IMSAloquium 2020

IMSA Illinois Mathematics and Science Academy | Student Inquiry and Research

April 22, 2020

Dear IMSA Students, Faculty, Staff and Friends,

Welcome to IMSAloquium 2020. This is IMSA's 33rd year of leading in educational innovation, and the 32nd year of the IMSA Student Inquiry and Research (SIR) Program.

With the worldwide challenge of COVID-19 facing all of us, the format of IMSAloquium has changed out of necessity. Projects will be presented concurrently in virtual "rooms" over the course of three morning sessions. We have regrettably omitted the poster session this year; it will return. Despite the challenges and changes to the program brought on by the COVID-19 crisis, it reminds us all of the importance of research as the world works to move in a positive direction in terms of good health and well-being, zero hunger, clean water and sanitation; the very things embodied in the United Nations Sustainable Development Goals. It is heartening to know that research is what IMSAloquium is all about.

Within this booklet, you will find a collection of abstracts from outstanding student projects. The topics range from biomedical research, chemistry and physics to mathematics to the social sciences, among others. Our students have worked hard on their projects, some individually, some in groups, and today is the day for them to display their hard work.

Many of our students have worked with mentors off campus at leading universities and research laboratories. Other students have worked with IMSA faculty on campus. In addition, this is the first year ever that on-campus SIR courses were held, and the work from those courses is represented at IMSAloquium. The SIR team would very much like to thank both our off-campus and on-campus mentors and teachers for their outstanding work with our students. The IMSA SIR program could not exist were it not for all of the mentors and teachers working with and advising our students.

In addition to thanking the mentors and SIR teachers, we wish to thank all IMSA faculty and staff who helped support the SIR program throughout the year, and their assistance with coordinating and hosting this year's IMSAloquium. We would like to especially acknowledge the work of Bill McGrail, Kevin Broy and Jean Bigger in assisting with setting up our virtual Zoom classrooms (Bill and Kevin) and displaying student work in Digital Commons (Jean).

We hope you enjoy your morning and find it to be a rewarding and educational experience!

Sincerely,

IMSA SIR Program Team
Cathleen Cunz
Dave DeVol, Ph.D.
Don Dosch, Ph.D.
Eric Smith, Ph.D.

IMSA Principal
Robert Hernandez, Ed.D.

IMSA President
José M. Torres, Ph.D.

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***NOTE:**
All presentations scheduled within these sessions will have a Zoom meeting ID. These Zoom meetings will have one staff member and one student from the presentation group assigned as a co-host.

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Behavioral and Social Sciences | BHVSO

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Biology | BIO

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Computer Science | CMPS

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Session I - 8:30a.m. – 8:45a.m.

Project ID: BHVSO 05
8:30a.m. – 8:45a.m.

Title: The Effect of Household Income on the Outcome of Gubernatorial Election in the Midwest
Presenter: Peter Leahy
Mentor: Mr. Patrick Kearney, IMSA
Abstract/Project Intention:
The purpose of this is to identify if there is a correlation between household income and gubernatorial elections, which could be useful for politicians that are wanting to know their chances based on past data. How I went about answering my research question was using previous gubernatorial election results in states in the Midwest, and analyzing the results using the programming language "R" to see if there was a correlation between the percentage of voters that voted democrat and the average income in a county, while also considering factors such as educational attainment in order to account for other observations that could also affect the outcome of my analysis. As of now, I do not have results yet.

Project ID: BHVSO 12
8:30a.m. – 8:45a.m.

Title: The Top Twenty Performers in The Last Fifty Years
Presenter(s): Derek C. Zhu
Mentor(s): Dr. Pradeep K. Chintagunta, The University of Chicago
Abstract/Project intention:
Many factors such as a company's marketing strategy, industrial sector, and target population may have large impacts on their success as a business. To test how these different attributes affect a company's stock performance, all mid cap, large cap, and mega cap companies globally were analyzed to find the top twenty stock performers and worst twenty stock performers in the last fifty years. The purpose of this research was to test for correlation between these variables, each attribute vs annualized return. In March 2005, Jeremy Siegel, a finance professor at the Wharton School of Business, published his book The Future for Investors: Why the Tried and the True Triumph Over the Bold and the New about a similar area of research. This project was designed to add to Siegel's work by reanalyzing the stock market to see how it has changed since Siegel's initial research fifteen years ago. Siegel found that successful companies created everyday products such as cigarettes and foods. With the growth of technology in past years, how has

this changed the stock market? The findings of this research is intended to be another source of information for investors and stock market analysts in making financial decisions.

Project ID: BIO 03
8:30a.m. - 8:45a.m.

Title: Computational Approaches to Detection of Mosaic Variants in Patients with Epilepsy
Presenter: Krisha Patel
Mentors: Dr. Gemma L. Carvill, PhD and Jonathan Gunti, Department of Neurology, Northwestern University Feinberg School of Medicine
Abstract/Project intention:
In recent years, many bioinformatics pipelines have been developed to call variants from next generation sequencing (NGS) data for conditions like epilepsy. Epilepsy is defined by recurrent, unprovoked seizures due to excessive, hypersynchronous brain activity with 70-80% of cases likely being caused by genetic variants. Somatic variants are low-allelic-fraction mutations occurring in only a subset of cells because of either tumor heterogeneity or somatic mosaicism, the co-existence of two genetically distinct cell populations within an individual. Given these variants' low read counts in sequenced DNA, they are often missed. Therefore, here we compare the sensitivity and specificity of two mosaic variant callers, MuTect and Mosaic Forecast, to develop the most accurate variant identification method.

Using the BWA aligner, we built two multiple-sample pipelines and applied them to whole exome sequencing (WES) data of a cohort of 21 epilepsy patients collected for a national and international collaboration. The candidate somatic variants detected using these methods were then validated with PCR amplification and Sanger sequencing or targeted NGS of the patients' DNA samples. In our initial analysis of the cohort, MuTect identified candidate somatic variants in the genes GRK5 (p.V247A) and GLUL (p.M1V), which are currently being validated. Using BamSurgeon, we also inserted 18 simulated variants to the WES data of 16 tumor-normal pairs, and MuTect characterized 17 of the 18 simulated variants indicating high sensitivity. Our long-term goal is to develop a pipeline that detects somatic variants as a function of sequencing depth and allelic fraction to provide more informed clinical diagnostics affecting epilepsy patient treatment and outcomes.

Project ID: BIO 10
8:30a.m. - 8:45a.m.

Title: Study of Muscle and Vascular Regeneration in a Rat Bladder Augmentation Model

Presenter(s): Milica Barac & Sonia Edassery
Mentor(s): Dr. Arun Sharma, Northwestern University

Abstract/Project intention:
Patients with Spina Bifida affected with myelomeningocele can typically display varying degrees of bladder dysfunction. In most cases, surgical reconstruction utilizing a piece of intestine is needed. However, this solution is unsustainable as many issues can occur, and in most cases the operation will have to be done multiple times. Instead of this surgical method, scaffolds with a biodegradable framework that could also serve as a carrier for bone marrow stem/progenitor cells could be used. The objective of our project was to look at muscle and vascular regeneration in a rat model that has gone through bladder augmentation with two different scaffolds, poly 1,8-octanediol-co-citrate (POC) scaffold and small intestinal submucosa (SIS) scaffold. We analyzed muscle regeneration and vascular regeneration of trichrome stained cross sections of augmented rat bladders. We used Adobe Photoshop to quantifiably compare the two scaffold groups, and we were able to observe that the rats with poly 1,8-octanediol-co-citrate (POC) grafts developed larger muscle bundles and larger vessels than the small intestinal submucosa (SIS) scaffold. The POC grafts were also less likely to develop large areas of collagen formation.

