presenter(s)
Shannon McKay, Illinois Mathematics and Science Academy

Advisor(s)
Mark Carlson, Illinois Mathematics and Science Academy

To remove agrochemicals such as pesticides from drinking water, a second stage was developed for anti-bacterial clay filters. These filters help kill bacteria in drinking water and must be affordable and readily available for people in the developing world. A chemical stage would have to be so as well. Activated carbon is a porous material that has the ability to adsorb small molecules like agrochemicals, which makes it an ideal filter material. The activated carbon was placed above the clay filters separated by multiple coffee filters. A bleach solution containing 4% sodium hypochlorite was passed through the filters and its concentration was measured using light absorbance. The concentration of the bleach solution was lowered by as much as a factor of 2. The conclusion from these results is that the activated carbon does decrease the concentration of bleach in the water. Preliminary results show that activated carbon has the potential to remove trichlorfon, a pesticide, from water as well.

Development of Visible Light Communications Prototype and Analysis of LED Configurations for Smart Lighting

Presenter(s)
John Messina, Illinois Mathematics and Science Academy
Edward Shi, Illinois Mathematics and Science Academy

Advisor(s)
Peter Clancy, Illinois Mathematics and Science Academy

Radio wave communication is the primary mode of data transmission, but is vulnerable to interception or data theft. In addition, its heavy use restricts its available bandwidth. Thus, Li - Fi, or Visible Light Communication (VLC), has potential as an alternative. Through Li - Fi, higher transmission speeds, unregulated bandwidth, and unprecedented security could be achieved, allowing for applications like smart lighting. To begin investigating the personal, local applications of Li - Fi, we designed a minimal prototype transmitter, which utilizes a conversion algorithm and the technique of On-Off Keying (OOK) to flash an LED in accordance with generated binary code. The receiver utilizes the photoelectric effect to generate current following the light pattern, allowing us to recreate the binary generated from the transmitter. Different light formations in the transmission mechanism were tested for interference to determine the optimal configuration for reception. An increase in LED number should not create significant interference to affect the OOK operations, and thus even a bright, multi - diode appliance would be successful. In conclusion, the designed local prototype of Li - Fi demonstrated a successful and applicable algorithm for communication, as well as illustrated the capability of future Li - Fi appliances for different LED configurations.

Shimming the Muon g-2 Magnet

Presenter(s)
Paul Nebres, Illinois Mathematics and Science Academy

Advisor(s)
Brendan Kiburg, Fermi National Accelerator Laboratory

During the summer of 2013, a 50-foot wide magnet was transported from the Brookhaven National Laboratory (BNL) in Brookhaven, New York to the Fermi National Accelerator Laboratory (FNAL) in Batavia, Illinois. This magnet will be used to repeat BNL's muon anomalous magnetic moment experiment with more precision and confirm whether new physics beyond the standard model was responsible for the observed deviation between BNL's experimental and theoretical results. The work done was in preparation for beginning shimming trials in which we find impurities in the magnetic field and correct them to make the magnetic field as homogenous as possible. We installed the magnet's wedge shims, designed the shimming trolley, conducted our first shimming trials, and ran statistical analyses to account for systematic offsets. The work we have done has resulted in a repeatable and precise process that we can continue to use to create our homogenous magnetic field. The shimming trolley we designed takes all the measurements we need. The statistical analysis uniformly corrects these measurements. We use the wedge shims to adjust the magnetic field impurities. This will help us improve upon the BNL experiment and potentially improve our understanding of the basic components of matter.

Erbium Doped Yttrium- Aluminum- Garnet Laser Induced Microjet Aimed at Tattoo Usage

Presenter(s)
Michelle Park, Illinois Mathematics and Science Academy

Advisor(s)
Jai-ick Yoh, Seoul National University

New ways to administer drugs without a needle have been developed. Using an erbium doped yttrium aluminum garnet laser induced microjet, the same technique may be used to develop painless tattoos. A piece of pig skin is placed underneath the laser which is set at 2940nm, a wavelength well absorbed by water. The laser is then pulsed at 150μS while ink is ejected from the microjet onto the surface of the pig skin. Results indicate that Er:YAG laser induced microjets can imbed ink into epidermis. Using this technique, the word IMSA was successfully tattooed into the skin of a pig in one minute. These results indicate the potential use of these microjets in the future in a less painful and quicker manner.

Novel Organic Light-Emitting Diode Materials Testing Method

Presenter(s)
Nathaniel Rabideau, Illinois Mathematics and Science Academy

Advisor(s)
John Thurmond, Illinois Mathematics and Science Academy

Organic LEDs (OLEDs) are better versions of the well-known LED that have many more practical applications, but are more expensive to produce and difficult to test at this time. Small batches of tris(bipyridine)ruthenium(II) complex ion and polyvinyl alcohol solutions are mixed and then spin-coated onto a 1” by 1” Indium-Tin oxide glass slide, which has a conductive layer on one side. Each slide is then placed into a drying oven and left for a week. Once dried, each slide is prepared with multiple layers including a cathode. A small current is put through the device to check for any luminescence from the material. Results thus far have shown that spin-coating each slide at a higher speed (3500rpm) vs. lower speed (1500rpm) is more effective because thin layers of solution are desirable. Because of the fast degradation of the materials, mixing and coating each solution iteration in the same lab day is the best method of testing, as the Ru-complex ion degrades in moist environments. Four testing devices have produced light thus far. These results show promise for testing other materials for luminescence with this method, but more work is needed to make a dependable process.

Creation of a Model to Predict Indoor Air Quality Using BEopt, EnergyPlus, and Python

Presenter(s)
Mylee Rolock, Illinois Mathematics and Science Academy

Advisor(s)
Brent Stephens, Illinois Institute of Technology

Indoor air quality and energy consumption are factors that constantly impact our lives, but they have a negative health impact. My SIR involved writing a program to model these two factors using Python, BEopt (Building Energy Optimization), and EnergyPlus and was part of a 3 year project to model indoor air quality and building energy consumption, predict how this will change by 2050 and 2080, and determine the health impacts of these factors. I wrote 3 programs to do this. They calculate the indoor air quality from input values and graph the results, modify IDF files, the type of files that EnergyPlus uses, and run lists of files through EnergyPlus. Together, these programs can use an IDF file to find the indoor air concentration of PM2.5 (particles smaller than 2.5 micrometers) and UFP (ultrafine particles smaller than 0.1 micrometers). They do not deal with energy consumption since I was unable to work on this aspect. In addition, a few outlying data points throw the graphs off. The work I did will help the 3 year project and this will help the scientific community by providing the health impact of these pollutants and a projection for how this will change.

Characterizing Icephobic Properties of Superhydrophobic Polypropylene Manufactured Using a Hot Emboss Method

Presenter(s)
Evan Sun, Illinois Mathematics and Science Academy

Advisor(s)
Michelle Khine, University of California at Irvine

The formation of ice on man-made surfaces, such as roads or airplanes, is problematic and costly, leading to hundreds of thousands of dollars spent each year. To circumvent this, many industries often utilize special chemicals that lower the freezing temperature of water on these surfaces. However, these chemicals are expensive and harmful to the environment. Recently, superhydrophobic (SH) surfaces, which greatly repel water and are characterized by a high water contact angle, have been developed through physically imprinting rough features onto commodity plastics, eliminating the need to use any chemicals. These SH surfaces have garnered large amounts of interest for their potential icephobic properties. The term icephobic has appeared to describe surfaces that passively prevent ice formation or reduce the force necessary to remove the ice. In this study, we tested whether or not SH polypropylene (PP) exhibits any icephobic properties. Specifically, we tested how lower temperature affects the contact angle and surface area covered and the force of adhesion of ice on SH PP compared to non-SH PP. While, the SH PP was found to exhibit SH properties despite temperature change, the force of adhesion required to remove ice was greater on SH PP, and thus SH PP cannot be considered icephobic.

English

What is Love?

Presenter(s)
Jin Komerska, Illinois Mathematics and Science Academy

Advisor(s)
Crystal Randall, Illinois Mathematics and Science Academy
Tracy Townsend, Illinois Mathematics and Science Academy

Ask a scientist, and they'll tell you "love is really just biology." Ask a hopeless romantic, and they'll tell you that love is an unexplainable, all- consuming force that can only be understood as fate. By comparing papers from scientific studies and writings by philosophers, poets, and social scientists, this study investigates both sides of the story. Topics covered include types of love, the connection between the brain and the emotion of love, and whether or not monogamy goes against human nature. The neurobiological standpoint supports love's representation and power in literature by explaining oxytocin, vasopressin, and dopamine and their roles in the phenomena of love. Meanwhile, the literary standpoint supports the neurobiological view by describing the different forms and symptoms of love. Further investigation may show deeper connections between the feelings of love written about in literature and the biological processes that affect such feelings.

The Hiroshima Survivor's Tale in Manga, Memoirs, and Anime

Presenter(s)
Angelina Liao, Illinois Mathematics and Science Academy

Advisor(s)
Michael Hancock, Illinois Mathematics and Science Academy

In 1945, America dropped two bombs on Nagasaki and Hiroshima, leading to devastating effects. Many survivors' stories have been written as cautionary tales in the hopes that this tragedy would not be repeated. I read John Hersey's Hiroshima (1946) and Keiji Nakazawa's children's manga Barefoot Gen (1985) and watched Studio Ghibli's Grave of the Fireflies (1988) before comparing how each medium uniquely helps to demonstrate the various hardships of a survivor after the Hiroshima bombing. I examined the depictions of how each survivor fulfilled their basic necessities such as food and housing. I also explored the progression of time and the long-term results of the Hiroshima bombing. The serial Barefoot Gen's length gives a years-long overview of what it meant to be in Hiroshima long after the initial bombing. As a result, Barefoot Gen provides the most insight into what it meant to live in Hiroshima after the dropping of the atomic bombs.

Tropes and Trends

Presenter(s)
Samuel Okoli, Illinois Mathematics and Science Academy

Advisor(s)
Tracy Townsend, Illinois Mathematics and Science Academy

Literature and culture can be analyzed alongside each other in order to determine the relationship between a work and its context of origin. By scrutinizing relevant sources, relevant data was collected for the purpose of exploring and articulating this relationship more precisely. Key sources included Joseph Campbell's Myths to Live By and The Hero with a Thousand Faces. Various works of fiction and literary articles were explored in their socio-political context. The majority of the research data indicated the continuing popularity of English classics and retellings. The appeal of these retellings pointed to the compatibility of the socio-political contexts between the source material and the audience of the present day. The differing contexts of the past, in contrast with the present, show how time has diminished the borders between nations with the aftermath of globalization, indicating that the modern world must birth its own myths, serving as the foundation for its future.

Environmental Science

Effects of Sand Filters in Wastewater Treatment Plants on Microplastic Output

Presenter(s)
Morgan Phillips, Illinois Mathematics and Science Academy

Advisor(s)
Catherine O'Reilly, Illinois State University
William Perry, Illinois State University

Microplastics, pieces of plastic between 5mm and 0.3mm, have been found in oceans and freshwater systems and can carry bacteria that the usual suspended solids do not. They also have a high potential for bioaccumulation, as even the smallest organisms can ingest them because of their small size. Because the research on microplastics in freshwater is limited, I wanted to know if they could be detected in freshwater streams, if the amount increased downstream of wastewater treatment plants (WWTPs), and if sand filters in WWTPs decreased microplastic output. Samples were taken at eight sites in and around four WWTPs, two with sand filters and two without. Microplastics were found in all the samples, though there were more downstream of WWTPs. The effect of filters on microplastics downstream was that though the total weight of the microplastics per liter did not increase, the number of pieces did, and those pieces were much smaller than those found downstream of WWTPs with no filter.

Assessing the Effects of Anthropogenic and Biogenic Ligands on Mercury Bioavailability

Presenter(s)
Katherine Su, Illinois Mathematics and Science Academy

Advisor(s)
Jean-Francois Gaillard, Northwestern University
Sara Thomas, Northwestern University

Mercury (Hg), released into the environment primarily by the combustion of fossil fuels, is a global pollutant that travels through the atmosphere before depositing into surface waters. When internalized by anaerobic bacteria living in aquatic ecosystems, Hg can be converted into monomethylmercury (MeHg), a potent neurotoxin. The Free Ion Activity Model (FIAM), which predicts trace-metal bioavailability, assumes that the free metal ion is the only bioavailable form. However, environmental Hg is almost always found complexed with a ligand, and thus it is necessary to study the bioavailability of Hg-ligand complexes. In this investigation, an *Escherichia coli* biosensor (containing a chromosomally inserted merR::luxCDABE fusion) that emits light in proportion to concentration of intracellular Hg was used to directly assess the bioavailability of various Hg-ligand complexes. Thiol-containing, anthropogenic ligands 2-mercaptopropionic acid, 3-mercaptopropionic acid, and thioacetic acid, as well as biogenic ligands cysteine and glutathione were used. Each ligand tested, except cysteine, was shown to decrease Hg bioavailability. The reason for cysteine's promotion of Hg biouptake is unclear. However, we can generally conclude that Hg-ligand complexation prevents ligand-exchange reactions from occurring and that thiol-containing ligands have a higher affinity for Hg than cell-surface thiol groups.

Fine Arts

Absolute And Relative Pitch: Factors Into The Origin And Acquisition

Presenter(s)
Austin Choi, Illinois Mathematics and Science Academy
Alexander Hughes, Illinois Mathematics and Science Academy

Advisor(s)
Emily Sites, Illinois Mathematics and Science Academy

Absolute pitch (AP) is a relatively untouched field of study within music. Not much is known about its origins or what factors may potentially affect the probability of a musician possessing AP. A survey was sent to the students-l email list to ask for responses to a participant survey. For the Factors Experiment, background information was obtained from the people who finished the survey and the data was analyzed for significant differences. Analyses to test for positive change in pitch recognition from the start to the end of a program designed to develop AP were conducted for the Development Experiment. The results from the Factors Experiment indicate the factors that affect an individual developing AP in their early childhood while the results of the Development Experiment suggest whether or not AP can be developed in musicians after early childhood. Results will be presented at IMSAloquium. These results add to the limited understanding of AP as a musical phenomenon by verifying which factors influence its development and its ability to be learned in adulthood. This can be helpful for musicians who hope to develop AP to further their musical careers.

Analysis of Rachmaninoff's String Quartets and its Application to Reconstruction

Presenter(s)
Isabella Spinelli, Illinois Mathematics and Science Academy

Advisor(s)
Peter Dong, Illinois Mathematics and Science Academy

Sergei Rachmaninoff is considered by many to have been the last great Romantic era composer. His works are characterized by virtuosity, the use and recurrence of motive thematic material, and sweeping melodies. Early in his career, Rachmaninoff composed two string quartets but never finished either; this study sought to reconstruct the second of these by composing its third movement based on thematic and harmonic material in the existing movements. String Quartet No. 1, Movement 3 and String Quartet No. 2, Movements 1 and 2 were analyzed thematically and harmonically in order to understand the structure and harmonic patterns. These analyses revealed a tendency to chromatic motion, linking themes and even movements with motives, and changing keys by sequencing. Through the composition of the third movement of the second string quartet, these methods proved effective in comprising one valid approach to reconstructing Rachmaninoff's work, providing insight to the defining qualities of Romantic style music.