Project ID: BIO 13
8:30a.m. - 8:45a.m.

Title: The Effects of Deltamethrin, Propiconazole, and Glyphosphate on Chlorella Vulgaris and Daphnia Magna
Presenter(s): Gnandeep Chintala, Namit Padgaonkar Padgaonkar
Mentor(s): Dr. Jessica Amacher, IMSA, Dr. Soumya Anjur, IMSA and Julie Polz, IMSA
Abstract/Project intention:
With the increase in food production, more pesticides have been released as a result of agricultural practices. This has had many adverse effects on the organisms present in water sources near the crops, as well as these freshwater ecosystems. The goal of our investigation was to determine the effect various harmful pesticides have on the primary producers and primary consumers in a freshwater ecosystem. We used Chlorella vulgaris as our primary producer and Daphnia magna as our primary consumers. We also used three pesticides: deltamethrin, an insecticide, propiconazole, a fungicide, and glyphosate, an herbicide. We tested for three different concentrations for each pesticide and a control, with twelve Chlorella and Daphnia samples. Over the course of five weeks, we measured the absorbance of the Chlorella at 550 nm, and over the course of three weeks, we measured the heart rate of the Daphnia.

Project ID: BIO 17
8:30a.m. - 8:45a.m.

Title: SEA-PHAGES
Presenter(s): Riley Brutto, Samantha Taylor, Abhiram Thati, Jaden Wang, and Xander Van Horn
Mentor(s): Dr**.** Crystal Randall, Illinois Mathematics and Science Academy
Abstract/Project intention:
The purpose of the SEA-PHAGES on-campus SIR is to discover new phages around the Illinois Mathematics and Science Academy. To do this, soil samples are collected around the campus and then examined for phages. First, the soil samples are isolated for phage via direct or enriched isolation. This filtrate is then spread onto an agar plate combined with a host bacteria. The host bacteria is from a given list provided by the SEA-PHAGES organization. For this project, the host bacteria was strain B16540, or Gordonia Rubripertincta. The host bacteria will indicate whether or not there is a phage: if there's phage, some of the bacteria will die. Phages were found in the soil samples taken around IMSA campus utilizing the host bacteria Gordonia Rubripertincta. In the near future, utilizing this analyzation the genome of any strain of virus or bacteria) will allow for the identification of any genome encountered in

medical clinics. This specific strain of bacteria is important because they are able to degrade hydrocarbons. Not only that, this bacterium can reduce nitrate in the absence of mycelium and can degrade environmental pollutants, xenobiotics, and other natural compounds that are not readily biodegradable.

Project ID: BIO 23
8:30a.m. - 8:45a.m.

Title: The Effects of Pepstatin A on Cathepsin D using GBM Cell Lines
Presenters: Jay Ganesan, Max Hellrung, Sachin Vijayraj
Mentors: Dr. Sowmya Anjur, IMSA
Glioblastoma multiforme (GBM) is a rapidly progressing brain cancer found to overexpress the biological marker Cathepsin D. Pepstatin A has been identified as a potential inhibitor of Cathepsin D in breast cancers. This study sought to verify the viability of Pepstatin A as a potential inhibitor of Cathepsin D in GBM cells lines by adding a solution of DMSO and Pepstatin A to GBM cells. A control was maintained for the comparison of cells treated with Pepstatin A and cells not treated. Exposing GBM to Pepstatin A should theoretically inhibit the progression of GBM. Future experimentation is planned to study the effects of Pepstatin D.

Project ID: BIO 25
8:30a.m. - 8:45a.m.

Title: Effect of Ayurvedic herbs on U118 Glioblastoma multiforme cell line
Presenter(s): Monika Narain and Prarthana Prashanth
Mentor(s): Dr**.** Sowmya Anjur, Illinois Mathematics and Science Academy
Abstract/Project intention:
Glioblastoma multiforme (GBM) is a stage IV astrocytoma, accounting for over 60% of all brain tumors in adults and a very poor prognosis of just 14-15 months. Despite numerous treatment options currently available, GBM recurs 90% of the time. With barriers in affordability and hesitance toward synthetic medicines, many people have turned to natural treatments for GBM. We tested the cytotoxicity of the U118 GBM cell line when treated with the common Ayurvedic herbs hing (Ferula asafoetida), triphala (a combination of Emblica officinalis, Terminalia bellirica, and Terminalia chebula), and coriander (Coriandrum sativum) using an MTT assay.

Project ID: BIO 30
8:30a.m. - 8:45a.m.

Title: Protein Engineering to Increase the Thermal Tolerance of Rubisco activase in *Miscanthus giganteus* and *Glycine max*
Presenter(s): Elizaveta Kuzmina and Grace Wulffraat
Mentor(s): Dr. Angela Ahrendt, IMSA
Abstract/Project intention:
Greenhouse gasses trap heat, and carbon dioxide levels are higher than they have been in the past 650,000 years. Global temperatures are up two degrees celsius from those during the industrial revolution, and temperatures are predicted to rise by at least six degrees celsius by 2100. With temperatures rising, there will be serious effects on agriculture. RuBisCO is one of the most abundant enzymes on Earth, and is involved in carbon fixation in all plants. RuBisCO activase is necessary for the effective function of RuBisCO, but is also a temperature sensitive protein that becomes inactive easily when temperatures increase. Our experiment aims to engineer the protein RuBisCO activase to have a higher thermal tolerance to mitigate the negative effects of increasing global temperatures on food supply. We chose Glycine max (soybean) as one target for protein engineering because of its importance in global agriculture. We chose Miscanthus giganteus as the other target because of its potential for use in biofuel production. We hope to create more stable versions of the RuBisCO activase enzymes from these plants using site-directed mutagenesis to introduce changes in the protein sequence followed by protein thermal shift assays to measure improvements in thermal tolerance.

Project ID: BIO 34
8:30a.m. - 8:45a.m.

Title: Characterization of segmented-filamentous bacterium intestinal colonization and its impact on skin graft outcome
Presenter(s): JuWon Park
Mentor(s): Marisa Alegre, University of Chicago and Martin Sepulveda, University of Chicago
Abstract/project intention:
Studies from the Alegre lab show that the microbiota can modulate allograft rejection in transplantation and that its perturbation reduces type I IFN signaling in APCs, which leads to reduced priming of alloreactive T cells. Specifically, simultaneous colonization of both skin and gut microbiota casually affects graft outcomes.

Intestinal colonization with segmented-filamentous bacteria (SFB) is sufficient to accelerate skin graft rejection. This current study assesses the intestinal colonization pattern of SFB. We compared the relative abundance and bacterial load of feces, cecal content, ileal scrapings, ileal content of specific pathogen-free (SPF), SFB gavaged SPF, SFB-mono colonized (positive control), and germ-free (negative control) mice. By using qPCR, I analyzed bacterial load and relative abundance with pan-16S and SFB-specific primers. SFB gavage treatment shows trends of increasing the relative abundance of SFB, although this is variable and not statistically significant. These results suggest that to study the impact of SFB on graft rejection, we should use GF and SFB-monocolonized mice as a transplant model.

This will contribute to the interpretation of findings in future experiments identifying the effects of SFB gavage treatment. Further research will help us develop possible therapeutic approaches to enhance graft acceptance.

Project ID: CHEM 07
8:30a.m. - 8:45a.m.