History

The Influence of Daoist Principles on Acupuncture and Herbal Remedies, Techniques of Traditional Chinese Medicine

Presenter(s)
Amy Liu, Illinois Mathematics and Science Academy

Advisor(s)
Robert Kiely, Illinois Mathematics and Science Academy

Taoism, an ancient Chinese philosophy, involves the idea of the Tao, or "the Way," and the belief that humans are inherently flawed and so, must look towards nature to find order. Taoism is founded on several principles including the concepts of Yin Yang, the Five Element Theory, the trigrams and hexagrams of the *I Ching*, and Qi. In order to investigate these underlying principles and their application to traditional Chinese medicine, I read the *Tao Te Ching*, one of the founding texts behind Taoist thought and practice. In addition, I also read texts regarding the practice of traditional Chinese medicine, including *The Shorter Science and Civilisation in China: 1* and *Between Heaven and Earth: A Guide to Chinese Medicine*. By reading about Taoism and traditional Chinese medicine, I sought to determine how one affected the other. Through this analysis, I concluded that the underlying principles of Taoism help to not only explain many traditional Chinese medicine techniques, specifically herbal remedies and acupuncture, but also serve to influence the daily practice of these techniques. Therefore, the conceptual principles of Taoism ultimately serve to influence acupuncture and herbal remedies in order to connect these ideas with nature and all of humanity.

The Destroyer of Worlds: An Understanding of Nuclear Strategy in the Twentieth Century

Presenter(s)
Luke Morrical, Illinois Mathematics and Science Academy

Advisor(s)
Lee Eysturlid, Illinois Mathematics and Science Academy

Throughout the twentieth and into the twenty first century the threat of nuclear warfare has been the preeminent danger in geopolitical relations. The most notable contributors to the nuclear threat were the United States and the Soviet Union. In the intervening years between the creation of the atomic bomb and the end of the Cold War these two states developed strategies on how to use, deter, and combat nuclear weapons against each other. However, since the end of the Cold War non-traditional nuclear states have arisen, specifically North Korea and Iran, whose nuclear capabilities present new challenges. Dealing with these threats requires knowledge of the nuclear strategies, such as the escalation ladder and massive retaliation that were developed to deal with challenges the United States and the Soviet Union presented to each other. This presentation will educate the viewers on these strategies.

Mathematics

Application of the Ordered Erdos Ginzburg Ziv Theorem to the Non-Abelian Dihedral Group

Presenter(s)
Ankit Agarwal, Illinois Mathematics and Science Academy
Robert Lou, Illinois Mathematics and Science Academy

Advisor(s)
Micah Fogel, Illinois Mathematics and Science Academy

In additive number theory and group theory the Erdos-Ginzburg-Ziv theorem describes the length of the shortest zero-sum subsequence modulo n, given a sequence of length 2n – 1 and has been described well for unordered sequences in non-abelian groups. However there is little to be found on ordered sequences and therefore, the goal of our research is to make progress on this problem by applying an ordered version of the Erdos Ginzburg Ziv theorem to the non-abelian dihedral group. We wrote programs in Python to assist us with the experimentation and data collection, which consisted of non-zero-sum sequences in Dn. We observed patterns in the data, especially looking for something similar to the Erdos-Ginzburg-Ziv Theorem. Our results showed that for odd $n \geq 3$, the lower bound on the length of a sequence made from elements in the dihedral group of order 2n that contains a zero – sum sequence is 4n -1. For the even case, the bound is 3n. These results are supported by the results of similar studies on non- abelian groups, and expand on those studies as well. Our study broaches into new areas in group theory and provides a starting point for future analysis.

Using the Laplacian Matrix as a Differential Operator in Quantum Graphs

Presenter(s)
Emily Jia, Illinois Mathematics and Science Academy

Advisor(s)
Niels Nygaard, Aarhus University
Phadmakar Patankar, Illinois Mathematics and Science Academy

A quantum graph is a weighted combinatorial graph equipped with a Hamiltonian operator acting on functions along each edge. As the name suggests, it can be used to model quantum phenomena such as wave propagation and free-electron theory. We investigate the behavior of quantum graphs when their Laplacian matrices are used as the operator. Specifically, we examine families of graphs and solve for their characteristic functions and vertex conditions based on the eigenvalues of the Laplacian. Preliminary results suggest a systematic method for complete graphs, star graphs, path graphs, and cycles. This would provide some of the first results on the relation between spectral graph theory and quantum graphs.

Predicting Grades of IMSA Students and Degree Completion Based on Past GPA and Standardized Test Scores With Respect to the Type of School the Students Attended Before IMSA

Presenter(s)
Violet Konopka, Illinois Mathematics and Science Academy

Advisor(s)
Don Porizo, Illinois Mathematics and Science Academy

Extensive research has been done to find the relationship between high school and college success. The current research is bringing this down one level by comparing a students' success at their past school to their success at IMSA by comparing a student's entering GPA and standardized test scores to their GPA at IMSA and their test scores after attending IMSA. Data will be collected from IMSA's Institutional Research Department that will include the type of school a student attended before entering IMSA, their GPA from their past school, and their SAT scores that were submitted for their IMSA application. Data from these students' GPA at IMSA and their ACT or SAT scores they used in their college application process will be collected as well. The data will then be analyzed to find if students from different schools perform differently during their time at IMSA. This will be done through descriptive, exploratory, inferential, and predictive analyses. The results will be presented at IMSAloquium. This data is significant because it will allow IMSA community members to predict which students will be most successful during their time at IMSA based on what school they are currently attending.

The Spectrum of Sparse Random Complex

Presenter(s)
Alan Liang, Illinois Mathematics and Science Academy

Advisor(s)
Dominic Dotterrer, University of Chicago

The combinatorial Laplacian is an operator that has numerous applications in physics, finance, randomized algorithms, and graph theory. It contains information that describes certain properties of the graph. One important set of information is its set of eigenvalues (also known as its spectrum). For example, one can determine the relative connectivity of a graph with this. Furthermore, one can determine global geometric properties through the spectrum. The graph Laplacian can be extended to simplicial complexes (higher dimension versions of graphs). The importance of the graph Laplacian therefore leads us to study the Laplacian for simplicial complexes. Through this operator, one can quantitatively measure the vanishing of cohomology – in other words a measure of higher dimensional connectivity. This investigation will present the ideas that have been researched.

Decomposition of the Gini Index into Non-Overlapping Subgroups

Presenter(s)
Sarah Mou, Illinois Mathematics and Science Academy
Franklin Ye, Illinois Mathematics and Science Academy

Advisor(s)
Michael McAsey, Bradley University
Libin Mou, Bradley University

The Gini index is a single number that attempts to measure inequality. However, this common measure of inequality fails to describe how unequal different parts of a population are, and only provides a view of the population as a whole. We investigated the relationship between the measures for specific groups and the measure of the total population. We constructed a formula that gives the Gini index as a function of the indices of the smaller groups within a population, given that they do not overlap. This formula expresses the Gini index as a sum of the Gini indices of the subgroups multiplied by coefficients plus a constant term. The coefficients which we use to write the Gini index in this formula are composed of the number of values in each subgroup and the totals of each subgroup, as well as the number of values in the distribution and the total of the distribution. Our formula leads to another form of the overall Gini index by considering each member in the population as a subgroup. The relationship has been researched in the past, and we provide a new formulation and direct proof.

The Entangling Properties of Knots and Links

Presenter(s)
Eshan Mehrotra, Illinois Mathematics and Science Academy

Advisor(s)
Louis Kauffman, University of Illinois at Chicago

It has been conjectured that quantum entanglement operators can be lifted to braiding operators by the way of the topological quantum field theory axioms set forth by Witten and Atiyah. Moreover, it can be readily shown that quantum link invariants need entanglement to construct topological invariants. Given these results and the already dense mathematical framework underlying topology and quantum field theory, we propose that, through the usage of quantum algebra and bracket models, we can identify a significant area of overlap where entangling R-matrix solutions to the Yang-Baxter equation can be used to construct invariants of knots and links. Such a connection illuminates the relationship between quantum and topological entanglement, and allows us to draw novel insights about properties of entangling gates, for example the question of what it is that allows some entangling R-matrices to generate topological invariants when others do not. In conclusion, by studying the boundary between topological and quantum entanglement we construct novel topological invariants that can have significant impact on the study of quantum computing and can help make progress towards the problem of representing the Artin braid group as unitary matrices.

Medicine

Determining the Effectiveness of Low-Dose Computerized Tomography Screenings in Detecting Early Stage Lung Cancer

Presenter(s)
Rakesh Chatrath, Illinois Mathematics and Science Academy

Advisor(s)
Rachel Logan, Riverside Healthcare Center

Historically, most lung cancers were detected at late stages (30% are stage III and 40% are stage IV). Trials were conducted testing the viability of low-dose computed tomography (LDCT) screening for nodule detection. The US Preventive Services Task Force identified guidelines for advising LDCT screening based on the National Lung Screening Trial. It was determined that those with a 30 pack-year smoking history who are current smokers or who have quit within 15 years, and are between 55 and 74 years old are at highest risk for lung cancer and therefore benefit most from LDCT screening. Furthermore, a 20% reduction in lung cancer mortality has been reported when properly implementing LDCT screening guidelines. Unfortunately, patients were not often receiving treatment within the recommended 14 week window. Delays were most commonly seen in obtaining a CT scan or awaiting biopsy or surgery. Therefore, it is important to establish efficient methods to deliver CT scans, biopsies and surgeries to patients. A retrospective study was performed to identify the effectiveness of a comprehensive lung nodule committee in a community setting for determining early stage lung cancers and ensuring timeliness of care between suspicion and treatment.

Exploration of Drug Encapsulation and Delivery Using Toroidal-Spiral Particles

Presenter(s)
Roy Chiu, Illinois Mathematics and Science Academy

Advisor(s)
Paola Leon Plata, University of Illinois at Chicago
Ying Liu, University of Illinois at Chicago

The current research explores the factors that may affect drug encapsulation and subsequent release rates in toroidal-spiral particles and we hope to ultimately apply our findings to create particles capable of delivering and controlling the release rates of a myriad of drugs. The particles are created by entrapment of a drug- containing drop within a polymeric drop, and upon toroidal-spiral drop evolution is cross-linked into a semisoft, millimetric-sized particle. For the preliminary study of controlled delivery using carbon nanotubes, different drops were tested in vitro: hemispheres, toroidal-spiral particles, and toroidal-spiral particles with suspended carbon nanotubes. Preliminary results suggest that hemispheres release the least amount of encapsulated drugs. The toroidal-spiral particles without carbon nanotubes had the next highest release rate, and those with carbon nanotubes had the greatest release rate. In terms of drop interaction, densities and viscosities are important factors. Drops need to be denser than the bulk solution in order to travel through the solution and properly interact with each other and both drops need to be viscous enough to develop as toroidal-spiral particles. Overall, the main factors in drug encapsulation and release have been determined; the next step involves exploring multiple drug encapsulation and release of each drug in vitro.

Utilizing Novel Scaffolds to Target Cytochrome-B of *Toxoplasma gondii* Tachyzoites

Presenter(s)
Sarah Dovgin, Illinois Mathematics and Science Academy

Advisor(s)
Kamal El-Bissati, University of Chicago
Farida Esaa, University of Chicago
Rima McLeod, University of Chicago
Ying Zhou, University of Chicago

Toxoplasma gondii, an apicomplexan parasite affecting one third of the world's population, causes the disease known as toxoplasmosis. Atovaquone is a current treatment against *T.gondii* which can partially reduce the number of bradyzoites. However, atovaquone-resistant mutants are rapidly selected during treatment with atovaquone. Atovaquone and related compounds have been developed against cytochrome b, a target within complex III of the parasite's electron transport chain, hypothesized to be a key component of adenosine triphosphate production within the parasite. A parasite assay determined compounds' effects upon *T. gondii* tachyzoites. Human foreskin fibroblasts (HFF) in 96-well plates were utilized as *in vitro* models. *T. gondii* tachyzoites invaded HFFs before compound concentrations of 0.03 micromolar (uM) to 10uM were added. A toxicity assay determined the effect of the compound upon HFFs. Varying concentrations of each compound were added to HFFs before WST-1 was added to quantify mitochondrial activity of remaining living HFFs. JAG021 and JAG050 led to significant decreases in parasites at compound concentrations from 0.125uM to 10uM. Additionally, all compounds had minimal levels of toxicity from 1uM- 10uM with exception of HFF toxicity at 15uM. Further studies will be conducted to determine the effects of the compounds within *in vivo* models to develop the compounds into medicines.

Development of a User-Friendly Biomedical Database

Presenter(s)
Nikitha Garapaty, Illinois Mathematics and Science Academy

Advisor(s)
Satyender Goel, Northwestern University
Kathryn Jackson, Northwestern University
Niloufar Safaenelli, Northwestern University

As an effect of the rising use of health information technology, biomedical databases consist of rising numbers of discrepancies. Ultimately this is affects the efficiency of data analysis in medical research. This study aimed to develop a method of eliminating these discrepancies and developing a biomedical database into a more research-friendly version. Medical lab data was acquired from HealthLNK Data Repository (HDR) which consisted of patient data from seven different medical institutions (Northwestern Medicine, University of Chicago Hospitals and Clinic, Rush University Medical Center, University of Illinois at Chicago Medical Center, Loyola University Medical Center, Cook County Health and Hospital Systems, and the Alliance of Chicago). The medical lab data was clustered based on similarities with the assistance of the Google OpenRefine software. Initially, 429 clusters, were identified by Google OpenRefine meaning the data was highly inconsistent. When concluding the clustering process of this investigation the number of clusters identified had been reduced to 43. As a result of clustering the data, a suggested standard method of labeling medical labs across medical institutions was developed in order to decrease the possibility of discrepancies arising in the future. The results of this investigation have projected a possible solution to making biomedical databases consistently user friendly in medical research.

What is the Role of *Clostridium difficile* Carriage in Inflammatory Bowel Disease?

Presenter(s)
Alexander Gonsalves, Illinois Mathematics and Science Academy

Advisor(s)
Dejan Micic, University of Chicago
David Rubin, University of Chicago

Inflammatory bowel disease (IBD) is an autoimmune condition that results in inflammation of the intestines. *Clostridium difficile* is a bacteria that resides in the colon, occasionally resulting in serious infection. Our goal is to identify the role of *C. difficile* isolation in patients with IBD. At the University of Chicago IBD Center, subjects were recruited and completed an enrollment questionnaire along with a rectal swab to test for *C. difficile* by bacterial culture. Six-months after enrollment, a final questionnaire was completed. Clinical symptoms were defined using validated instruments. Logistic regression analysis was preformed to identify the role of *C. difficile* carriage on clinical outcomes. The study included 133 subjects (68.4% with Crohn's disease; age 41.5 $\pm$ 15.9 years), 70 (52.6%) of whom were male and 114 (85.7%) were white. Eighty-one (60.9%) were clinically asymptomatic at enrollment. Of the 133 subjects, 83 (62.4%) completed the final questionnaire, 55 (66.3%) of whom were asymptomatic. Seven patients developed worsening clinical symptoms over the study period. *C. difficile* at baseline was protective of a change in clinical symptoms (OR: 0.15, 95% CI 0.004-0.25). Patients with *C. difficile* in IBD are less likely to have a change in clinical symptoms over time.

Reprogramming of Veins Into Arteries for Cardiac Bypass Surgery

Presenter(s)
Sachin Govind, Illinois Mathematics and Science Academy

Advisor(s)
Kishore Wary, University of Illinois at Chicago

For coronary bypass surgery, the great saphenous vein is routinely used as a replacement graft. However, the venous graft often fails primarily due to “cellular mismatch,” as venous endothelial cells (ECs) have never seen oxygenated arterial blood before. Therefore, prior to grafting, reprogramming of venous ECs to arterial identity provides a clinically relevant approach to enhance graft patency and reduce the prevalence of graft failure. Cultured human saphenous vein ECs (hSapVECs) were treated with chromatin- modifying chemicals (5-Azacytidine, 5-Aza and Trichostatin A, TSA) and Wnt3a. To determine conversion to arterial fate, total RNA was prepared and subjected to qRT-PCR to amplify arteriovenous- specific genes. Treated hSapVECs showed significant increases in the expression of arterial genes and dramatic decreases in venous genes in a dose-dependent manner, indicating the ability of 5-Aza, TSA, and Wnt signaling to diminish venous identity and thereby induce arterial phenotype. Furthermore, microscopic examination of hSapVECs treated identically showed robust induction in the level of critical arterial-specific proteins. Importantly, this stimulation in an ex vivo experiment also induced robust neovascularization. We demonstrate that venous ECs can be epigenetically reprogrammed into arterial ECs. Thus, altering the venous ECs to arterial fate prior to grafting should minimize “cellular mismatch,” thereby increasing the chance of a successful saphenous vein graft.

The Effectiveness of Preventative Shoulder Exercise Programs in High School Softball and Baseball Athletes

Presenter(s)
Paxton Greco, Illinois Mathematics and Science Academy

Advisor(s)
Brian Kosan, Illinois Mathematics and Science Academy

Many baseball and softball players suffer from shoulder injuries due to overuse. Often times this happens in youth or high school age because of the lack of restrictions and preventative care provided for the players. This research project analyzed the effectiveness of different exercise programs to prevent shoulder injuries or soreness in the shoulder of baseball and softball players. We split up the baseball and softball teams into four groups: boys Blackburn and girls Blackburn, boys Thrower’s ten and girls Thrower’s ten. Blackburn and Thrower’s ten have been studied and practiced by will be the two programs that are used by athletic trainers and physical therapist. The participants filled out surveys throughout the intervention to see how the residual pain changed with the exercises. These results will be presented at IMSAloquium. The results of this investigation will show which of these two programs is better and will bring more attention to the prevention of overuse injuries in young athletes.

Structural Considerations for Novel Small Molecule Agonists at the CXCR4 Chemokine Receptor

Presenter(s)
Cindy Ho, Illinois Mathematics and Science Academy
Jessica Phung, Illinois Mathematics and Science Academy

Advisor(s)
Brittany Hopkins, Northwestern University
Richard Miller, Northwestern University

In a prior study by Mishra et. al, numerous novel drugs were identified as possible ligands of the CXCR4 receptor, which plays many roles in diseases such as human immunodeficiency virus (HIV), Warts, Hypogammaglobulinemia, Infections, and Myelokathexis (WHIM) syndrome, and at least 23 types of cancer. This study takes a more detailed look into one of the prospective agonists found in the screening of the study, drug 54118. When the CXCR4 receptor is activated, downstream signaling leads to increased levels of intracellular calcium ions. A calcium-imaging assay was used, in which human melanoma cells are incubated in fura-2 dye and injected with various concentrations of drug 54118 to see changes calcium levels. From calcium imaging, a dose-response curve was created from the data depicting the efficacy of the drug at different concentrations. Based on the results, 54118 was confirmed to be a robust agonist of the CXCR4 receptor, and the EC50 value was found to be 0.1497. By looking at possible agonists and antagonists for the CXCR4 receptor, new understandings and advancements in treatments for cancer, HIV-1 and WHIM can arise.

Effect of Cigarette Smoke Induced Chronic Obstructive Pulmonary Disease on Lung Endothelial Cells

Presenter(s)
Neal Modi, Illinois Mathematics and Science Academy

Advisor(s)
Kishore Wary, University of Illinois at Chicago

Chronic obstructive pulmonary disease (COPD) represents a progressive disease that makes it hard to breathe. Cigarette smoking that give rise to COPD is thought to be mainly due to the obliteration of airway epithelial cells. The occurrence of airway endothelial cell (EC) death in COPD was reported more than 50 years ago, however, the role of EC-dysfunction in relation to COPD remains unknown. Here we test the hypothesis that cigarette smoke activates EC genes, which might contribute to basement membrane dissolution and destruction of airway epithelial cells. We treated cultured human lung microvascular endothelial cells (hLMVECs) with cigarette smoke condensate (CSC) for 4 hours, prepared mRNA and determined the expression of genes known to be associated with the initiation and progression of COPD. In parallel hLMVECs were treated for 18 hours, thereafter subjected to Fluorescent Activated Cell Sorting assay to monitor apoptosis. Among the genes we examined, the expression of SERPINA-10 (an enzyme that counteracts the action of neutrophil elastase) decreased and IL-8 (an inflammatory cytokine) increased significantly. Further, CSC induced greater than 90% apoptosis of hLMVECs. These findings suggest that the CSC induced EC-dysfunction, which could in turn promote the destruction of airway epithelial cells giving rise to COPD.

Levels of Transforming Growth Factor Beta and Programmed Cell Death 1 in Normal and Cancerous Pancreatic Cells

Presenter(s)
Sneh Patel, Illinois Mathematics and Science Academy

Advisor(s)
Paul Grippo, University of Illinois at Chicago

Pancreatic cancer is the fourth deadliest cancer in America and it continues to take more lives every year. However, there are not many viable options to treat this pernicious cancer. We tested for levels of Transforming Growth Factor Beta (TGFB) and Programmed Cell Death 1 (PD-1) using Western blots. TGFB is used to suppress T cells which are responsible for targeting and destroying cancerous cells, so if we suppress TGFB there should be increased T cell activity. Furthermore, PD-1 also regulates T-cells, and inhibition of PD-1 should lead to specific targeting of the cancerous tumor. Therefore before clinical trials proceed, the levels of these two proteins in cancer cells need to be determined. Results showed that levels of TGFB did not increase significantly in cancerous cells and PD-1 was only expressed in the cancerous cells. Based on these results, we have concluded that TGFB is not necessarily an anti-cancerous agent and that PD-1 supports the growth of pancreatic cancer. Thus, further studies will need to be completed to analyze the relationship between TGFB and pancreatic cancer's progression.

Correlating Biomarkers with Muscular Properties in Stroke

Presenter(s)
Amy Xie, Illinois Mathematics and Science Academy

Advisor(s)
Kristen Jakubowski, Northwestern University
Sabrina Lee, Northwestern University

Stroke is one of the leading causes of long-term disability in the United States. Studying altered neuromuscular mechanics in stroke patients has significant applications in enabling physicians to treat changes related to muscle function. This study aims to correlate biomarker data from stroke patients with their biographical data and muscle architecture data-- quantified by clinical tests and measurements of muscle material properties in the upper extremity. A select set of inflammatory markers and regular biomarkers were first plotted in a scatterplot graph against biographical data. This same set of inflammatory and biomarkers were plotted against shear wave velocity and echogenicity data and then again against data from various clinical tests. The relationship between the data was analyzed using linear regression analysis and generated an r2 value for each graph. Significant correlations were found involving the variables Ostepontin, echogenicity, upper extremity Fugl-Meyer test, passive and active range of motion tests, shear wave velocity, and potassium. Finding these correlations contribute to developing a set of markers to be included in annual blood analysis. This application allows physicians to determine and diagnose onset or severity of stroke, revolutionizing methods for a leading global disability.

Neurobiology

Better Understanding the Anatomical Changes of Spiny Projection Neurons in Parkinson's Disease Through 3D Reconstruction

Presenter(s)
Jason Barraza, Illinois Mathematics and Science Academy

Advisor(s)
Savio Chan, Northwestern University
Harry Xenias, Northwestern University

The Globus Pallidus External (GPe) receives input from the Striatum (Str) as well as projects back to its spiny projection neurons (SPN). This pallidostriatal pathway was historically difficult to study due to technological restrictions. Recent advances in transgenic technologies allowed for the creation of a new mouse line to be combined with optogenetics, a genetic technique which causes specific cell types to fire action potentials using light-activated channels. To better understand the connection and electrophysiological significance in the pallidostriatal pathway, the GPe neurons can be excited through shining light on them while recording the Str projection neurons. In a Parkinson's disease experimental mouse model, it was found that GPe-Str connections became stronger and GPe- SPN contacts increased, meaning that electrophysiological properties were altered. A 3D reconstruction of SPN neurons is being performed, revealing the location of GPe-SPN connections in an effort to better understand these anatomical changes and connections. This will allow for mathematical analysis to determine whether these connections are becoming more sparse or clustered. In addition, the data will be able to be correlated to the locations of proteins which transduce inputs from GPe to signals in the SPNs.

Development of an Antibody-Targeted PET Probe for Early Diagnostic Imaging of Alzheimer's Disease

Presenter(s)
Adrian Bebenek, Illinois Mathematics and Science Academy

Advisor(s)
Erika Cline, Northwestern University
William Klein, Northwestern University
Kirsten Viola, Northwestern University

There currently exist no methods to diagnose Alzheimer's Disease (AD), which is the most common neurodegenerative disease characterized by progressive mental deterioration. The molecular focus on AD is shifting away from amyloid plaques and towards their peptide form- the amyloid-β oligomer (AβO). The pathology of AβOs and downstream tau more closely correlate with neuronal loss in comparison to amyloid plaques and have only been found in demented individuals, suggesting that AβOs initiate AD pathogenesis. We selected NU4 as our high-affinity, therapeutic antibody to direct our probe towards the desired target. In this study, we concluded that NU4 labels pathology distinct from traditional plaque stains and that NU4-DOTA retains its immunoreactivity to AβOs in vitro. Mice injected with NU4PET displayed a robust AD-dependent signal. The PET signal correlated with fluorescent intensity detected using immunofluorescent analysis. Human brains labeled with NU4 demonstrated pathology similar to that seen in mice, suggesting that mouse-derived NU4 can be used to target AβOs in humans. A study comparing age and sex dependence on AβO levels demonstrated that AβOs are present at 2 months of age in 5xFAD mice, 2-3 months before the onset of dementia. Conclusively, NU4PET demonstrates tremendous potential as an early diagnostic agent for AD.

Tumor Location in the Brain and its Effect on Survival of Glioblastoma Muliforme Patients

Presenter(s)
Lauren Bystrom, Illinois Mathematics and Science Academy

Advisor(s)
Lei Wang, Northwestern University
Paula de los Angeles, Northwestern University

Glioblastoma Multiforme (GBM) has an average survival rate of 12 months, making it the most aggressive form of brain tumor, and unfortunately it is also the most common brain tumor found in humans. GBM can also occur in any lobe or structure of the brain, which could possibly have an effect on the patient's long term survival. We pursued this line of inquiry by doing an analysis in the brain images to ensure that the images were an accurate representation of the subject and using FreeView we labeled each subject with the location of the tumor. Using these labels we are doing a statistical analysis of the location of the tumor compared to days of survival to find which, if any lobes or structures of the brain have a significant difference in survival. The results we get from this analysis will be presented and discussed at IMSAloquium.

Effect of Outside Stimuli During Sleep Stages

Presenter(s)
Gloria Choi, Illinois Mathematics and Science Academy
Kirstin Johnson, Illinois Mathematics and Science Academy

Advisor(s)
Moran Cerf, Northwestern University

Previous studies has shown that stimuli during certain sleep stages could potentially affect decision making skills in people. Our goal was to find what specific factors would affect our subjects during a sleeping state. To do so, we used a meditation device called MUSE headband to track the brain activity while subjects were asleep. The MUSE headband contains 7 brain sensors and has an application that translate the signals it receives into raw electroencephalographic (EEG) data. This headband and application provides real time brain rhythm while subjects were asleep. We then tracked their different sleep stages, and located the slow wave sleep stage and enacted various types of smelling stimuli such as different foods and fragrance to determine whether outside stimuli during sleep can affect future decisions.The main indicators were the sleep spindles and K-complexes shown in the EEG graphs. Our results showed that in the case of smelling stimuli, there was not a correlation.

Manganese and Zinc Alzheimer's Disease Diagnostic Probe

Presenter(s)
Esther Chung, Illinois Mathematics and Science Academy

Advisor(s)
William Klein, Northwestern University
Kirsten Viola, Northwestern University

A new iron oxide magnetic resonance imaging (MRI) probe has been developed to diagnose Alzheimer's disease (AD) earlier. It does this by using a NU4 antibody which binds to oligomers in the brain. Currently, many AD probes use antibodies that target amyloid plaques. However, there is evidence that oligomers occur earlier, making them a better target for diagnosis. My investigation was on a manganese and zinc probe, a modified version of this iron oxide probe. By adding both manganese and zinc, the magnetization of the probe is increased. In theory, an increase in magnetization will result in images that are much darker in areas where there is AD pathology. These images will help radiologists interpret images and diagnose AD patients with increased accuracy. However, before these probes can be tested with MRI, preliminary tests to determine its efficacy as a probe have to be conducted. Immunohistochemistry and immunocytochemistry were conducted on both the iron oxide and manganese zinc probes. The results were compared to determine the binding efficacy of the manganese zinc probe and whether or not adding these metals affected immunoreactivity. A toxicity assay was also conducted to determine if this probe is safe for human-use.

Morphological Properties of Diseased Astrocytes in the Hippocampus and Globus Pallidus

Presenter(s)
Divya Dureja, Illinois Mathematics and Science Academy

Advisor(s)
Savio Chan, Northwestern University

Little is known about the effects of Alzheimer's and Parkinson's disease on the astrocytes in the hippocampal and basal ganglian regions of the brain. In order to understand how astrocytes are affected in these parts of a diseased brain, images of astrocytes in diseased and non-diseased mouse brains were collected. Preliminary results, found using a sholl analysis, have shown that there is no significant morphological difference between astrocytes found in mice with the familial form of Alzheimer's disease and those found in control mice brains. In addition, other preliminary results show that there will be no significant morphological difference between the astrocytes found in mice with a familial form of Parkinson's and astrocytes in control mice brains. However, these results have yet to be confirmed, as the number of sample images in both experimental groups has grown. As this investigation continues, the results of this investigation could potentially identify the specificities of what neurological diseases do to astrocytes and redirect medicinal research.

Understanding the Chicken Embryo Model for Alzheimer's Disease-Related Research

Presenter(s)
Nathan Errampalli, Illinois Mathematics and Science Academy
Michael Qian, Illinois Mathematics and Science Academy

Advisor(s)
William Klein, Northwestern University
Kirsten Viola, Northwestern University

One major hallmark of Alzheimer's disease (AD) is the accumulation of toxic amyloid-β oligomers (AβOs), but scientists do not fully understand why this increase occurs. Most researchers currently use the transgenic mice model to understand the AD pathways, but some studies have shown that the chicken embryo may be a more suitable and less costly alternative because chickens and humans have identical Aβ peptides. The purpose of our study was to gather more information on this embryonic model. First, we observed the relationship between AβOs and APP in the brain tissues of embryos that have been fertilized for 6-14 days (E6-E14). After normalizing the brain extracts between all samples, we obtained the relative concentrations between APP and AβOs at each stage of development tested and determined that there is a statistically significant correlation between APP and AβOs ($p < 0.01$). In addition, we chose to test the abilities of chicken embryo cultures for drug testing research. Hotspot assays were conducted on 3-day-old E8 cell cultures to determine if synthetic AβOs will bind to the avian neurons. Because oligomers did not bind to the neurons, we concluded that we cannot perform drug testing research on cell cultures of the model.