Title: Synthesis of fenarimols as novel drug candidates for Mycetoma
Presenter(s): Jackson Grotke, Roman Putnam, Benjamin Weber
Mentor(s): Dr. John Thurmond, IMSA
Abstract/Project intention:
Mycetoma, an infection caused by the Eumycetoma fungus, is a neglected tropical disease. This study was done in collaboration with OpenSource Mycetoma. The non-profit Open Source Mycetoma provided structures of molecules to synthesize based on their lead compound. The novel compounds were synthesized and later purified using techniques such as column chromatography. Using nuclear magnetic resonance (NMR) and thin layer chromatography (TLC), the compounds were characterized against the starting materials and other data to ensure the proper compound was synthesized. Confirmed molecules will be sent to our collaborators within the OpenSource Mycetoma organization for biological testing and will be shared with us to design new molecules. Three compounds have been successfully synthesized to date.

Project ID: CMPS 7
8:30a.m. - 8:45a.m.

Title: Generating and analyzing high resolution structural connectomes for breast cancer patients to assess cognitive impairment
Presenter(s): Rachna Gupta
Mentor(s): Dr. Lei Wang, Julie Petersen at NIACAL: Neuroimaging Applied Computational Anatomy Lab, Feinberg School of Medicine
Abstract/Project intention:
Post-surgery adjuvant therapy produces changes in cognitive function in up to 70% women with breast cancer. The nature of these changes is a relatively new area of research, with very few studies assessing the neural correlates of adjuvant hormonal therapy or determining how to identify individuals at risk for treatment-related cognitive impairment. This project is part of an ongoing HippoPCI study which uses magnetic resonance imaging (MRI) and structural and functional assessments that are sensitive to the integrity of the hippocampal-cortical circuitry to identify predictors and mechanisms of cognitive impairment in breast cancer patients receiving hormonal treatment.

As part of HippoPCI, this project centers around creating a connectome for diffusion tensor images (DTI) using the high-resolution structural connectome (HRSC) methodology to visualize and assess the changes in connectivity from hormonal therapy. The HRSC quantifies the connectivity between each neuron using individual network elements such as nodes. We converted the incidence matrices for each of the subjects into connectivity matrices and degree maps and generated an average degree map for the population. Group analysis is being conducted using individual comparisons between each subject and the controls.

Project ID: ENGN 2
8:30a.m. - 8:45a.m.

Title: Overhaul of a Miniature Goniophotometer
Presenter(s): James Guo and Ethan Tse
Mentor(s): Dr. Kevin Martin, Northern Illinois University
Abstract/Project intention:
A goniophotometer is a device that determines the different intensities (luminosity) of different wavelengths of light emitted from an LED at different angles. Modern goniophotometers are expensive, and the entire setup takes up the size of a large room. Our research is concerned with creating a miniaturized version of a goniophotometer. We are picking up the project from undergraduate students who have developed a one cubic meter version of the goniophotometer. Their version utilizes a Raspberry Pi, and a nanoLambda spectral sensor. However, this was only a prototyped and incomplete model, so while the previous goniophotometer was able to take spectral measurements, there were extreme inefficiencies in the coding and in the measurement algorithm. We have been working on doing a complete overhaul of the project, which includes replacing the nanoLambda sensor with a AS726X spectral sensor, two rotary encoders to more precisely measure the angle of measurements, and a complete remake of all the code

Project ID: ENGN 8
8:30a.m. - 8:45a.m.

Title: Analyzing the Diffraction of Light Through High Entropy Alloys to Predict Elemental Interactions

Presenter(s): Ryan Talusan
Mentor(s): Abhijit Phakatkar, University of Illinois at Chicago and
Dr. Tolou Shokuhfar, University of Illinois at Chicago

Abstract/Project intention:

In recent years, high entropy alloys (HEAs) have become a new research focus in the engineering, materials, and nanomaterials community due to it containing several major elements without a clear base element in contrast to typical metallic alloys. The influence of varying alloying elements was studied in terms of crystal structure by using X-Ray Diffraction (XRD), and the examination of crystal structures and crystal defects in greater detail were carried out using Selected Area Diffraction (SAD), which is performed inside a Transmission Electron Microscope (TEM). I am currently in the early stages of my investigation and am spending time developing my skills using binary alloys, such as Fe-Cu, and well-researched nanoparticles, such as Iron Oxide. Along with learning new techniques, I have been reading extensively on other research articles related to high entropy alloys and the characteristics of nanoparticles. As of right now, the experiment is still ongoing, which means that I currently have no data or conclusive information.

Project ID: ENGN 9
8:30a.m. - 8:45a.m.

Title: Taiwan GPM Reflectivity and Precipitation
Presenter(s): Jason Liu
Mentor(s): Dr. Yadong Wang, Southern Illinois University Edwardsville
Abstract/Project intention:
Although advancements in meteorological technology have made weather prediction increasingly more accurate, it is still one of the more unpredictable sciences. This project worked to develop a more accurate method for weather prediction using the data gathered by NASA's GPM (Global Precipitation Measurement) satellite in the Taiwan region. To do so, the Ku-band and Ka-band Taiwan radar data from the GPM satellite was graphed and analyzed using MATLAB to find correlations with which a more accurate weather prediction algorithm could be developed. The results from the analysis performed throughout this project confirm the previously identified correlations between the reflectivity at different levels of the atmosphere and the type of precipitation. Along with the type of precipitation, the severity of the storms could also be accurately predicted. Although an improved algorithm was not developed through the research thus far, the project has proved the accuracy of the current models and precipitation analysis methods to be among the forerunners of modern meteorological technology.

Project ID: HIST 1
8:30a.m. - 8:45a.m.

Title: Bastions: Siege Warfare from the 16th to the 18th Century
Presenter(s): Alex Bantchev, Daniel Chacon, Rhiannon Davids, Paul Dunlap, and Max Orr
Mentor(s): Dr. Lee Eysturlid, IMSA
Abstract/Project intention:
The bastion fort was developed in Europe during the early modern period (the 16th-18th centuries). The advancements in artillery in the 15th century made castles obsolete. As such, most of Europe was defenseless. To counter this new artillery, the bastion fort was developed. They are made out of low, thick walls of dirt and stone with pentagonal fortifications called bastions used as hardpoints and artillery platforms. This style of warfare was used for a few centuries, before new technology paved the way for more advancements. We focused on the reasons behind the design, uses, and limitations of bastion fortress.

To do this, we delved into the history of the bastion fort, examining historical sieges as well as the military engineer Marshal Vauban's manuals on the construction of bastion forts. As a capstone to our project, we 3-D printed a bastion fort model for Dr. Eysturlid as an educational tool. We also prepared a basic game system that goes over the process of besieging a bastion fort to interactively display our information to the audience.

Project ID: MATH 6
8:30a.m. - 8:45a.m.

Title: Bi-leveled Trees and Quotient of Twist2 Map
Presenter(s): Patrick Borse
Mentor(s): Dr. Aaron Lauve, Loyola University Chicago
Abstract/Project intention:
We analyze the structure of the bi-leveled trees labeling the vertices of the Multiplihedra, a family of polytopes placed between the permutahedra and associahedra. For both permutahedra and associahedra it is understood that there exist Hopf algebras on their vertices. In 2010, Lauve and others attempted to provide the vertices of the Multiplihedra with a similar Hopf algebra structure but did not achieve the establishment of a full Hopf algebra on bi-leveled trees.

Using the notion of the Twistk Hopf algebra introduced by Pilaud (2018), we establish a Hopf map Φ from Twist2 to its dual. From combinatorial evidence it appears that the image of Φ has the same graded dimensions as the span of the bi-leveled trees. Using this map and analyzing the Twist2 Hopf algebra using SageMath, we attempt to find a bijection between the bi-leveled trees and a basis for Twist2 / ker(Φ) to form a Hopf algebra on the vertices of the Multiplihedra.