The Effects and Role of the Natural Compounds Curcumin and Diallyl Trisulfide on Glioblastoma Cell Lines

Presenter(s)
Megan Estrada, Illinois Mathematics and Science Academy
Wincy Phine Mejias, Illinois Mathematics and Science Academy

Advisor(s)
Don Dosch, Illinois Mathematics and Science Academy

Glioblastoma, one of the most lethal forms of astrocytoma, has a median survival rate of fifteen months post diagnosis. Due to its multiple pathways that allow this cancer to quickly grow, divide, and invade the brain, glioblastoma has a high recurrence rate despite aggressive treatments. Our primary goal for this study is to determine the effect on cell viability of different compounds. Recently, natural substances have been used to impact cell growth of cancer cell lines. Throughout our experiment, we have maintained A172, which is a glioblastoma cell line. Using curcumin and diallyl trisulfide (DATS), compounds found potent against glioblastoma and naturally occurring in foods, we started treating these cells to induce apoptosis. Using the microscope to view the effects curcumin had on the cells, it was concluded that high amounts of curcumin manage to decrease culture growth. After treatment with DATS and curcumin, we determined the viability using an MTT Assay which measures the cellular metabolic activity.

Localizing GABAergic/Dopaminergic Hybrid Neurons

Presenter(s)
Nikitha Garapaty, Illinois Mathematics and Science Academy

Advisor(s)
Rajeshwar Awatramani, Northwestern University
Giuliana Caronia-Brown, Northwestern University
Jean-Francois Poulin, Northwestern University

Dopaminergic (DA) neurons are the primary source of the dopamine produced in the central nervous system. These DA neurons have recently been shown to have diverse molecular and physiological properties. A recent study implied that the SNc neurons may release the neurotransmitter, GABA, along with dopamine. Through our research, we aimed to localize these “hybrid” neurons which produce both GABA and dopamine together. To achieve this objective we utilized an intersectional approach. We crossed the VgatCre mouse line to a ThFlpo,Frepe mouse line. The first mouse line expresses Cre recombinase from Vesicular GABA transporter (Vgat), a gene that defines GABAergic neurons. The latter mouse line allows expression of Flpo recombinase only in DA neurons. When the VgatCre and ThFlpo gene are both expressed, the reporter gene expresses a green fluorescent protein (GFP), and this allows us to localize these “hybrid” DA neurons. The results showed 11% of SNc dopamine neurons as hybrid neurons. On the other hand, 19% of VTA dopamine neurons are shown as hybrid neurons. The results reveal a higher density of hybrid neurons in the VTA than in SNc. Further studies will be needed to determine the functional consequences of Vgat in DA neurons.

High-frequency Brain Activity Supports Architectonic Parcellation of Cortex

Presenter(s)
Alexis Giff, Illinois Mathematics and Science Academy

Advisor(s)
V. Leo Towle, University of Chicago

The cerebral cortex can be separated in a number of ways, including macro- anatomically and micro-anatomically. This paper compares anatomical gyri to cytoarchitectonic Brodmann areas. Gyri are typically more useful in a live patient, as they are easily identifiable ridges on the brain; meanwhile, Brodmann's areas are only examined postmortem, but can provide more details about neural organization. Since both methods of parcellation separate the cortex differently, the objective of this study was to evaluate which cortical classification system (cytoarchitectonics or classical anatomy) best mapped to patterns of electrical activity. We studied eleven epilepsy patients throughout the course of the investigation, at stable periods. Each patient underwent a series of language tasks, as well as magnetic resonance imaging scans. Using these tools, we compared waveforms from consecutive electrodes in both Brodmann areas and gyri and determined whether the latency/amplitude qualified them as similar in activation or different. Brodmann's areas better identified specific brain regions (73% correct), and more accurately predicted the location of exact functions, compared to gyral borders (58% correct). Overall, the difference between gamma activation in the two areas was extremely statistically significant. The repeat auditory condition was the most statistically significant, with a high number of border-following electrodes in Brodmann's areas.

Nerve Terminal Degeneration in Painful Diabetic Neuropathy

Presenter(s)
Cindy Ho, Illinois Mathematics and Science Academy

Advisor(s)
Nirupa Jayaraj, Northwestern University
Daniela Menichella, Northwestern University
Richard Miller, Northwestern University

Diabetes Type II affects at least 382 million people worldwide. One of the long-term complications of diabetes is diabetic neuropathy which leads to higher mortality and morbidity with painful diabetic neuropathy (PDN) as the most common cause of such pain, affecting about a quarter of diabetic individuals. Using Nav 1.8/cre X tomato reporter mice on a high fat diet which have the reporter gene Nav1.8 labeled with red fluorescence as a model for diabetes, the presence of nociceptors, which are nerves that sense pain, can be observed during the development and progression of diabetes over the course of 10 weeks. After cutting 20 micron skin sections of both regular diet (11% fat diet) and high fat diet mice (42% fat diet) with a cryostat, the tissue is viewed under a confocal microscope (FV10i) to compare the difference in the number of nociceptor nerve endings between the two types of mice. Preliminary results suggest that the number of nociceptors in high fat diet mice decreases over time with a complete lack of nerve endings by 10 weeks. Results from this study demonstrate the role of nociceptors in PDN and extend our knowledge of the mechanisms and treatments for diabetes.

Using Electroencephalography and Functional Magnetic Resonance Imaging to Identify Regions of Epileptic Seizure

Presenter(s)
Raghuram Koganti, Illinois Mathematics and Science Academy
Jiaxuan Li, Illinois Mathematics and Science Academy

Advisor(s)
Todd Parrish, Northwestern University

Our project sets out to find the effects of combining both electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) to pinpoint the regions of epilepsy in the human brain. On their own, MRIs and EEGs are useful in diagnosis, but the combination of the two is expected to be even more powerful in terms of spatial and temporal resolution. In order to collect our data, tests were run on patients diagnosed with epilepsy in the forms of the both fMRI and EEG. The patient completed simple motor tasks during scans, and then the data was analyzed for regions. At the moment, we do not have enough data to determine definite results or conclusions, but we expect to see a correlation in the EEG data with the fMRI activity, and if a correlation exists, then we are further able to determine those regions of epilepsy.

Assessing the Movement and Focus of Eyes During the Viewing of Advertisements with the use of Eye-Tracking Software

Presenter(s)
Ramyashree Lakshmanan, Illinois Mathematics and Science Academy
Shivali Shukla, Illinois Mathematics and Science Academy

Advisor(s)
Todd Parrish, Northwestern University

Advertisements are created to appeal to certain audiences in order to market a specific product. There are both popular advertisements and ones that fall short. This difference in their ranking has to be caused by specific factors in the advertisement itself. This investigation focuses on the movement of the eye and where it focuses in relation with the ranking of the advertisement using eye-tracking software which will output x and y coordinates that will be analyzed. We expect to see a difference in the location of the focus of the eye depending on if the advertisement is ranked high or low on a pre- determined popularity scale. Exact results will be presented at IMSALoquium. These findings support the hypothesis that there is a correlation between the focus of the eye and how “good” the advertisement is ranked. In the future, these results could be used to improve the quality of advertisements by incorporating the focus points of the better ranked advertisements.

An Examination of the Effect of Increasingly Complex Visual Stimuli on Brain State and Activity

Presenter(s)
Isabel Lee, Illinois Mathematics and Science Academy

Advisor(s)
Todd Parrish, Northwestern University

Our brains are arguably the most crucial organ in our body, comprehending what we see and sense. Yet for the great majority of human history, it has been incredibly difficult to look into it and perceive exactly what is happening. This has changed with the invention and popularity of the functional Magnetic Resonance Imaging (fMRI) machine; using fMRI, researchers are able to examine the brain spatially and concisely while subjecting the patient to a variety of stimuli. This investigation studied the response and activity recorded in the brains of subjects to a short video played while they were scanned in a fMRI machine. The video goes through several stages of complexity, starting from almost no visual stimuli and working up to a dynamic animation. The data from each scan was cleaned and processed with computer software, and then different regions of the brain were tested for correlation. In the end, my results show that some regions of the brain consistently change correlation depending on the stimuli shown, as different visuals will trigger different areas of the brain.

Ion Channels and Action Potentials in Primary Vestibular Neurons: Impact of Damage and Regeneration in the Vestibular Epithelium

Presenter(s)
Jessica Lee, Illinois Mathematics and Science Academy

Advisor(s)
Ruth Anne Eatock, University of Chicago
Antonia Gonzalez Garrido, University of Chicago

Vestibular receptors (hair cells) transduce head motions and transmit their signals to primary afferent neurons, but it is not known how death, and regeneration of the hair cells affects the signals of afferent neurons. To answer these questions, we compared the electrical signals of afferent neurons from control mice and mice treated with a toxin that selectively kills hair cells. We isolated the vestibular ganglion, comprising cell bodies of primary afferent neurons, dissociated the tissue in culture medium, incubated them overnight, and viewed them on a microscope. Using the patch-clamp technique, we recorded the fast sodium (Na+) current (I) and the voltage responses (V) of the neurons. To analyze the recordings, we calculate the conductance (G), and fit G(V) relations with the Boltzmann equation and compare the control against the toxin-treated data. Preliminary results suggest that Na+ currents are smaller in regenerated hair cells, as seen during development. We will obtain more data to test this hypothesis, and whether this change affects action potentials. This study will determine how the death and regeneration of hair cells affects the afferent neurons, which is relevant to treatment options for damaged inner ears.

Comparing the Sequence and Protein Structure Characteristics of Wild Type Copper-Zinc Superoxide Dismutase and Several Mutant Genotypes Commonly Associated with ALS

Presenter(s)
Wincy Faith Mejias, Illinois Mathematics and Science Academy

Advisor(s)
Sarah Oleary, Illinois Mathematics and Science Academy

The underlying cause of amyotrophic lateral sclerosis (ALS), a progressive neurodegenerative disease characterized by the selective death of motor neurons in the brain and spinal cord, is unclear. Scientists believe that approximately 20% of familial ALS is affected by the mutated copper-zinc superoxide dismutase (SOD1); however, how SOD1 causes ALS remains unknown. To gain a better understanding of the enzyme, we looked at multiple mutant structures and compared their protein characteristics to determine how certain mutations affect normal SOD1. We were able to find the secondary and tertiary structure of five mutant structures using the Molecular Modelling Database and Cn3D, an interactive examination of the sequence structure relationship using the National Center for Biotechnology Information database. We found that the original variants of SOD1 had specific point mutations associated with them along with specific differences in their secondary and tertiary structures. These changes included differences in the number of sulfate, copper, and zinc ions and the number of chains and interactions that formed the structure. The structural changes of SOD1 may cause it to gain a toxic property resulting in ALS. A further, more detailed analysis of the misfolded proteins may help answer how SOD1 could cause ALS.

The Analysis of Parkinson's Disease in Mice as Seen Through Astrocyte Morphology

Presenter(s)
Sruti Mohan, Illinois Mathematics and Science Academy

Advisor(s)
Savio Chan, Northwestern University

Parkinson’s Disease (PD) is a progressive nervous system disorder that causes the dysfunction and the gradual death of vital nerve cells. The pathology in the nerve cells can cause various motor dysfunctions, such as tremors, rigidity, postural instability etc. Glial cells, like astrocytes, are the most abundant cell type in the brain and ensure the proper function of surrounding neurons and helps sustain the communication in neuronal circuits. In this investigation, mice that are injected with agents that induce PD-like pathology and behavior are used to study astrocyte morphology. In ex vivo slices, astrocytes are injected with a fluorescent dye to fill the entire cell body and their processes. Confocal microscopy is then used to obtain stacked images of the astrocyte in ImageJ. Using a Sholl Analysis, data of the cell body size and total length and branch size of astrocyte projections can be obtained. This data will demonstrate the complexity of the astrocytes’ function and determine the differences in astrocyte morphology in cell from control and PD mice.

Creating an N-Methyl-D-Aspartate Receptor 2B-Specific Vector with Green Fluorescent Protein and Optimizing a Transfection Protocol.

Presenter(s)
Naima Muckom, Illinois Mathematics and Science Academy

Advisor(s)
Amanda Gross, Northwestern University
Roger Kroes, Northwestern University
Joseph Moskal, Northwestern University
Mary Schmidt, Northwestern University

N-methyl-D-aspartate receptors (NMDAR) play an important role in development and are also known to be associated with certain brain disorders. Commercially available NMDAR subunit specific antibodies from Cell Signaling and Abcam were shown to not be very specific and can skew results. The purpose of this investigation was to create a green fluorescent protein (GFP) tagged NR2B expressing vector that could be used to more accurately measure NMDAR2B trafficking. Following the successful creation of the GFP tagged NMDAR2B vector, the transfection protocol for this specific vector was optimized. The growth rate of the transfected cells and NMDAR2B protein expression of the transfected cells were measured in order to determine the most efficient protocol. Preliminary results of the transfection protocol suggest that changes in concentrations of chemicals used in the protocol can increase protein expression; these are being confirmed. Creating a vector with NMDAR2B and GFP will allow for examination of NMDAR2B expression in live cells, both *in vitro* and *in vivo*, and will provide a greater understanding of NMDAR function.

Effects of Home-Based Progressive Resistance Training on the Body Composition of Older Adults with Advanced Multiple Sclerosis

Presenter(s)
Irisa Myint, Illinois Mathematics and Science Academy

Advisor(s)
Lara Pilutti, University of Illinois at Urbana-Champaign

People with advanced multiple sclerosis (MS) experience mobility impairment, which worsens with the natural muscle loss caused by aging. Progressive resistance training (PRT) is a possible treatment for alleviating the severity of mobility impairment in MS by increasing muscle mass and improving function. Twenty-five elder, severely impaired individuals with MS were recruited to participate in 6-months of home-based PRT that consisted of 10 exercises done 2-3 times a week using resistance bands, and participants were randomly assigned to an exercise or wait-list control condition. Pre- and post-assessments measured whole-body soft tissue components and bone mineral content and density through dual-energy X-ray absorptiometry scans. There were no significant differences between conditions post-trial in percent body fat (P=0.71), fat mass (P=0.20), lean soft tissue mass (P=0.51), BMC (P=0.77), or BMD (P=0.81). However, effect sizes show higher fat mass (np^2=0.12), arm percentage of fat (np^2=0.11), and arm fat mass (np^2=0.13), as well as higher trunk lean soft tissue mass (np^2=0.15), and lower body bone mineral content (np^2=0.06) and density (np^2=0.06) in the intervention group post-trial. These results suggest that with further research and modifications to the study design, PRT may improve body composition in elder, advanced MS patients.

Optimization of a Phosphodiesterase (PDE) Assay to Determine the Effects of Vindeburnol on cAMP Levels

Presenter(s)
Charmaine Ong, Illinois Mathematics and Science Academy

Advisor(s)
David Braun, University of Illinois at Chicago
Douglas Feinstein, University of Illinois at Chicago

Derived from the vincamine plant, vindeburnol is a drug that has been shown to enhance release of noradrenaline, a key chemical in the regulation of neuroinflammation, in locus coeruleus neurons. Evidence shows that vincamine modulates cAMP levels in neurons, suggesting that vindeburnol is able to as well. Since the enzyme phosphodiesterase (PDE) breaks down cAMP, we use the PDE- Glo™ Assay to explore the idea that vindeburnol is a direct inhibitor of PDE, increasing cAMP levels. The assay is comprised of two separate reactions. In the first, PDE converts cAMP into AMP. In the second, AMP is converted into ATP, which is quantified as light, and is proportional to the amount of cAMP converted. Completed optimization of the second reaction shows that consistent peak light levels can be obtained for up to 20 uM AMP using a pH 7.8 buffer with 5mM Mg after 30 minutes of incubation at room temperature. We are currently optimizing the first reaction with respect to the concentration of cAMP, incubation time, and temperature. Following optimization, we will use similar conditions to thoroughly determine the effects of vindeburnol on PDE, and how its derivatives may work in animal models of Alzheimer's disease and multiple sclerosis.

The Efficacy of Neurofeedback when Applied to Post-Concussion Syndrome

Presenter(s)
Joseph Palakeel, Illinois Mathematics and Science Academy

Advisor(s)
Lori Russell-Chapin, Bradley University

Every year millions of people suffer concussions and need hospital care. Many patients are healed, but several are later diagnosed with what is known as Post-Concussion Syndrome (PCS), an adequate treatment for this condition is yet to be developed. This investigation was to determine whether neurofeedback could be used to treat PCS successfully. After conducting a preliminary electroencephalogram test followed by a head injury questionnaire and a problem checklist, neurofeedback treatment was applied to one patient. The final results were compared to the pre- test results. Five regions of the brain and respective brainwaves were treated, Sensorimotor Rhythm was aimed at Fz, O1, and Cz regions of the brain, Theta Alpha Gamma was aimed at FzPz, and Alpha aimed at Cz. After a period of twenty treatment sessions, the patient's condition improved, only a few symptoms remained. The data provides evidence that neurofeedback has a positive effect on those suffering from Post-Concussion Syndrome.

Creating Three-Dimensional Neuron Tracts Through Diffusion Tensor Imaging Applied To Post-Ischemic Stroke Patients

Presenter(s)
Tim Pan, Illinois Mathematics and Science Academy

Advisor(s)
Jun Yao, Northwestern University

Diffusion tensor imaging allows for visualization of white matter tracts by tractography. Methodology in this new magnetic resonance imaging (MRI) varies to match the desired use. In this study, methods of creating three-dimensional (3D) tracts were tested to analyze the corticospinal tract (CST) and somatosensory tract in post-stroke patients both before and after neurorehabilitation. Using an imaging software called FSL, I was able to superimpose the fractional anisotropy brain image with the T1 MRI image and create mask where the tracts have a higher probability of being found. The software then connected the tracts, producing a 3D visualizations of the tract which I then superimposed onto a 3D brain to show the tract in space. I found that the CST had the most reliable and reproducible results. However, the somatosensory tract results varied and I could not get a concrete methodology for this tract.

Identifying Toxic Amyloid-Beta Oligomers Species (AβOs) in Alzheimer's disease

Presenter(s)
Shrey Patel, Illinois Mathematics and Science Academy

Advisor(s)
Erika Cline, Northwestern University
William Klein, Northwestern University
Kirsten Viola, Northwestern University

In the field of neurobiology, there is great discussion about which particular species of amyloid-beta oligomers (AβOs) contributes to the pathogenesis of Alzheimer's disease (AD), a progressive neurodegenerative disease. Previously, our group has found, using molecular weight cutoff filters (MWCO), that AβOs are primarily 100-300 kilodaltons (kDa). The goal of this project is to verify this finding using size exclusion chromatography (SEC). SEC can be used to determine AβO molecular weight according to the amount of time it takes the AβOs to pass through the SEC column. Overall, the project yielded results showing significant portion of AβOs are either >1300 kDa or around 13 kDa. We are currently investigating further reasons why the MWCO and SEC data yield very different results.

An Electrocorticographic Study of Embodied Cognition in the Human Brain

Presenter(s)
Kate Pauss, Illinois Mathematics and Science Academy

Advisor(s)
V. Leo Towle, University of Chicago

Gamma activation in the motor cortex is often observed during language processing tasks in the human brain. Conventional neurology considers this phenomenon to be irrelevant in language comprehension and processing. In 2010, however, Pulvermüller theorized that gamma activity in the motor cortex during the processing of language nouns and verbs. In order to test this, epilepsy patients were tested using a semantic-based language processing task to collect wavelengths from electrodes implanted on the brain's surface, and an evoked potentials test in order to determine which electrodes were in contact with the motor cortex. Together, these data show whether electrodes over the motor cortex were activated during the processing of movement-related words. The results showed that the motor and language circuits are independent of each other.

Classifying Cortical Areas and Neurons Involved in Proprioception

Presenter(s)
Grace Ryan, Illinois Mathematics and Science Academy

Advisor(s)
Sliman Bensmaia, University of Chicago
James Goodman, University of Chicago

Proprioception is the body's ability to know the relative position of its parts in space and the force applied to them. The set of receptors in the body that provide proprioceptive information are well-understood. However, the specific computations that are performed by proprioceptive cortex are still unclear. Moreover, a clear functional distinction between motor and proprioceptive neurons in cortex has also proven surprisingly elusive. I analyzed neural data collected from electrodes in primary somatosensory and motor cortex during hand grasping behavior. I visualized this data using MATLAB to determine the time course of action potentials aligned to the moment at which hand movement started. Preliminary results suggest that the timing of spiking activity is indeed different between motor and proprioceptive sensory cortex. This information can inform improvements to the design of cortically controlled prostheses for controlling robotic limbs, which have yet to successfully implement sensory feedback vital for fluid movement.

The Effects of Antipsychotics on the Integrity of Thalamic Connectivity in Schizophrenia Patients

Presenter(s)
Braxton Schuldt, Illinois Mathematics and Science Academy

Advisor(s)
Anna Varentsova, Northwestern University
Lei Wang, Northwestern University

In schizophrenia, many patients take medications in order to relieve their psychotic symptoms. However, the effects of these antipsychotics on the connections within the brain are not completely understood. Many of these connections are associated with the thalamus, making it an important subcortical region to analyze when measuring connectivity throughout the brain. This study aimed to see if there was any effect of antipsychotics on the integrity of thalamic connectivity for patients with schizophrenia. For this study, diffusion weighted images from 22 subjects were used. The images were processed using the TORTOISE software package and this was followed by TBSS analysis. Then, data analysis was performed using the FMRIB Software Library. We found no statistically significant association between total drug exposure and the fractional anisotropy values of the thalamus ($p>0.05$). However, we found an asymmetric effect where the left side of the thalamus experienced a stronger association. This implies that, while our results are not significant, further studies can be done using different methodologies and more subjects to measure the association between thalamic connectivity and antipsychotic drug exposure.

Hand Movements and Hand Postures Encoded in the Brain

Presenter(s)
Anna Shabayev, Illinois Mathematics and Science Academy

Advisor(s)
Sliman Bensmaia, University of Chicago

Proprioception is the ability to know where the limbs are in relation to the rest of the body. My investigation was on how the hand has its movements and postures encoded in the brain. For this investigation a Rhesus macaque had its hand movements captured by a motion capture camera as it completed object grasping tasks. Simultaneously, the activity of neurons in the somatosensory cortex was also captured by chronically implanted microelectrode arrays embedded in the brain. It is known that proprioceptive information is processed in this area of the brain, but it is not known specifically how single neurons and populations of neurons encode specific kinematics of the hand. My main focus of this investigation was to see how hand movements and hand positions are represented by the neurons in the somatosensory cortex.

Inhibiting Epigenetic Histone Methylation Within Pediatric Brainstem Glioma via PRC2 Methyltransferase

Presenter(s)
Aadit Shah, Illinois Mathematics and Science Academy

Advisor(s)
Rintaro Hashizume, Northwestern University
Quanhong Grace Ma, Northwestern University

The pediatric brainstem glioma is one of the most deadly malignancies throughout the human body. Such pediatric central nervous system tumors are found to compose of approximately ten percent of all central nervous system malignancies in children. Thus, in attempts to inhibit this neoplastic growth, it was found that a protein complex associated with an epigenetic factor known as PRC2 methyltransferase was inhibited by the histone H3F3A gene mutation (K27M) in the encoded histone H3.3 protein that occurred in sixty percent of brainstem gliomas. This reduced methylation-induced gene silencing: creating abhorrent growth. As such, to counteract this neoplastic mutation, tests were performed to determine what aspect of the PRC2 methyltransferase complex could be modified to overcome the K27M mutation. Through analysis of the protein complex, SUZ12, a component of the PRC2 complex, was determined to be a potential target. After which, genomic editing of the glioma DNA was performed to remove SUZ12. This modified cellular DNA was then transfected and expressed in vitro cultures to observe the actual impact of SUZ12 absence in relation to tumor growth. This, in turn, exhibited the protein's significant impact upon uncontrolled growth and its inhibition was found to be a valuable anti-cancer target.

Analyzing the Function of Induced Pluripotent Stem Cells in Parkinson's Disease

Presenter(s)
Priya Sharma, Illinois Mathematics and Science Academy

Advisor(s)
Ben Hiller, Rush University Medical Center
Jeffrey Kordower, Rush University Medical Center
David Marmion, Rush University Medical Center

Each year in the United States, 60,000 people are diagnosed with Parkinson's disease (PD) which causes impaired motor abilities and tremors. PD is caused in part by the loss of dopamine neurons in the substantia nigra secondary to the loss of dopamine fibers in the striatum; so current research is focused on reversing those symptoms. The purpose of this study was to determine whether induced pluripotent stem cells reprogrammed to midbrain dopamine neurons (iPSC-mDA) can survive, innervate, and reverse motor disability in rats. A neurotoxin called 6-hydroxydopamine was injected in the brains of rats unilaterally to create a lesion mimicking the effects of PD. Rats were then injected in the striatum with iPSC-mDA neurons, which were hypothesized to reverse the motor symptoms or vehicle. To test the effects of the transplanted neurons, cylinder paw-touching and drug-induced rotation motor asymmetry tests were performed at baseline and every three (cylinder) and two months (rotations) for six months. In this study, iPSC-mDA neurons survived and projected TH fibers into the rat brain. Amphetamine-induced rotations were fully reversed; however we found no recovery in the cylinder task. Further studies are necessary to determine how iPSC-mDA neurons affect the lesioned rat brain.

Neonatal Alcohol Exposure Reduces the Volume of Cerebellar Lobules Without Affecting Number of Parvalbumin Interneurons in a Mouse Model of Fetal Alcohol Spectrum Disorder

Presenter(s)
Snigdha Sharma, Illinois Mathematics and Science Academy

Advisor(s)
Justin Rhodes, University of Illinois at Urbana-Champaign

Fetal Alcohol Spectrum Disorder occurs when a mother consumes alcohol during pregnancy, leading to physiological and neurobehavioral abnormalities and deficits in the brain of the fetus. This study investigated whether ethanol reduces the population of parvalbumin- expressing purkinje cells in the cerebellum of a mouse model of Fetal Alcohol Spectrum Disorder. Additionally, another objective was to find thickness parameters for stereological counts of parvalbumin positive cells in the cerebellum. The mice were injected with either 0.9% saline solution (which has no effect on brain development) or ethanol which was administered two times a day for 3 days. The brain was sectioned in sagittal 30 micrometer thick sections, stained as a 1-in-3 series, and then parvalbumin cells counted using stereology within specific lobules. The ethanol treatment reduced volume of lobules III, VI and VII without changing total number of parvalbumin- positive cells in these regions. These results suggest that the volume reduction is not caused by reductions in the number of the parvalbumin positive cells, suggesting that other cell types, or processes must be reduced to account for the ethanol-induced volume loss in the cerebellum. Results have implications for understanding the long term impact of ethanol exposure on development of the brain.

Time-Course Acute Intermittent Hypoxia Therapy in Individuals with Spinal Cord Injury

Presenter(s)
Simon Su, Illinois Mathematics and Science Academy

Advisor(s)
Zev Rymer, Rehabilitation Institute of Chicago
Milap Sandhu, Rehabilitation Institute of Chicago

Spinal cord injuries (SCI) interrupt the pathways between the brain and spinal cord, prompting profound impairment in motor control and disability. Despite recent advancements, individuals with SCI have few effective treatment options. A strategy to induce plasticity is exposure to acute intermittent hypoxia (AIH)–which constitutes breathing air containing low concentrations of oxygen (~10%) alternating with normal air (21%), for a brief period of time. AIH has been shown to significantly augment neuromotor function after SCI, as measured by ankle torque, gait speed, gait endurance and muscle EMG. However, the optimal time-course and dosage of this intervention is unknown. This study seeks to establish the time- course the time-course of AIH-induced improvement and decay of outcome (hand strength) in individuals with chronic incomplete cervical SCI. Grip strength and pinch strength was tested before and for five hours after a single session of AIH. Preliminary data suggests that AIH improves voluntary hand function in persons with SCI. It appears that effects of AIH persist longer than one hour. Experiments with a larger sample size are currently in progress. This study can ultimately determine the extent to which AIH therapy can improve overall function and quality of life in individuals with SCI.

Analysis of the Affect Auditory Stimuli have on Brain States and Networks Using Functional Magnetic Resonance Imaging

Presenter(s)
Katherine Swerbenski, Illinois Mathematics and Science Academy

Advisor(s)
Todd Parrish, Northwestern University

The brain has a default mode of functioning based upon the observed activation of particular brain networks when no explicit task is performed which can be referred to as resting state. The purpose of this study was to examine the affect auditory stimuli had on resting state and which brain networks were activated as we increased the complexity of the stimuli consisting of silence, tones, music, words and a story. These stimuli were played while a subject was scanned using functional Magnetic Resonance Imaging (fMRI) without performing an explicit task with their eyes closed. We analyzed the data collected from these scans using Northwestern University's Neuroimaging Data Archive's (NUNDA) resting fMRI analysis. We expected the images we collected to show that while the less complex stimuli are played brain networks associated with resting state will be active but as the stimuli become more complex other brain networks, particularly the language network, will be activated. However, initial results have been inconclusive. These results will tell us how the complexities of auditory stimuli affect which brain networks are active.

Death of Subthalamic Nucleus Neurons due to Mitochondrial Oxidative Stress in Huntington's Disease Mouse Models

Presenter(s)
Srivarun Tummarakota, Illinois Mathematics and Science Academy

Advisor(s)
Mark Bevan, Northwestern University

Huntington's Disease (HD) is a neurodegenerative disease that belongs to a class of hyperkinetic disorders which affect the basal ganglia. The role of the subthalamic nucleus (STN) in HD progression is relatively uncharacterized although prior experiments have shown that STN neuron firing is disrupted during HD. In other brain areas, mitochondrial oxidative stress has been shown to have a role in neuronal dysfunction in HD. This oxidative stress can also lead to production of hydrogen peroxide which is known to disrupt firing. Thus, to elucidate the role of oxidative stress in STN dysfunction, we used electrophysiological recordings to test the effect of degrading hydrogen peroxide with catalase on the firing phenotype of neurons. Catalase was able to return firing to normal providing evidence that mitochondrial oxidative stress underlies slowed firing. We also looked at potential cell loss due to mitochondrial oxidative stress by studying differences in the number of STN neurons in wild- type and 12 month old Q175 mice using unbiased stereological counting techniques. Our results showed that Q175 mice had a significantly lower number of STN neurons than wild type littermates. Thus STN neurons are dysfunctional in HD models due to mitochondrial oxidative stress, ultimately causing cell loss.