In addition, we aim to prove a general statement for positive integers k. In particular, we desire to show that a Hopf map Φk exists from Twistk to its dual whose image has equal graded dimensions to the vector space on k-leveled trees.

Project ID: MEDH 03
8:30a.m. - 8:45a.m.

Title: Improving In Vitro PTV Approximations for Proton Therapy
Presenter(s): Nishant Bhamidipati, Micah Casey-Fusco
Mentor(s): Steve Laub (Physicist), Mark Pankuch (Head Physicist), Northwestern Proton Center
Abstract/Project intention:
When designing therapeutic proton plans, it is important that the amount of healthy cells affected is minimal. The target area, which includes the tumor and the "error margin" around it, is called the planned target volume (PTV). The PTV is used to ensure the tumor receives the appropriate amount of dose, even if there are clinically reasonable set up errors. The trade-off is that surrounding healthy structures may also receive treatment-level doses. This may cause damage to healthy tissue, which presents as clinical toxicities. Using an estimate of the PTV from the patients' treatment data, the Northwestern Medicine Proton Center plans to find a correlation between the PTV area and the presence of clinical toxicities. It is difficult, however, to find a correlation with approximations, so we created a computer application that approximates the PTV more accurately. Previously, treatment areas were estimated using the radius of the tumor and calculating a circle of area around the center. However, due to the irregular shape of tumors, these estimations can be very inaccurate. Our program uses the coordinates from uniform proton therapy treatments, relative to the iso-center, to calculate the area using Heron's formula and a multitude of triangles extending from the area's midpoint.

Project ID: MEDH 08
8:30a.m. - 8:45a.m.

Title: Prognosis of Glioblastoma using MRI data
Presenter(s): Matthew Lee
Mentor(s): Dr. Jane Wu, Ryan Spear, Northwestern University Feinberg School of Medicine
Abstract/Project intention:
Glioblastoma is a highly invasive malignant tumor caused by cancerous astrocytes. Due to the irregular, amorphous form, it is often difficult to identify and distinguish between the tumor core and surrounding edema in MRI imaging, making it difficult for doctors to accurately prognose the condition. This project aims to identify survival using machine learning techniques between the size and location of the tumor and the age of the patient to more accurately prognose a patient with glioblastoma. In order to

do so, a segmentation program would segment the images of the tumor from the open source database BraTs 2019 provided by the University of Pennsylvania. Using the images to train the model as well as the provided information about the patients survival and age will be used as factors for a support vector machine to be able to prognose patients into short and long term survival. Data is yet to be collected.

Project ID: MEDH 18
8:30a.m. - 8:45a.m.

Title: Cell Proliferation Of Glioblastoma Depending On Age Using TORC1 Enzymes
Presenter(s): Sttefy Gabriel and Asha Wiggs
Mentor(s): Dr**.** Sowmya Anjur, IMSA
Abstract/Project intention:
Using three Glioblastoma cell lines; T89G, U118, U87, we looked at how fast the glioblastoma spread based on the age of the person each cell strand belonged to. We also looked at how present the TORC1 enzyme, which helps regulate cell growth, was in each cell strand to see if there was a correlation with the cell proliferation. We grew each cell line in flasks and maintained them by changing out their media, so they could grow to a point where we had enough cells to work with. We used the ELISA assay to see how much of the TORC1 enzyme is in each of the cell lines. After we used the ELISA assay, we compared the concentrations of the TORC1 enzymes in each cell line to the actual concentration in the rabbit TORC1. We also used a Matrix assay to compare cell proliferation and see if there were any other proteins that had a correlation with the cell proliferation.

Project ID: MEDH 22
8:30a.m. - 8:45a.m.

Title: ER and NFkB activity in BC cell clones vs Bulk population
Presenter(s): Shreenithi Palamuthy
Mentor(s): Dr. Jonna Frasor, University of Illinois at Chicago
Abstract/Project intention:
In order to develop effective treatment to target breast cancer (BC), the relationships between the various molecules involved must be examined. Of these molecules, NFkB (Nuclear Factor kappa B) and ER (Estrogen Receptor) have displayed a possible correlation which could have an effect on breast cancer cells. To analyze the crosstalk between NFkB and ER activity in ER+ BC cells, we examined multiple BC cell line clones transfected with plasmids for NFkB-GFP and ER-mCherry activity to find a clone that represents the bulk population. These cells were then treated with E2 and TNF to activate the plasmids. Cells were scanned for ER and NFkB activity using the Celigo cytometer and analyzed the data based on confluence. This data was plotted and graphed to identify trends between ER/NFkB activity in the clones compared to the activity in the bulk population. Concrete conclusions must be drawn from further results.

Project ID: MEDH 23
8:30a.m. - 8:45a.m.

Title: Striatal Projection of dSPNs to GPe Pathway and Intrapallidal Projection in Relation to Parkinson's Disease
Presenter(s): Saivasudha Chalasani
Mentor(s): Dr. Savio Chan and Dr. Qiaoling Cui, Northwestern Feinberg School of Medicine
Abstract/Project Intention:
The external globus pallidus (GPe) in the basal ganglia is associated with a variety of functions including the control of voluntary movements. To fully understand the input control of the GPe, the projections from the striatal dSPN neurons to the Npas1 neurons within the GPe in Parkinson's Disease (PD) model and control mice were studied as well as reciprocal connections between Npas1 neurons and PV neurons within the GPe. Using cell-specific transgenic mice, current amplitudes of dSPN-Npas1 projection were recorded with whole-cell patch-clamp recordings and optogenetics. It was found that the dSPN-Npas1 projection in the mouse model of PD had significantly greater synaptic current than in control mice. The amount of dSPN axons in the GPe, i.e. fiber density, was also increased. To unveil the underlying mechanism, the number of dSPN-GPe synaptic contacts between a mouse model of PD and control mice was explored. Synaptic contact was identified through two ways:

1) the immediate spatial relationship between GFP+ terminals from dSPNs and postsynaptic marker gephyrin; 2) the overlap between GFP+ terminals from dSPNs and presynaptic marker Vesicular GABA transporter (VGAT). This investigation of the dSPN-Npas1 pathway within the basal ganglia helps to lead to a better understanding of the wiring principle of the basal ganglia in PD, allowing for further research on cures for this movement disorder. Subsequently, intra-pallidal circuitries were also investigated through measurement of effects of Npas1 input on the firing rates of the PV neurons and current amplitudes of Npas1-PV projection. A correlation between current amplitude and inhibition of PV+ firing rate was found. Previous results from a similar experiment in which Npas1 projected to Npas1- neurons instead of focusing on specific cell class PV were compared with results from this study to search for a common trend as PV neurons are the most populous within the GPe. Overall, from the study of dSPN-Npas1 and Npas1-PV projections, a better understanding of the circuitry within the basal ganglia is reached and can be used to more specifically target root causes of symptoms in Parkinson's Disease.

Project ID: PHYS 04
8:30a.m. - 8:45a.m.

Title: Calculating the Collins-Soper Angle of Simulated Particle Physics Data
Presenter(s): Ayan Mallik
Mentor(s): Dr. Peter Dong, IMSA and Dr. Leonard Spiegel, Fermilab
Abstract/Project intention:
The Collins-Soper angle, referred to as cos(Θ*), measures the angle of the negatively charged lepton in dilepton events with respect to the beam axis. When we reconstruct events that are simulated using Monte Carlo, we sometimes encounter situations where both leptons in the dilepton pair share the same sign. This sign error originates from our particle detector because the curvature of high-energy electrons is hard to measure. However, the calculation of cos(Θ*) requires the leptons to have opposite signs. Rather than randomly assigning charges to the lepton and antilepton, we determined that we should trust the sign of the particle with the lower pseudorapidity. Instead of guessing correctly half of the time, our new strategy identified the negatively charged leptons at a 70% success rate. Using the modular framework that we built to analyze cos(Θ*), we have continued to investigate the behavior of our simulated data by looking at acceptance, migration, and mass resolution.

Project ID: PHYS 05
8:30a.m. - 8:45a.m.

Title: Running Limit Generation Framework of Compositeness on Condor
Presenter(s): Michael J. McKelvie
Mentor(s): Peter J. Dong, IMSA and Dr. Leonard Spiegel, Fermilab
Abstract/Project intention:
Preons are a proposed type of subatomic particle more fundamental than quarks and leptons and form the core of the theory of compositeness. Within our analysis, we focused on developing a new way to generate limits on the energy scale Λ, the energy level where compositeness could be proven. More specifically, we have implemented the limit generation framework on Fermilab's Condor system, as the limit calculations are too intense to be done on a single computer, and the Condor system is a cluster of computers at Fermilab that allows for parallel processing of the expected limits.

Project ID: PHYS 12
8:30a.m. - 8:45a.m.

Title: Invariant Mass and pT Distributions for Compact Muon Solenoid (CMS) Data from 2016 and 2017
Presenter(s): Sreyansh Mamidi and Kodai Speich
Mentor(s): Dr. Peter Dong, IMSA
Abstract/Project intention:
In particle physics, invariant mass and transverse momentum are key to analyzing collision data from the Compact Muon Solenoid (CMS) experiment. Using CMS data from 2016 and 2017, we created distributions of invariant mass and transverse momentum (pT). Invariant mass distributions are important to set limits on the energy scale Λ for nonresonant searches, and pT is used to study the kinematics of the collision events. Invariant mass distributions are broken up into different mass bins (ranges). PYTHIA, a Monte-Carlo generator, was used to generate sample events for the four different mass ranges of 300, 800, 1300, and 2000 GeV/c^2. These mass ranges were then scaled by their cross sections, with regard to luminosity, and combined into a single histogram. The results of this study of invariant mass and pT provide an important foundation for the rest of the analysis.

Session I - 8:50a.m. - 9:05a.m.

Project ID: BHVSO 06
8:50a.m. - 9:05a.m.

Title: The Effects of Migration on State GDP
Presenter(s): Kayla Quigley
Mentor(s): Patrick Kearney, IMSA
Abstract/Project intention:
This research explores the statistical relationship between state GDP and migration in the United States. The statistical relationship can then be applied to a social science relationship in the real world, not just numbers. Other researches have conducted research on the same topic, but either nationally (not state GDP), but also in different countries. By looking at a closer scale, we can more closely look at the relationship and what this means in regards to state. By using the program R, we can see how the p-value and other means of measuring this relationship can help predict future events. If the relationship is significant, then that means migration heavily influences state GDP and we can see patterns in history, but also predict future GDP's. This project works to connect numbers to real life situations and to see what kind of relationship migration and GDP have with one another by using data from 2004, 2005, and 2006 and R. This can be done by graphing and T-tests. So far, this is a work in progress by gathering data into spreadsheets and working through R. This means that as of right now, there is no found relationship as of now. The significance of this research is to help predict ways GDP might vary in different states and predict patterns.

Project ID: BHVSO 13
8:50a.m. - 9:05a.m.

Title: Immediate Early Gene Expression in Striatal D1 and D2 Spiny Projection Neuron during Striatum-Dependent Reinforcement Learning
Presenter(s): Cynthia Mu, Emily Shao
Mentor(s): Dr. Jones G. Parker, Madison Martin, BS, Niki Moya, Seongsik Yun, PhD, Northwestern, Feinberg School of Medicine
Abstract/Project intention:
Phasic fluctuations in dopamine are thought to drive divergent changes in D1 and D2 spiny projection neuron (SPN) activity by regulating intracellular signaling and gene expression cascades that modify their excitatory synaptic strength. These changes may be crucial for brain processes such as reinforcement learning. In our research, we quantified the expression of the immediate early gene Fos, a marker of neuronal activity, in D1- and D2-SPNs in mice trained on a head-fixed, striatum-dependent fear conditioning task. We quantified Fos expression in two groups of mice: mice that selectively express the red-fluorescent protein tdTomato in D2-SPNs (A2A-tdTomato mice) and mice expressing a Fos-GFP fusion protein in both SPN types (Fos-GFP mice). Subsequent to training, we harvested brains from mice that either learned or failed to learn to run in place on a wheel while head fixed in response to an auditory tone that predicted a mild tail shock. Immediately after training in A2A-tdTomato mice or 30 min after training in Fos-GFP mice, we euthanized the mice and and transcardially perfused them with a phosphate buffered saline solution followed by the same solution containing 4% paraformaldehyde. After brain fixation, we acquired 100-µm thick brain sections using a vibratome. We then immunostained these brain slices with a rabbit anti-Fos primary antibody and amplified this immunostaining using either a donkey anti-rabbit secondary antibody conjugated to a green fluorophore in A2A-tdTomato mice or conjugated to a red fluorophore in Fos-GFP mice. We then used a two-photon microscope to acquire fluorescent images of striatal tissue. We used ImageJ, Matlab, and Excel to quantify the number and fluorescence intensity of Fos positive D1- and D2-SPNs in A2a-tdTomato mice and the overlap in native Fos immunostaining with Fos-GFP transgene expression in Fos-GFP mice. This information lays the groundwork for future investigations to pinpoint the mechanisms by which striatal neural activity is altered to drive reinforcement learning, which could develop therapies that more precisely target specific domains of dysfunction in diseases associated with the striatum.

Project ID: BIO 04
8:50a.m. - 9:05a.m.

Title: MR Image analysis in Python
Presenter(s): Vibhav Adivi
Mentor(s): Ramana Davuluri, Northwestern University
Abstract/Project intention:
Analyzing medical images allows tracking of trends in types of medical images along with detecting problems in the images. In recent years, the technology to analyze these images has greatly improved so that thousands of similar images can be analyzed together. Python, which was the language used in this investigation, can be used to look at all of these images and gather information. To begin, a few datasets from Kaggle.com were examined, along with corresponding Python notebooks that had been written, which were found along with the datasets. From this I learned the proper method of programming in this context, which led me to write a few programs based on those I had seen. I worked with a histopathological cancer image dataset, with which I wrote a program.

Project ID: BIO 11
8:50a.m. - 9:05a.m.

Title: Peri-Implant Osteolysis Effects on Local and Remote Tissues
Presenter(s): Meghana Karan
Mentor(s): Dr. Meghan Moran, Rush University Medical Center
Abstract/Project intention:
Aseptic osteolysis is bone loss triggered by wear particle-induced inflammation and is one of the main causes for implant loosening after primary joint replacement surgery. It is known that wear particles travel from the joint to remote tissues including the liver, spleen and lymph nodes. Previously, we showed in a rat model that loss of implant fixation (a measure of implant loosening) and decreased peri-implant bone results in alterations in the gut microbiome and liver. The current study aimed to determine if a local immune response is associated with these pro-inflammatory remote system alterations. Briefly, rats underwent implant placement surgery and some rats were intra-articularly administered vehicle, lipopolysaccharide (LPS) doped polyethylene (PE) particles, or CoCr particles for 6 weeks. Intact knee joints were harvested and fixed for immunohistochemistry on select immune cell markers: CD68, (macrophages) MPO, (neutrophils) CD3, (T-cells) and CD20 (B-cells). CD68 positive cells were present in the synovium of LPS-PE and CoCr treated knees, but not vehicle-treated knees. MPO was only present in the synovium of CoCr-treated, but not in LPS-PE-treated knees. CD3 and CD20 results were inconclusive. Our results suggest that local immune reaction is critically associated with systemic inflammation we reported in the liver and gut.