Cellular Pallidostriatal Connectivity Within a Parkinson's Disease Model

Presenter(s)
Neha Verma, Illinois Mathematics and Science Academy

Advisor(s)
Savio Chan, Northwestern University
Harry Xenias, Northwestern University

Parkinson's disease (PD) is a neurodegenerative disorder of the basal ganglia. Within these nuclei, the dorsal striatum(dSTR) is innervated by the external globus pallidus (GPe) via an inhibitory pathway. However, specific striatal targets and locations of GPe- SPN contacts have not yet been described. We used transgenic mice and a technique called whole cell patch clamp recording, which allows filling of recorded cells, dStr spiny projection neurons (SPNs), with fluorescent dyes. We then used confocal microscopy to image pallidostriatal contacts. This aided us in determining if the pallidostriatal projection in a PD model is altered. Finding the exact location of GPe-SPN contacts relative to the SPN soma provides indication about the nature of the GPe input. Contacts closer to SPN somas elicit stronger inhibition. Between two SPN cell types, we found GPe-SPN interaction varied. Contacts onto D2+ SPNs were more proximal than D1+ SPNs. Additionally, we found that in a PD model, GPe-SPN contacts onto D2+ SPNs occurred closer to the soma than in a healty model. However, GPe-SPN contacts onto D1+ SPNs occurred farther from the soma, contrary to our expectation. Understanding the pallidostriatal projection could provide insight into the pathogenesis of PD, and subsequently, its treatment.

The Effect of Shared Emotional States on Helping Behavior in Rats and its Basis in Empathy

Presenter(s)
Rongzhen Zhou, Illinois Mathematics and Science Academy

Advisor(s)
Peggy Mason, University of Chicago

Empathy is a complex psychological phenomenon that can motivate the occurrence of behaviors that benefit others in distress; we call this helping. In humans, the relationship between empathy and helping is modified by the emotional state of the potential helper. To test if the same holds true in rats, midazolam, an anxiety-reducing drug, was administered to a rat that could help his trapped cagemate by releasing him from a restrainer. Control rats received either saline or no injection. The two rats from the same cage were placed into an arena, with one rat in a restrainer in the center and the other rat free to move around within the arena. One-hour testing sessions were repeated for 12 days. We found that rats injected with midazolam did not help their cagemate although saline-injected and uninjected rats did. These data suggest that the ability to share another's distress is required for motivating helping, even in rodents. Movement analysis across the conditions will be presented. By studying helping and its basis in empathy in rats, we can develop a better understanding of biological contributions to empathy in people, and thereby improve relationships between people.

The Effects of Chronic Alcohol Exposure and Histone Deacetylase Inhibition on GABA-A Receptor Subunit Expression in the Rat Cortex

Presenter(s)
Rajangad Gurtatta, Illinois Mathematics and Science Academy

Advisor(s)
Subhash Pandey, University of Illinois at Chicago
Tara Teppen, University of Illinois at Chicago

The changes in gamma amino butyric acid-A (GABA-A) receptor function have been shown during acute and chronic ethanol exposure and its withdrawal. However, the changes in the mRNA levels of the GABA-A receptor subunits are less clear. In addition, ethanol withdrawal after chronic ethanol exposure shows an increase in histone deacetylase (HDAC) activity in the rat amygdala. We measured the gene expression of certain GABA-A receptor subunits (α1, α4, α5, and δ) in the prefrontal cortex of chronic ethanol and withdrawal rat groups using the Quantitative Real-Time Polymerase Chain Reaction. Cohorts of the control and withdrawal groups were treated with suberoylanilide hydroxamic acid (SAHA), an HDAC inhibitor, in order to test whether changes in HDAC levels would alter transcription of the GABA-A receptor subunits. It was observed that chronic ethanol exposure upregulated mRNA levels of the α5 subunit, which returned to normal levels during withdrawal. Transcriptional levels of other subunits were not significantly altered by ethanol treatment or withdrawal. The SAHA treatment during withdrawal did not alter the expression of any subunits of the GABA-A receptors. These results, although preliminary in nature, may suggest an important role for the α5 subunit in the dysregulation of GABA-A receptors during alcohol dependence.

Hippocampal Functional Connectivity in Breast Cancer Patients with CRCI

Presenter(s)
Khusbu Patel, Illinois Mathematics and Science Academy

Advisor(s)
Alexandra Apple, Northwestern University
Lei Wang, Northwestern University

Chemotherapy-related cognitive impairment (CRCI) can result in changes in memory, attention, and motor skills in cancer patients. These impairments can be short-term or affect patients for the rest of their lives. Previous studies have shown that functional connectivity is abnormal in hippocampi for situations involving cognitive decline, such as traumatic brain injury and Alzheimer's disease. Therefore, we hypothesized that a change in hippocampal functional connectivity may be present in CRCI. The hippocampus is a part of the default mode network, which is activated when the brain is not focused on a specific task. Thus, acquiring resting state functional magnetic resonance imaging (rsfMRI) data where the patient is not given a task could provide insight for the effects of CRCI. We utilized a novel task-regression technique to obtain pseudo-rsfMRI data from event-blocked data. Then, we compared resting state functional connectivity in breast cancer patients and normal patients. Preliminary results suggest that there is decreased hippocampal functional connectivity in breast cancer patients; however, definitive statistical analyses are needed to support this assertion.

Physics

Medium Correction for Proton Final State Interaction for Lower Simulation Deviation

Presenter(s)
Kyle Bachinski, Illinois Mathematics and Science Academy

Advisor(s)
Minerba Betancourt, Fermi National Accelerator Laboratory

Final State Interactions are the interactions of particles created by previous particle interactions. Simulated Proton Final State Interactions for show large variations from experimental. Final State Interactions are difficult and expensive to examine through experiments, making further research prohibitively resource intensive. If simulated Final State Interactions more closely matched experimental data, more accurate observations may be made. An accurate simulation is vital as some of the resulting particles may be absorbed, preventing observations. Simulations must accurately calculate the cross section, or the area in which the re-interactions occur, as the size of the cross section affects the probability of absorption. Some variations between experiments and the simulation may be attributed to the cross section of the interaction being calculated to be too large, resulting in a smaller distance between the smaller interactions of the Final State Interactions. A correction identified by Pandharipande and Pieper of Argonne was applied to the simulation with the intent to reduce the deviations from the experimental data by limiting the size of the cross section. It was found that the correction made reduced the discrepancy. This small change suggests that other factors may be at work in the experiment that have not yet been identified.

Understanding the Analysis of Ultrasonic Propagation in Ablative Materials

Presenter(s)
Felicia Chen, Illinois Mathematics and Science Academy

Advisor(s)
Carol Vorres, Industrial Measurement Systems Inc.
Donald Yuhas, Industrial Measurement Systems Inc.

Ultrasonic thermometry uses precise ultrasonic time-of-flight (ToF) to remotely measure temperature in materials without direct access to a hot surface and without disturbing the thermal transport at that heated surface. This technique has been used to measure the internal barrel temperature during firing of large Navy guns with sensors attached to the external barrel surface. This technique has also been used to measure the temperature of thermal protective materials during space vehicle re-entry. Ultrasonic thermometry relies on various propagation models to determine the estimated ToF of the ultrasonic wave. The scope of this SIR involves comparing various models and verifying model calculation results with laboratory experimental data on a known material. First, a simple model based on geometrical optics was compared to a MatLab wave propagation model. Secondly, several parameters such as sample size, sensor dimensions, frequency, ultrasonic velocity and attenuation were varied in the MatLab model to determine optimal settings and model convergence. Using optimal settings, the model was used to simulate the laboratory experimental conditions on a copper block test sample. Lastly, a series of ToF measurements were made on the copper block and compared with the model calculations.

The Effect of Media on Heat Distribution by 1860 Nanometer Wavelength Infrared Radiation

Presenter(s)
Kyle Brennan Feliciano, Illinois Mathematics and Science Academy

Advisor(s)
Claus-Peter Richter, Northwestern University
Xiaodong Tan, Northwestern University

Infrared radiation can be utilized to stimulate the nervous system. Its ability to travel through different media must be tested to ensure its safe use in living tissue. In this study, we analyzed the heat distribution patterns of infrared light in different media. Theoretical equations for heat distribution were employed as a basis for the experiment. Saline was used to observe heat distribution in a medium similar to nervous tissue, and heavy water was used as a comparison. Changes in temperature over time in about two square millimeters of the medium were recorded and analyzed in MATLAB. Preliminary results tell us that the heat absorption constant of saline and heavy water are different. This changes the beam profile of the infrared laser in each media, lengthening its reach into the medium when the absorption constant is low, and shortening it when the absorption constant is high. Through this study, we gained a better understanding of the interactions between infrared light and different media, which helps to prepare us for the use of infrared radiation in nervous stimulation devices like cochlear implants.

Search for the Standard Model Higgs Boson in Associated *WH* Channels Resulting in $b\bar{b}$ Decay in DØ Data Using Matrix Element Analysis

Presenter(s)
Alexander Gonsalves, Illinois Mathematics and Science Academy
William Tong, Illinois Mathematics and Science Academy

Advisor(s)
Ryuji Yamada, Fermi National Accelerator Laboratory

The Higgs boson is a particle that ultimately justifies the present, best explanation for mass. In the following investigation at Fermi National Accelerator Laboratory, data from the DØ detector was used in an attempt to find the real Higgs event. The particular form of multivariate analysis used in this investigation is called the Matrix Element method. By manipulating the probabilities generated from this method, a discriminant value that encapsulates the likelihood that a particular event contains a signal of a certain process may be calculated. Ultimately, while discriminant plots for data were successfully generated, the ultimate quality of the discriminants may be questioned, given odd variances in one of the data sets. Furthermore, while an event with a high discriminant certainly suggests a high probability of observing the chosen process, a discriminant value alone is not enough to qualify an event as a signal. Thus, the discriminants produced from this investigation may be seen as a starting point in determining whether the Higgs boson was truly sighted at DØ. Nonetheless, by the end of the investigation, around a dozen likely events where observed, meriting further investigation.

Decoherence and Dephasing Rates of the Fluxonium Qubit Under the Influence of Charge Noise

Presenter(s)
Aakash Lakshmanan, Illinois Mathematics and Science Academy

Advisor(s)
Jens Koch, Northwestern University
David Schuster, University of Chicago

Quantum computing provides significantly more efficient methods than classical computers for doing rigorous calculations such as encryption, search algorithms, and physical simulations. This is accomplished through the use of qubits which exist in a superposition of multiple states at once allowing for both complex and fast calculations. Environmental fluctuations interfere with these states and resulting in decoherence and dephasing and the break down of the algorithm. One type of qubit is the fluxonium: a superconducting artificial atom derived from the Cooper pair box. The purpose of this project was to analyze the effect of charge noise on the fluxonium qubit which, in the past, has never systematically been done before. Charge noise enters the qubit in the form of 1/f noise resulting in interference with the Cooper pairs, two loosely bound electrons, hopping between the superconducting island and reservoir. A program was developed to simulate the qubit's state over time by solving a stochastic differential Schrodinger equation numerically. The program simulated the noise by using its 1/f power spectrum. Looking into the both its wavefunction and density matrix, its dephasing and decoherence rates were determined for different inductive, capacitive, and Josephson energies. Results will be presented.

A Comprehensive Look at Nucleon Decay Modes for the DUNE Experiment

Presenter(s)
Lisa Lin, Illinois Mathematics and Science Academy

Advisor(s)
Maury Goodman, Argonne National Laboratory

Set to begin in 2021, the Deep Underground Neutrino Experiment (DUNE) is a particle physics experiment focused on the detection of the yet unobserved phenomenon of proton decay, a prediction of all Grand Unified Theories, which postulate the unification of strong, weak, and electromagnetic particle interactions. Though previous studies have placed limits on several nucleon (proton or bound neutron) decay modes, no experiment has published a comprehensive search for all such modes. Current lifetime limits of the modes were extrapolated and compared for both DUNE and Super-Kamiokande, the only currently ongoing proton decay experiment. A data table on an Excel spreadsheet and corresponding memo were created detailing the assumptions and calculations made for each mode, specifically the existing limits for each decay channel, algorithms used to extrapolate both experiments, and the likelihood of each discussed particle to escape the nucleus, rendering it visible to the detector. Preliminary extrapolations suggest that by 2053 DUNE's exposure will have surpassed that of Super-Kamiokande. It is recommended that more extensive analyses such as Monte Carlo simulations are performed for the most promising modes in the DUNE experiment.

Modeling and Simulation of Radiation Doses and Nuclide Distributions in the Mu2e Experimental Hall with MARS15

Presenter(s)
Tianyuan Lu, Illinois Mathematics and Science Academy

Advisor(s)
Vitaly Pronskikh, Fermi National Accelerator Laboratory

Mu2e is an experiment at Fermilab that will investigate the neutrino-less conversion of muons to electrons. The necessary muons will be generated by a relativistic proton beam hitting a tungsten target, which is expected to result in radiological hazards in the experimental hall. To model the emission of radioactive particles, we developed an algorithm in C++ as an extension to MARS15, a Monte Carlo code system that can simulate transport and interactions of particles. The algorithm is split into two stages. In the first stage, MARS15 generates nuclide inventories for regions in the model of the experimental hall. In the second stage, the Decay and Transmutation add-on to MARS15 adjusts these inventories for radioactive decay, and the resultant inventories are used to simulate the emission of gamma rays from regions in the model. Our results showed that the radiation levels in the remote handling room are only slightly above natural background levels, while those between the Production Solenoid and beam dump ranged from 100 to 10000 millirem per hour. Our algorithm may be adopted as a standard feature of MARS15 and assist other users in calculating residual doses in models of experiments in particle physics.

Analysis of Neutrino Events From the NUMI Beamline With NOvA Near Detector

Presenter(s)
Liam McParland, Illinois Mathematics and Science Academy

Advisor(s)
Zelimir Djurcic, Argonne National Laboratory
Maury Goodman, Argonne National Laboratory
Guang Yang, Argonne National Laboratory

Neutrinos are the most mysterious of the elementary particles that make up all matter in the universe. Nearly massless and rarely interacting with other matter, they are extremely difficult to detect. The NOvA experiment seeks to observe and place bounds on factors relating to their oscillation properties. This knowledge could provide insight into the formation of the universe and the interactions between matter and antimatter. Our research used a Monte Carlo prediction to produce simulated data that includes both a neutrino beamline simulation and the detector response model used in the NOvA experiment. We then used Root statistical and graphical analysis software to create plots comparing the simulated data with data collected at the NOvA Near Detector facility at Fermilab. We focused our analysis and extrapolation on neutrinos of energy range $0 < Ev < 5$. We compared the Monte Carlo data to organized data taken from established PIDs, or Particle Identification software, like Library Event Matching. We identified areas where there were significant differences in the data, and determined bounds on the existence of sterile neutrinos.