Project ID: BIO 14
8:50a.m. - 9:05a.m.

Title: Investigating Differences in Oral Microbiomes in Varying Dietary Choices
Presenter(s): Elizabeth Murphy
Mentor(s): Dr. Sowmya Anjur, IMSA and Dr. Don Dosch, IMSA
Abstract/Project intention:
With over 700 species of bacteria, the oral microbiome is one of the most diverse environments of the human body, second only to the gut. Due to its importance in human health, the gut microbiome has been more extensively studied than any other human body microbiome, leaving far less research on the other microbiomes. The oral microbiome has been connected to systemic diseases in humans, including diabetes and cardiovascular disease. This study looked to discover differences in the presence of various genera of bacteria within the oral microbiomes, specifically regarding subjects' diets. Polymerase chain reactions were employed using genera-specific primers to amplify the bacterial DNA within the samples before they were run through gel electrophoresis to determine the specific bacteria present. A limited number of samples were isolated and amplified and I used those samples to develop a procedure for isolating DNA from subjects' oral cavities and amplifying the bacterial DNA within the samples.

Project ID: BIO 19
8:50a.m. - 9:05a.m.

Title: Find Phage Using Microbacterium Testaceum
Presenter(s):, Zoe Kurzweil and Philip Paulson
Mentor(s): Dr. Crystal Randall, IMSA
Abstract/Project intention:
Bacteriophages are found everywhere, and this study is looking into discovering more about them in a specific area, using the host Microbacterium Testaceum. When considering how abundant phages are, as well as how important they are to the ecosystem, we know shockingly little about specific genomes of phages. Only a few genomes of phage have been released to the public for this host, so we are using it as our host in hopes of finding more. We are attempting to find more phage genomes by going out and collecting soil, and testing the soil to see if it has phage that is compatible with our host. To do so we complete processes that isolate the phage from the dirt, purify the phage so that there is a confirmed singular strain, and then amplify that strain so we have enough samples to send to a different lab that sequences phage genomes. Getting these genomes sequenced will give other scientists more types of phage to work with when studying phage in the future, such as looking into their use as possible treatments to disease.

Project ID: BIO 21
8:50a.m. - 9:05a.m.

Title: The Effects of the Endothelial Glycocalyx on Blood Flow
Presenter(s): Pratibha Bhalla
Mentor(s): Dr. Irena Levitan, University of Illinois, College of Medicine
Abstract/Project Intention:
The glycocalyx is an essential biological component in humans. It is a thin layer of anionic material that lines endothelial cells and is composed of proteoglycans and glycoproteins. The glycocalyx also contains soluble glycosaminoglycans from the bloodstream and endothelium. The various components are significant in glycocalyx's role in the body and therefore any enzymatic removal of any of its constituents dramatically affects its properties. The glycocalyx influences blood cell-vessel wall interactions by repulsing red blood cells. It is also considered a potential translator of biochemical forces into biochemical signals. Although it is well-known that this layer affects blood flow in the human body, our experiment strives to discover which components of the glycocalyx affects flow in the endothelium. To do this, we noted the flow of blood in various conditions and noted any significant changes in the regulations of genes that occur as the flow of blood changed from either static to laminar or in the presence/absence of Kir 2.1, a potassium channel. This allowed us to identify what specific proteins, and therefore genes, in the endothelial glycocalyx contribute to blood flow.

Project ID: BIO 24
8:50a.m. - 9:05a.m.

Title: Glioblastoma - Effects of Natural Compounds
Presenter(s): Alana Rock and Maahum Hamayat
Mentor(s): Dr. Sowmya Anjur, IMSA and Dr. Don Dosch, IMSA
Abstract/Project Intention:
Glioblastoma Multiforme (GBM) is an aggressive brain cancer that leaves the average patient with a projected survival time of just one year after an initial diagnosis, despite the common utilization of standard therapies such as chemotherapy. To combat the side-effects of such a disease, researchers have been looking into naturally occuring, less toxic agents for their antitumor and apoptotic effects in GBM cell lines. Our goal with our glioblastoma research project is to add to the inventory of scientific research on the subject of natural product usage in GBM treatment. Caffeine, a widely known natural neurostimulant, is known to impact psychological performance, enhance long-term memory, and decrease the risk of neurodegenerative diseases such as Glioblastoma Multiforme, and curcumin was used experimental models in previous studies due to its ability to augment the apoptotic effects of

ceramides. In this SIR project, we studied the efficacy of curcumin and turmeric in the enhancement of GBM cell destruction by splitting our cells lines multiple times and conducting the serial dilution method involving separate solutions of curcumin and caffeine. Afterwards, we counted the amount of cells present, treated the cells with the dilution, and performed an MTT assay. Further experimentation is planned to gather evidence to make conclusions.

Project ID: BIO 31
8:50a.m. - 9:05a.m.

Title: Looking at GD3 as an immunotherapeutic target to treat benign TSC Tumors
Presenter(s): Nikhilesh Gupta
Mentor(s): Dr. Caroline Le Poole, Dr. Ancy Thomas and Ms. Emilia Dellacecca, Department of Dermatology, Northwestern University Feinberg School of Medicine
Abstract/Project Intention:
Tuberous sclerosis complex (TSC), is a genetic disorder presenting with benign tumors which can pose severe health problems including altered organ function. A method to combat TSC might be to target ganglioside D3 (GD3) which is overexpressed in TSC tissues. Chimeric antigen receptor transduced T cells (CAR T-cells) specific to GD3 were injected into a mouse model of TSC to measure whether CAR T-cells mediate a robust immune response to tumors. The project incorporates using TSC2 heterozygote mice that develop TSC tumors in the liver and kidneys after about 9 months. After CAR T cell infusion, the liver and tissue were preserved and sectioned for immunofluorescence staining to characterize immune responses and GD3 expression. CD4 and CD8 T cell staining marked the immune infiltration. GD3 expression in the TSC-diseased mice was found to be significantly higher ($p<0.02$). At N=8 treated mice and N=10 control mice, we observed GD3 CART cells held a significantly reduced tumor presence in the mice ($p=0.00025$). We found that the mice that were treated with CAR T cells were significantly less burdened by tumors which correlated with greater T cell presence. In conclusion, the findings provide support for treating TSC by GD3 CAR T-cells.

Project ID: BIO 41
8:50a.m. - 9:05a.m.

Title: Effects of the Extracellular Matrix in Creating a Hydrogel
Presenter(s): Isha Kadakia
Mentor(s): Ali Djalilian, Ghasem Yazdanpanah, University of Chicago at Illinois
Abstract/Project Intention:
Understanding corneal wounds and their connections to the structure of the eye is often important when determining a treatment plan for the wound. Characteristics of the extracellular matrix, such as tissue function and structure affect the reattachment of tissue and cells contained within this structure. Potential solutions explored during this experiment include different materialled “cushion” to reattach the tissue to the cornea, especially in hydrogel. The survival of epithelial and mesenchymal cells in the cornea were tested with porcine models. To build the hydrogel, tissue was extracted from porcine models and added to solutions to form a hydrogel that cells were able to survive in. Although this testing is a continuous process to receive consistent results, the hydrogel was best formed with 20 mg/mL. Additionally, proliferation assays conducted determined the high survival of primary epithelial cells. Based on the makeup of the gel, the cells’ responses are observed to see the survival of the hydrogel in the eye as a long-lasting treatment. Therefore, testing cells present in the hydrogel, as well as the endurance of the hydrogel models, gives insight into the efficiency of using an external tissue for corneal wounds.

Project ID: BIO 42
8:50a.m. - 9:05a.m.

Title: Identifying Dopamine Receptor Genes and Transcription Marbled Crayfish
Presenter(s): Saisupritha Talasu
Mentor(s): Wolfgang Stein, Illinois State University
Abstract/Project intention:
Modulatory transmitters are major contributors to nervous system plasticity and behavioral flexibility, they determine motivational states and are involved in psychiatric and neurological disorders. Neuromodulators act through distinct receptors and the diversity in receptor subtypes and distribution allows a single neuromodulator can exert many different actions. A prerequisite to understand the ways modulators work is to identify which receptors are expressed in an animal.

I studied which Dopamine receptors are present in the Procambarus virginalis also known as Marbled Crayfish, a highly invasive female species with high quality genome and transcriptomes. Their broad behavioral repertoire makes them ideal for studying the actions of neuromodulator receptors. We focused on Dopamine receptors as they play a role in Parkinson's disease and the reward system of vertebrates and invertebrates.

Using bioinformatics, we identified which dopamine receptors (D2Alpha and D2beta) exist in marbled crayfish. After identifying homologs of both receptors, a conserved domains search revealed no direct functional domains for these putative D2alpha and D2beta receptors. PCR with D2alpha primers on ventral nerve cord mRNA further revealed that this putative receptor is not expressed in the marbled crayfish nervous system. We are currently testing the expression of D2beta in in the ventral nerve cord.

Project ID: CHEM 08
8:50a.m. - 9:05a.m.

Title: Antibacterial Activities of Extracts from Hypoxis hemerocallidea corm
Presenter(s): Eliza Apavaloaiei, Rachel Mason
Mentor(s): Dr. John Thurmond, IMSA
Abstract/Project intention:
In developing countries, people with severe/chronic illnesses rely on medicinal plants. Unfortunately, very little is known about the chemical composition of these plants, meaning their effect on diseases is unknown. One popular medicinal plant in South Africa is the African Potato, which is used to treat Tuberculosis and other maladies. Many uses have been cited for the plant, but few studies have been conducted to confirm the plant's effectiveness. This study explored it's claimed uses by looking at the chemical properties of the plant. Samples of Hypoxis hemerocallidea corm were extracted using various techniques and then tested using thin layer chromatography. The properties of the extracts were analyzed by testing their antimicrobial properties against multiple ESKAPE pathogens using the Kirby-Bauer method. Extraction using sonication was used during testing for total phenolic, saponin, proanthocyanidin, and flavonoid content. We chose our most effective extract, our capsule sample in ethyl acetate, and ran NMR and IR spectroscopy to determine the characteristics of the compounds in Hypoxis hemerocallidea. The drug discovery process is very long and costly so by basing the drug design off of the structure and properties of the plant it will decrease the cost and time it takes to design a new drug.

Project ID: CMPS 1
8:50a.m. - 9:05a.m.

Title: Analyzing Location-Based Advertising Pricing
Presenter(s): Pascal Adhikary and Moksh Shah
Mentor(s): Dr. Randall Berry, Northwestern University
Abstract/Project intention:
Vehicle service providers can display commercial ads in their vehicles based on passengers' origins and destinations to create a new revenue stream. In this work, we study a vehicle service provider who can generate different ad revenues when displaying ads on different arcs (i.e., origin-destination pairs). The provider needs to ensure the vehicle flow balance at each location, which makes it challenging to analyze the provider's vehicle assignment and pricing decisions for different arcs. For example, the provider's price for its service on an arc depends on the ad revenues on other arcs as well as on the arc in question. We capitalize on theory and assumptions that this traffic network corresponds to an electrical network and, to tackle this problem, develop modules within Python that simulate the outlined algorithmic structure. This code enables us to determine the resulting equilibrium for a network with one or two links with potential for a fully multi-linked system. We later hope to investigate the performance of our advertiser selection strategy based on a real-world dataset.

Project ID: ENGN 1
8:50a.m. - 9:05a.m.

Title: Multispectral Imaging and Unmanned Aerial Vehicles
Presenter(s): Klaybis Asllani and Marcus Ludwig
Mentor(s): Dr. Colby Borchetta, Research Assistant, Morton Arboretum
Abstract/Project intention:
With recent technological advances, unmanned aerial vehicles (UAV) provide a unique platform to acquire remotely sensed data. UAV platforms have several advantages over traditional techniques, including price, resolution, data acquisition time, and overall utility. The Morton Arboretum currently has a suite of instrumentation to study and monitor tree health, including a Parrot Sequoia multispectral camera. Multispectral imagery enables calculation of vegetative indices that can be used to reveal information on crop stress, infestation, disease, and nutrient deficiencies. This sensor is currently implemented on a commercially sold DJI Phantom 4 drone on a fixed mount, i.e fixed camera angle. During data acquisition, it is often required to change that camera pitch angle to ensure the subject of interest is captured optimally. The objective of this project was to create a 1-degree of freedom camera mounting system for the Phantom 4 that can be controlled remotely from the

ground control station to enable control of the camera pitch angle. To accomplish this, two arduino uno microcontrollers equipped with LoRa radio transreceivers are used to communicate wirelessly and control a servo motor attached to the camera. The control station also includes an LCD shield to set and display the current camera position.

Project ID: ENGN 3
8:50a.m. - 9:05a.m.

Title: Testing Chloride Content and Penetration Capability within Concrete
Presenter(s): Hasan Almousawi
Mentor(s): Dr. Mohsen A. Issa, Director of Structural and Concrete Research Laboratory University of Illinois at Chicago
Abstract/Project intention:
The purpose is to measure the penetration capability of chloride within unknown specimens of concrete. To measure chloride within a specimen is to measure the structural integrity of concrete when chloride provided materials introduce the possibility of corrosion in steel reinforcements. Following standard cement mixing procedure, four concrete solutions were mixed in addition to control. Every specimen was composed of: Wcement = 3.137 lbs., Wwater = 1.568 lbs., Wsand = 7.842 lbs., Wgravel = 8.626 lbs., with varying amount of known sodium chloride added beginning with the control of no added chloride. Added chloride is relative to the calculated limit for a 0.0857 lbs. per cubic inch sample, spanning from below to above the limit of 0.0105-0.0210 lbs. The samples were chipped and ground finely into powdered form to run through a series of the American Society for Testing and Materials (ASTM) approved chloride permeability tests to assess the accuracy at which chloride is present.

The purpose of testing the accuracy of the method is to establish a procedure to thoroughly and authentically calculate chloride permeability within bridge samples. Further testing requires levels of different depth of sample to be collected utilizing a precision drill. Future samples will run through both acid-soluble and water-soluble chloride detecting tests regulated by the ASTM standard testing methods. The results of chloride content will be graphed against depth to establish a profile of the penetration capability of both acid-soluble and water-soluble chloride within the concrete sample laid.

Project ID: ENGN 7
8:50a.m. - 9:05a.m.