Improvements in Sensitivity and Background Modeling in WH→ℓνbb Matrix Element Analysis

Presenter(s)
George Moe, Illinois Mathematics and Science Academy
Nicholas Nusgart, Illinois Mathematics and Science Academy

Advisor(s)
Ryuji Yamada, Fermi National Accelerator Laboratory

In 2012, the 125 GeV Higgs boson was detected using high-energy ($\sqrt{s}$ = 7 TeV) collisions at the ATLAS and CMS detectors. However in the lower- energy collisions of the Tevatron collider, the evidence of Higgs particles was shown at 3 sigma, but not discovery. We present a search for such a Higgs boson in proton-antiproton collisions ($\sqrt{s}$ = 1.96 TeV) collected at the D0 detector. At these energies, WH→ℓνbb has the largest cross-section of any Higgs interaction, although it is minuscule compared to the background which includes look-alike single-top interactions such as Wt→ℓνbb. To effectively separate signal from background, we use an implementation of "Matrix Element" analysis, which uses leading order matrix elements to compute event probability densities for each possible interaction (both signal and background) and rate events with a "discriminant" based upon the likelihood of a signal. We pair these discriminants with cuts derived from known characteristics of the Higgs boson, such as its invariant mass, to isolate probable Higgs events. There are some promising events with a very high likelihood of being Higgs events; these results will be discussed in detail during our presentation. We hope that this novel approach may be useful to future measurements in identifying low-cross- section interactions in noisy situations.

Quench Degradation Limits and Mechanisms of High Current Density Ag/Bi-2223 Superconducting Tapes

Presenter(s)
Jason Wu, Illinois Mathematics and Science Academy

Advisor(s)
Tengming Shen, Fermi National Accelerator Laboratory

Quench degradation properties are important issues in understanding the stability of high-temperature superconductors (HTS). With a growing interest in Ag-alloy- sheathed $BiSr_2Ca_2Cu_3O_{8+x}$ (Bi2223) as an implementable HTS for commercial applications in high-field magnets, it is crucial that its quench behavior and degradation limits, including conditions that decrease its critical current, are well understood. However, there still is a knowledge gap for Ag/Bi2223 tapes. This investigation aims to experimentally determine quench degradation behaviors and the temperature limit that can be used to develop an effective quench protection system. Short samples of control-overpressure processed (CT-OP), high current density Bi2223 from Sumitomo were quenched with a local heater at 77 Kelvin. Under varied quenching conditions, the voltage and temperature changes were recorded and analyzed to identify any correlation. Preliminary results suggest that the Bi2223 samples showed a highly significant sensitivity to temperature during quenching, exhibiting irreversible decreases in critical current at < 200 Kelvin.

Analyzing Different Categories of Stars and Star-like Objects Within the Dark Energy Survey's Camera System

Presenter(s)
Jack Mueller, Illinois Mathematics and Science Academy

Advisor(s)
Douglas Tucker, Fermi National Accelerator Laboratory

The Dark Energy Survey (DES) was designed to discover the effects of Dark Energy throughout the known universe. Dark Energy is an unknown property which causes the universe to expand at an accelerating rate. The DES seeks to measure redshift, the elongation of light by objects traveling away from an observer. DES analyzes the relative brightness of objects using 5 filters to create infrared/near-infrared spectra and determines how colors of objects change with redshift. During my previous investigation, I studied DES data and discovered that some objects had different color patterns than others. This SIR, I sought to discover what these objects were. At first, I suspected that they were active galactic nuclei, the centers of galaxies, but quickly found that these only accounted for some of the unusual data. I then learned that these objects could instead be white dwarf binary pairs of stars and plotted the redshifts of those objects. Graphing the colors of these pairs against the DES data showed that my hypothesis was correct. In summary, my results indicate which classes of stars exhibit unusual data patterns in the DES Camera filter system confirming trends in brightness of the DES data.

Field-Programmable-Gate-Array Implemented on Time-to-Digital Converter: Improving its Resolution

Presenter(s)
Soomin Park, Illinois Mathematics and Science Academy

Advisor(s)
Jin-Yuan Wu, Fermi National Accelerator Laboratory

The purpose of this investigation is to discover critical experimental factors that could lead to the variation of time measurement by a time-to-digital converter (TDC) implemented on field-programmable-gate-array (FPGA). Two pulses were generated by a pulse generator, and the second pulse was given a 20 nanoseconds delay. In an ideal experiment, the mean of the entry data would have been 20 nanoseconds since the two channels (8,c) obtained pulses that were given the same delay. However, due to device errors and quantization errors, which is produced during analog-to-digital conversion, time difference between hits varied from 22.1 to 22.7 nanoseconds. The top test results have shown that the time measurement better than 80 picoseconds was obtained for more than ten tests. FPGA can be used as a base gadget to improve TDC resolution, and although still at the state of development, this particular application will continue to develop and ultimately improve resolutions of Positron Emission Tomography scanners (PET scanner) and future medical imaging.

Bayesian Statistics and Estimating Stellar Masses in the Blind Cosmology Challenge and the Dark Energy Survey

Presenter(s)
John DeMastri, Illinois Mathematics and Science Academy

Advisor(s)
James Annis, Fermi National Accelerator Laboratory

The purpose of this investigation was to apply the techniques and strategies developed on simulated data over the course of the summer on actual data from the Dark Energy Survey. Bayesian techniques were developed to measure the stellar masses of galaxy clusters through the use simulated data from the Blind Cosmology Challenge (BCC) using models derived from Simha et al (2014) and Conroy and Gunn's FSPS. Our analysis of data from the BCC mirrors the results of the Canada France Legacy Survey for high mass galaxy clusters (clusters of at least 10^13 stellar masses). There is discrepancy at lower masses because the BCC underestimates the size of central galaxies in lower mass galaxies. We are currently awaiting results on our analysis of galaxies cataloged by the Redmapper galaxy catalogue and these results will be presented at IMSAloquium. We can conclude that Bayesian methods of analysis can provide accurate results when applied to live data. Additionally, since this Bayesian technique provides not the best fit value, but rather, the most likely value, our estimates for stellar mass could be useful as a proxy for the galaxy richness, a key variable when analyzing and modeling the cosmology of a cluster.

Psychology

The Effect of Perspective Taking on Moral and Religious Convictions

Presenter(s)
Baylee Blackburn, Illinois Mathematics and Science Academy

Advisor(s)
Allison Mueller, University of Illinois at Chicago
Linda Skitka, University of Illinois at Chicago

In my study I examined whether taking on the perspective of someone with an opposing viewpoint on the issue of abortion can backfire. Usually, perspective taking is helpful to blur the line between two sides and help people to sympathize with the other side of the issue. However, we hypothesized that in the case of high moral and religious conviction, perspective taking will create a bigger difference between the in-group and out-group. To test this hypothesis, we asked all participants to read convincing arguments on the issue of abortion that they opposed (i.e., pro-life participants read pro-choice arguments, and vice versa). However, the instructions we gave them for this task varied: We randomly assigned people to either take the perspective of the writer (perspective taking condition) or to pay attention to the writing style of the passage (control condition). Then, we recorded whether their moral and religious conviction towards the issue increased or decreased from their baseline levels of conviction. The investigation is still ongoing, but we predict that when asked to take on the perspective of another opposing party, people are more likely to double down on their own convictions instead of being swayed by the other side's arguments.

The Effect of Social Anxiety on Acute Responses to the Drug MDMA (Ecstasy)

Presenter(s)
Kasey Cervantes, Illinois Mathematics and Science Academy

Advisor(s)
Kasey Van Hedger, University of Chicago
Harriet de Wit, University of Chicago

MDMA, commonly known as ecstasy, is a recreational drug that has been shown to increase sociability in its users. Acute prosocial and drug effects are explored in relation to individual differences in social and general anxiety. A three session, double-blind, within subject study design was deployed in which 60 subjects received placebo, a low dose of MDMA, and a high dose of MDMA. At several time points after administration, participants self-reported data of their mood and any drug effects they felt. These responses were compared to the participants' trait levels of social closeness and stress reaction. Based on prior research and a graph of drug effects over time (0-240 minutes after drug administration), 120 minutes was determined to be the time of peak drug effects. Preliminary results show that individuals' social closeness trait is not significantly correlated with state anxiety at 120 minutes for any dose. However, individuals' stress reaction trait is negatively significantly correlated with how much participants like the effects of MDMA at 120 minutes for low and high dose. Individual's trait anxiety is likely to affect the acute responses of MDMA. In psychotherapy, MDMA could have different effects on different people because of their different traits.

Creating Deeper Engagement in Serious Video Games

Presenter(s)
Madison Dong, Illinois Mathematics and Science Academy

Advisor(s)
Patrick Jagoda, University of Chicago
Ashlyn Sparrow, University of Chicago

So-called "serious" video games, focused on political, social, or cultural topics, have the ability to change a player's attitude towards a subject and even contribute to social change. Game developers have created serious games, such as Depression Quest, Third World Farmer, and The Migrant Trail that seek to accomplish these tasks. However, these games struggle to balance learning objectives, attitudinal and behavioral change, and player engagement. Examining survey data of player experiences with entertainment- oriented games reveals certain features key in engaging a player. Drawing on work by Patrice Bouvier, Elise Laboue, and Karim Sehaba from the University of Lyon, I am defining engagement as: immersion, involvement, presence, and flow, along with four types of engaged behaviors: environmental, social, self-directed, and action-directed. By understanding and implementing these features into design, it may be more possible for developers to not only create more engaging entertainment games, but also more engaging serious games that have the ability to more effectively impact attitudes and behaviors of players. Completion of examination revealed specific features of video games.

Cross-cultural Differences in Personality among Ethnicities in the United States and Races Worldwide

Presenter(s)
Samhita Inampudi, Illinois Mathematics and Science Academy

Advisor(s)
William Revelle, Northwestern University

People differ both within and between cultures. This study was designed to examine similarities and differences in personality between different ethnic identities within the United States and ultimately with the country of origin. Using a large data set (n=191,893) collected over the web by the Synthetic Aperture Personality Assessment Project (SAPA) and the R statistical data analytic package, descriptive graphics and statistics were implemented to compare the differences in mean levels of ten ethnicities in the United States and the corresponding countries as well as the correlational structure within each group. The results show that there is very little variance of personality between ethnic groups and between people of different countries. However, since the sample size is large, the results shown are very precise. It can be concluded that while groups do not differ much, the differences that exist per personality factor are very reliable. These results help understand personality to a greater degree and can therefore help understand the behavior of people in order to help them.

The Effect of Visual and Auditory Reaction and Memorization Based Tasks on Temporal Judgement

Presenter(s)
Ryan Johnson, Illinois Mathematics and Science Academy

Advisor(s)
David Evenson, Illinois Mathematics and Science Academy

There is a common phrase time flies when you are having fun, and most people would agree with that. This study sets out to discover what effect certain aspects of tasks have on ones perceived passage of time. A survey comprised of a visual reaction test, a visual memory test, an auditory reaction test, and an auditory memory test was sent out to all current IMSA students. Upon completion of all four tests, the participants were asked to fill out a questionnaire which asked them to rate each task on a scale from one to ten on how long they felt the task took. All tasks felt statistically longer than the visual based reaction task, and the auditory memorization task felt statistically longer than the auditory reaction task. Lastly, the visual based memory test felt marginally statistically longer than the auditory reaction test. The data that has been collected shows that people find reaction based tasks shorter in length than memory recall based tasks, and that people find auditory based tasks longer than visual tasks, but that the temporal difference between auditory reaction and visual memory is only marginally significant, confirming the results of similar studies.

The Effects of Physical Activity on Linguistic Memorization

Presenter(s)
Linnea Lee-Brown, Illinois Mathematics and Science Academy

Advisor(s)
David Lundgren, Illinois Mathematics and Science Academy
Jay Thomas, Aurora University

The current study will determine whether exercise improves short term linguistic memory in students. Students of the Illinois Mathematics and Science Academy (IMSA) who do not speak Russian were tested in this investigation. The same list of twenty Russian words and their English translations was read to the participants, and the participants then exercised or watched appropriate YouTube videos, each for twenty minutes. After twenty minutes, each participant was given one of the six randomized test lists with ten of the twenty Russian words, and the participants had to tell us the English translations for as many of the words on the test list as possible. Results were analyzed using a matched pairs T test which compared the test scores of those who exercised, and those who did not. Final results will be presented at IMSAloquim.

Frequency of Marijuana Use and its Impact on Skill Development and Academic Achievement in Homeless Youth Populations

Presenter(s)
Jaszmine Simmons, Illinois Mathematics and Science Academy

Advisor(s)
Scott Hunter, University of Chicago

Homeless youth populations are exposed to numerous external factors that impact their development. Heavy substance abuse, in specific marijuana use, is common in these populations. The purpose of this study is to examine the frequency of marijuana use and its impact on executive functioning and academic development in emerging homeless youth populations. Interviews were administered to one-hundred forty- eight individuals ranging in age from 18-22 years old. Participants in the study were given the Wechsler Abbreviated Scale of Intelligence (WASI) test, the Wide Range Achievement Test (WRAT), and the California Verbal Learning Test (CVLT), measuring IQ, academic achievement, and memory, respectively. The Youth Risk Behavior Survey was also administered to define heavy use in the sample population. Similar studies have found that frequent exposure to cannabis has had negative effects on IQ, impairs emotional memory, and cognitive performance. Preliminary findings have suggested that heavy use will have a similar impact on executive functioning and academic development in homeless youth populations.

Monogenic Diabetes and its Cognitive Difficulties Concerning Executive Function

Presenter(s)
Alexa Tyszka, Illinois Mathematics and Science Academy

Advisor(s)
Megan Scott, University of Chicago

Monogenic diabetes is a rare, genetic form of diabetes with a low prevalence rate. Research in monogenic diabetes has established that most of this population has deficits in areas of neurological functioning, but there is a wide range of presentations depending on the specific mutation. Neuropsychological research is important, as the population is small and medications may not treat all symptoms. The subjects in this study had an average age of 14. We included only those with the R201C or R201H mutation. Subjects with low IQ were removed(n=15) for one part of analyses, and included(n=17) for the other. Brief neuropsychological tests were completed with monogenic patients as part of ongoing research at the University of Chicago. This set includes data from neuropsychological assessment including tests on behavioral functioning, adaptive functioning, attention, and executive function. These tests were the BASC, WAIS, BRIEF, Vineland, DKEFS, and VMI. Subjects who preformed poorly on the executive function tasks that required them to problem-solve also had difficulty adapting during daily living, as well as reported adaptive function. Problem-solving was the area with the most connections to low IQ and function. We were able to further understand the function of those with monogenic diabetes, as well as hypothesize why there were connections between specific areas relating to function, allowing us to help people with monogenic diabetes.

How Students Adjust: Analyzing the Accuracy of the W-Curve Theory to IMSA Sophomores

Presenter(s)
Zachary Ungerleider, Illinois Mathematics and Science Academy

Advisor(s)
Quinton Backstrom, Illinois Mathematics and Science Academy
David Evenson, Illinois Mathematics and Science Academy

The W-Curve Theory of Adjustment describes a student's varied emotional stages upon entering a residential academic setting for the first time. While the W-Curve Theory is founded upon research studies surrounding adults in new environments, it has never been proven to be accurate to high school students. We are setting out to determine whether the W-Curve is an accurate description of the transition into IMSA, using Plutchik's Wheel of primary emotions for reference. The data collection portion of this SIR will take place during the 2016- 2017 school year with the IMSA class of 2019, who will be surveyed on a regular basis and plotted on graphs expressing their emotional states over time. Should the W-Curve prove to be statistically accurate, this investigation will serve as a reference for its accuracy in the future; in the case that the Curve proves to be inaccurate, the data obtained will also be used in an attempt to find a more accurate pattern to describe student adjustment. A better understanding of how sophomores adjust to the IMSA environment will help parents, staff, and students themselves navigate through the adjustment process, and how we can all work to make the transition as smooth as possible.

The Relationship Between Parent Praise, Math Anxiety, and Students' Theories of Intelligence

Presenter(s)
Amy Yu, Illinois Mathematics and Science Academy

Advisor(s)
Sian Beilock, University of Chicago
Lori Petersen, University of Chicago
Marjorie Schaeffer, University of Chicago

Parents' attitudes, behaviors and beliefs play an important role in the development of their children. Therefore, it is important to understand how parents can influence their children during early childhood, the time when children are the most susceptible to influence. In this study, I investigated how parents' math anxiety and theories of intelligence can impact parental feedback and praise, and in turn, how these factors can impact children's math anxiety and theories of intelligence. Forty-seven first-grade children and their parents were recorded working through math problems in an app called "Bedtime Math." Fifteen videos were coded for a variety of variables based on parents' feedback, praise, persistence, and motivation. The results suggest that parents who are more math anxious are less responsive to their children while working on math problems. There is also evidence to demonstrate that parent math anxiety is related to their children's levels of math anxiety, and that a relationship exists between parents' math anxiety and their theories of intelligence.

Social Science

A Study of Bias in Perceived Leadership Ability

Presenter(s)
Alec Elston, Illinois Mathematics and Science Academy

Advisor(s)
Michelle Hoehn, Illinois Mathematics and Science Academy

Leadership potential is one of the most coveted traits in candidates for college admissions, jobs, and promotions. However, one's perceived leadership ability may be impacted significantly by bias. This project studies correlations between race, gender, and perceived leadership ability, as well as correlations between race, gender, and perceived professionalism, intelligence, and motivation, which have been shown to impact perceived leadership ability. Subjects were asked to rank how important motivation, intelligence, and professionalism are to leadership ability. Then, they were given images of three people, male or female, black or white, and dressed in formal, semiformal, or informal attire, and asked to rate each person's motivation, intelligence, and professionalism, based solely on their appearance. Results will be presented at IMSAloquium.

Shinto and Japanese Youth Today

Presenter(s)
Gabriel Jankowski, Illinois Mathematics and Science Academy

Advisor(s)
Jonathan Besancon, Illinois Mathematics and Science Academy

Shinto, the native religious traditions of Japan, has been around for millennia, and has thus become part of the way of life of most Japanese people. However, young people have become increasingly less religious, and therefore the beliefs of Japanese youth pertaining to Shinto, is a valuable field of study. I produced a survey and administered it on Japanese high school students. Results to be discussed.

Effects of Computerized Note-taking Versus Handwritten Note-taking on the Test Scores of Illinois Mathematics and Science Academy Students

Presenter(s)
Sarah Leahy, Illinois Mathematics and Science Academy
Mackenzie Smith, Illinois Mathematics and Science Academy

Advisor(s)
Amy Keck, Illinois Mathematics and Science Academy

Taking notes has been found to increase recollection of facts from reading and lectures, although research contradicts whether computerized or pen-and-paper notes produce better test scores. Our research was to study whether typed or handwritten notes were more effective for retaining information for tests and quizzes. Our objective was to see which of these two methods appear to produce better test scores among IMSA students. Data was collected from classes who agreed to participate in the anonymous study. Each student indicated on the quiz which method they used to take notes and we compared the two methods for each assessment. We also worked in IMSA's dormitories, where we made our own lessons for students to take notes on and then complete a quiz. As collected with class data, each student anonymously indicated note-taking method then took the quiz. The findings of our research will better enable others to select a method to more effectively take notes. The results of our research will be presented at IMSAloquium.

The Effects of Attending a Residential Summer Camp on Youth Between the Ages of 5 and 18

Presenter(s)
Tess Mangan, Illinois Mathematics and Science Academy

Advisor(s)
David Evenson, Illinois Mathematics and Science Academy

Camp has made a difference in many children's lives, however some parents choose not to give the experience to their children. In this investigation, a child's leadership skills, friendship making skills, and independence were examined to see the effects that attending a residential summer camp had on the child. To collect the data a survey was created that was 14 questions long. The questions ranged from the number of years the child attended a residential summer camp to how they have seen themselves grow. The findings of this investigation will be presented at IMSAloquium.

Genuine and Non-Genuine Smiles in Married Couples: Associations with Well-Being

Presenter(s)
Samantha Murphy, Illinois Mathematics and Science Academy

Advisor(s)
Claudia Haase, Northwestern University
Taylor Shelton, Northwestern University
Ryan Svoboda, Northwestern University
Sara Thomas, Northwestern University

The present laboratory-based study investigates associations between spouses' genuine and non-genuine smiles during a marital conflict discussion and well-being (i.e., life satisfaction; marital satisfaction). Fourteen married couples (N = 28 spouses) engaged in 10-minute video-recorded conversations about a disagreement in their marriage. Two trained raters coded the frequency of genuine (i.e., Duchenne) and non-genuine (i.e., non-Duchenne) smiles during the conversation using the Faction Action Coding System. Life satisfaction and marital satisfaction were assessed using well- established questionnaire measures and showed high internal consistency. We expect that spouses with (a) greater levels of genuine smiles and (b) a greater ratio of genuine to non-genuine smiles will show greater life satisfaction and greater marital satisfaction. We also explore whether (c) greater overall levels of smiling will be linked to greater marital satisfaction. Findings will be controlled for gender (as we expect women to smile more). The expression of non-genuine smiles may be a meaningful predictor of lower individual and relational well-being. Future research could investigate potential mechanisms for this relationship.

Correlations Between Hours of Sleep and Educational, Social, and Physical Characteristics

Presenter(s)
Mariah Yelenick, Illinois Mathematics and Science Academy

Advisor(s)
William Gentzler, Illinois Mathematics and Science Academy

Sleep is one of the most important factors in student success, both academically and socially. Although many schools recognize the importance of sleep for their students, they fail to make changes that allow or help their students to get more sleep. In order to observe how sleep, or a lack thereof, affects students' lives and grades, surveys were sent to students of Illinois Mathematics and Science Academy, as well as students of Watseka Community High School to see if students under more academic pressure had significantly different sleep habits or perceptions of the quality of life. Using the results of these surveys allowed us to make overall conclusions about sleep habits of high school students as well as a unique comparison in sleep habits of two different types of schools. Findings will be discussed during the presentation.

Perceptions and Effects of Science and Math Gender Stereotypes Upon Illinois Mathematics and Science Academy Students and Parents

Presenter(s)
Amy Yu, Illinois Mathematics and Science Academy

Advisor(s)
Leah Kind, Illinois Mathematics and Science Academy

Women have continually been underrepresented in the science, technology, engineering, and math (STEM) fields, even with all the advances made in the world today. In this investigation, I examined how Illinois Mathematics and Science Academy students and parents perceive math and science gender stereotypes, and how these perceptions affect the students. Students filled out surveys that assessed their self-perceptions of their skills in different courses, the kinds of toys they played with during childhood, the amount of parent involvement in their school work, and the effects of different classroom environments upon them. Parents were also interviewed to gain a deeper understanding of their thoughts on gender stereotypes and how their perceptions may have impacted their students. Results and conclusions will be presented at IMSAloquium.

Understanding the Effect of Design Education on Students' Outlooks of the Future

Presenter(s)
Tian Lin Yuan, Illinois Mathematics and Science Academy

Advisor(s)
Erin Huizenga, Till School

Design is the practice of creating a solution to enhance a situation. The design process promotes interdisciplinary thinking to encourage greater innovation, which suggests that undergoing the design thinking process will motivate students to participate in their community. The purpose of this study is to determine if design education has a significant positive effect on student motivation to succeed and participate in their community. A survey addressing students' engagement, motivation, and beliefs will be conducted on 18 15-18 year old students of the Illinois Mathematics and Science Academy. Participants were split into two groups: 9 students who have received a design education and 9 students who have not. Preliminary results suggest that design education does help improve the way in which students reach out to others in the community. Findings will help education systems to determine the importance of including design into its curriculum, which may change how schools teach community outreach.

Space Science

The Efficiency of the Large Synoptic Survey Telescope for Finding Planet Nine-Like Objects

Presenter(s)
Varun Iyer, Illinois Mathematics and Science Academy
Nicholas Michuda, Illinois Mathematics and Science Academy

Advisor(s)
Mark Subbarao, Adler Planetarium

The alignments of distant Kuiper Belt objects suggest the presence of another gravitational object in the Solar System, currently denoted as Planet Nine. The object has not been observed by current sky surveys, however given its predicted orbit, its location is likely to be in the observational limits of the future Large Synoptic Survey Telescope (LSST). The telescope will conduct a ten-year survey of the sky that will produce a comprehensive catalogue of objects 10-100 times greater than the current record, improving models of Solar System formation and evolution. This investigation compares current mapping strategies of LSST in their ability to observe Planet Nine- like objects, given its expected orbit. A metric was designed to calculate the probability Planet Nine is in the observational limits of the survey, using LSST Stack software and Anaconda Python framework. Running simulated sky surveys with mapping strategies of LSST through this metric provide a strategy’s chance of observing Planet Nine. Preliminary results suggest that strategies extending north have a greater probability in observing Planet Nine. The metric created for this investigation can be applied to find other objects like Planet Nine during the lifespan of the LSST, improving the catalogue of the solar system.

Using Globular Clusters as Tracers of Dark Matter in the Virgo Cluster Dwarf Elliptical Galaxies

Presenter(s)
Milutin Perovic, Illinois Mathematics and Science Academy
Karolina Podsada, Illinois Mathematics and Science Academy

Advisor(s)
Brooke Schmidt, Illinois Mathematics and Science Academy

Most galaxies in the universe contain large amounts of dark matter. However, the presence of dark matter in dwarf elliptical galaxies has not been thoroughly investigated. This investigation took data from four different galaxies in the Virgo Cluster to search for the presence of dark matter by comparing the observed orbital velocities of approximately 150 globular clusters within the four galaxies to the calculated escape velocities. Using information such as the luminosities, radial velocities, and inclination/declination angles, the distances of the globular clusters to the galaxies were calculated using mathematical software and formulas from previously conducted research. Differences between the calculated and actual escape velocities would suggest a discrepancy in our estimation of the mass of the galaxies and this could point to the presence of dark matter. Additionally, by using the calculated escape velocity and comparing it to the observed orbital velocity of the cluster we could profile the distribution of the dark matter at different radii of the galaxy. The findings of this investigation could support previous research describing the existence of small amounts of dark matter in the outer regions of dwarf elliptical galaxies. The dark matter content found would help us gain an understanding of the formation of these galaxies. The details of the results will be discussed during the presentation.

An Automated Search for Almost Dark Galaxies in the Sloan Digital Sky Survey

Presenter(s)
Pranav Sivakumar, Illinois Mathematics and Science Academy

Advisor(s)
Don York, University of Chicago

One of the most important problems in astrophysics today is the mystery of dark matter. A class of dwarf galaxies known as Almost Dark Galaxies (ADGs), which contain a high percentage of dark matter and little to no starlight, are the ideal laboratories to study this mystery. I developed two distinct methods for automated detection of ADGs in the Sloan Digital Sky Survey (SDSS) – the first approach selects image sections with uneven light distribution not centered on bright objects. This indicates presence of a faint diffuse object, usually a galaxy, whose light causes the SDSS bounding box to shift away from the center object. A second method that I am currently developing identifies clusters of closely separated blue objects. This pattern is clearly observable in Leo P, a prototypical ADG, and my algorithm is searching to locate similar clusters in order to identify ADG candidates. Preliminary results from both approaches are promising, with the bounding box approach successfully identifying Leo P. I am presently confirming results from the blue cluster approach. Constructing a large, statistically valid sample of ADGs could not only help understand how these galaxies formed but also play an important role in determining the distribution of dark matter in the universe.

Comparing Waveform Templates in Extracting Astrophysical Information from Gravitational Wave Signals

Presenter(s)
William Tong, Illinois Mathematics and Science Academy

Advisor(s)
Vicky Kalogera, Northwestern University
Brandon Miller, Northwestern University

A phenomenon that stands on the brink of revolutionizing our understanding of the cosmos, gravitational waves are disturbances in the fabric of space-time, propagating from massive star-systems at the speed of light. Transparent to matter particulates and other obstacles that would normally hinder traditional, light-based observation, gravitational waves hold the potential to provide clear, undistorted data on everything from the Big Bang to black holes. This investigation focused on interpreting gravitational wave data using a variety of mathematical models called waveform templates. By comparing templates of varying degrees of complexity and comprehensiveness, general conclusions regarding the accuracy and computational efficiency of different templates may be drawn. A particular focus at the moment regards analyzing the efficacy of templates that focus on just one segment of a typical gravitational wave signal. Preliminary estimates suggest that the template IMRPhenomPv2 may provide a thorough, precise analysis of signals while being relatively computationally cheap. Ultimately, the work done through this investigation may provide a formal valuation of the different waveform templates, building a foundation for future gravitational wave analysis.

Measurements and Comparisons of Diffuse Interstellar Bands around the MBM12 Interstellar Cloud

Presenter(s)
Melanie Hess, Illinois Mathematics and Science Academy

Advisor(s)
Don York, University of Chicago

The interstellar medium is full of cool clouds, around 100°K, made of atoms, molecules, and dust particles. Mysterious components of these clouds are carriers of diffuse, unidentified interstellar bands (DIBs). Because they are too broad to be caused by atoms, they are thought to consist of over 400 non-terrestrial molecules. I tried to observe the behavior of DIBs around the isolated cloud, MBM12, using absorption lines in spectra of background stars. Suitable stars were picked from a database accumulated at the University of Chicago. Spectra were examined using a piece of analysis software, arcexam, written by Dan Welty, that compares wavelength and flux of two stars. I measured 90 lines in the six stars behind the cloud. Probing mainly the edges of the cloud, I found that two DIBs were exceptionally strong compared to their strengths in the other stars in the galaxy. More observations of fainter stars, buried in dust at the cloud center, will be necessary to understand the DIBs more fully. I have demonstrated that this cloud is ideal for such studies. It was found that many of the DIBs that are common in foreground and background stars were usually twice as strong in the background stars.

Theology

Daughters of Eve: Social Behaviors of Women in the Old Testament and Their Role in the Story of God's Divine Plan

Presenter(s)
Kadyn Geier, Illinois Mathematics and Science Academy

Advisor(s)
Michael Hancock, Illinois Mathematics and Science Academy

This investigation focuses on Eve, Sarah, Miriam, Delilah and Esther in the Old Testament. It asks the question, to what extent does Eve serve as a paradigm for other women of the Old Testament, and what is the role of these women in the Bible's providential narrative? This investigation was based upon extensive reading and analysis of both primary and secondary texts. Conclusions of this investigation indicate that numerous women throughout the Old Testament display social behaviors that closely mirror the actions of Eve. These women originally oppose the will of God, then guide others into belief in his power, later creating a greater following and larger accomplishment of his divine plan. Overall, this study indicates the integral role of women in the larger biblical narrative.

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T08	142	Yuan, Tian Lin	08:25	A-135
F01	72	Zelman, Samuel	10:15	A-115
C35	63	Zhang, Mickinney	11:05	B-131 Grainger
Q37	125	Zhou, Rongzhen	09:15	B-133
B05	41	Zhu, Michelle	10:40	B-125 Tellabs

- These presentations will be pre-recorded videos due to the students presence at another commitment.