Title: Water Sanitization through UV-C Radiation
Presenter(s): Abigail Stevenson
Mentor(s): Dr. Mark Carlson, IMSA
Abstract/Project intention:
Despite access to safe drinking water being declared a human right, it is estimated that 790 million people don't have sanitized water available, leading to 88% of diarrheal disease deaths. Many people face barriers of poverty and development, preventing their attainment of a filter. This project focuses on the development of a cheap, durable water filter that can provide 40L of water daily. Using a mercury-based aquarium UV-C light bulb, I tested radiation sanitation effectiveness by exposing a bacterial solution for various lengths of time and depths of solution. I performed static tests, yielding kill rates reaching 99.99% in only 3 minutes of exposure. The filter configuration for these tests consisted of a 3-inch PVC pipe with a suspended lightbulb. To reduce work input by the user, the static system was converted to continuous flow. The flowing system is not currently reliable for flow rate or kill rate, but work is ongoing. My research works to find the most efficient relationship between water yield, UV-C exposure time, and bacterial kill rate to find the maximized flow rate to produce safe drinking water.

Project ID: ENVR 2
8:50a.m. - 9:05a.m.

Title: Tree Growth Responses to Long-Term Fertilization in a Lowland Tropical Rainforest
Presenter(s): Alana Depaz
Mentor(s): Silvia Alvarez-Clare and Richard Condit, Morton Arboretum
Abstract/Project intention:
Trees play an important role in the global carbon cycle since they use carbon to build biomass and they release oxygen as a by-product of photosynthesis. Thus, understanding which environmental factors influence tree growth and survival is crucial in predicting how forest ecosystems will respond to global changes. Two factors that can affect a tree's growth are 1) availability of the most limited soil nutrient and 2) a tree's species or size. I leveraged data from a long-term (12 yrs) nitrogen (N) and phosphorus (P) nutrient addition experiment in Costa Rica. Using mixed linear models in RStudio v.3.5.1., I investigated how the different fertilizers, species, and diameter at breast height (dbh) affected growth rates of trees.

I found that overall, there were no significant fertilizer effects. However, smaller trees (<15 cm dbh) grew more in the N, then NP and then P treatments relative to the control. Larger trees (>15 cm dbh), grew more in the N treatment only. There was a strong species effect but because species respond differently to fertilizers, results "cancel out", resulting in a lack of net responses to fertilizer at the community level.

Project ID: MEDH 04
8:50a.m. - 9:05a.m.

Title: Library Molecules as a Tool to Study Quorum Sensing in *Lactobacillus sp.*
Presenter(s): Hiteshi Patel
Mentor(s): Dr. Perez Morales, Benedictine University
Abstract/Project intention:
Quorum sensing (QS) is a process for cell-to-cell communication where cells bacteria release signals that lead to a coordinated social response among a variety of bacteria. Most QS systems make use of a transcriptional regulator and a signal to modulate gene expression. The laboratory I shadowed over the summer focuses on the Rgg QS systems present in Gram-positive bacteria. This system is currently being studied in several pathogenic species of Streptococcus and the human commensal Lactobacillus. It is generally composed of a positive regulator, Rgg, and a small signal peptide, SHP. However, there are no predicted signal peptides for Lactobacillus. The laboratory uses small molecules to be able to study the Lactobacilli QS pathways in the absence of peptides. In the summer, I learned the process to create constructs (plasmids) that are used for bacterial transcriptional studies and how bioluminescence assays work. I was able to observe increase in gene expression when a small molecule was added to the target QS system. Lastly, I also participated alongside the undergraduate research students from their weekly presentations to learn how to present research work.

Project ID: MEDH 09
8:50a.m. - 9:05a.m.

Title: Early Biomarkers of Alzheimer's Disease
Presentor(s): Vaishnavi Tetali
Mentor(s): Dr. Suraj Cherian, Northwestern University Feinberg School of Medicine
Abstract/Project intention:
Alzheimer's disease (AD) is an irreversible, progressive brain disorder characterized by the deterioration of memory, visuospatial ability, and executive function. Because this neurodegeneration happens slowly, early diagnosis and intervention is needed. This study utilizes a preclinical transgenic mouse model of AD, 5XFAD, because it is characterized by an increase in amyloid-β oligomers (AβOs) in the hippocampus. Preliminary results show that the excitability of CA1, primary output neurons in the hippocampus, are only altered in younger mice but not in older animals. Additional evidence shows an increase in levels of two cytokines in the hippocampus in the younger age group. These results point to a potential link between excitability of these neurons and neuroinflammation. The innate or adaptive systems characterized by alterations in microglia, astrocytes of the brain, and peripheral immune cells such as T cells may underlie the mechanism for the shift in excitability of the neurons. Because functional changes in neurons are typically accompanied by changes in morphology, hippocampal tissues (post recording of electrical activity) were fixed and stained to be imaged. Current efforts include 3D reconstruction of traced neurons and Sholl analysis to determine if morphology is altered in 5XFAD and their control wild type littermates across different age groups.

Project ID: MEDH 24
8:50a.m. - 9:05a.m.

Title: Detection of mutagenic agent MDA in human ovaries
Presenter(s): Samantha Lazcano
Mentor(s): Animesh Barua, PhD, Rush University, Chicago
Abstract/Project intention:
Defective DNA-damage repair mechanism together with formation of mutagenic DNA adducts (a portion of DNA bound with cancer causing agent) is a hallmark of cancer development. Malondialdehyde (MDA) is one of such agents produced during lipid peroxidation, can form mutagenic DNA adducts and may be a marker of early detection of ovarian cancer (OVCA), a lethal disease of women. The goal of this pilot study was to determine the changes in MDA expression in ovaries in women during aging. Ovarian specimens were collected from women of reproductive age (<50 years, n=5), postmenopausal women (60-65 years old, n=5) and women with OVCA at early stage (n=5). Expression of MDA was determined by immunohistochemistry, protein and gene expression studies. Significant differences in the intensities of MDA expression among different groups were assessed by ANOVA and paired t-tests and significance was taken when $P<0.05$. Compared with women of reproductive age, the intensity of MDA expression was significantly high in postmenopausal women and OVCA women ($P<0.01$). Results of this study suggest that MDA levels in ovaries increase during aging as observed in OVCA women. Thus, MDA levels in the ovary may predict prevalence of mutagenic DNA adducts indicative of risk for OVCA development.

Project ID: MEDH 29
8:50a.m. - 9:05a.m

Title: Development of Double-Controlled Drug Eluting Stents with Nanotechnology

Presenter(s): Brandon Park
Mentor(s): Dong-Hyun Kim, Northwestern University Feinberg School of Medicine, Kijung Kwak, pre-med student and Bo Yu, researcher

Abstract/Project intention:
For the past few decades, various of drug-eluting stents (DES), coated with an additional layer over stents mesh as a drug loading platform, were developed to steadily emit a drug for preventing the hyperplasia, and these stents could provide direct delivery of an antitumor drug to the local site and reduce the rate of blockage in the case of tumor recurrence. However, the clinic's outcomes of these DES were limited by its poor drug release kinetics and subsequent damage to adjacent normal digestive epithelial cells. Drug release from pH- and enzyme sensitive polymeric delivery systems is mainly attributed to stimuli-triggered degradation. Usually, if the pH is lower, then the rates of polymer erosion and drug release are faster, which can cause adverse effects. Also, temperature affects the solubility of the polymer and can speed up degradation, and the encapsulated drugs in the polymer will be released. Furthermore, encapsulating drug-loaded nanoparticle not only increases drug efficiency, but also allows more uniform distribution and possibly sustained drug release than encapsulating a pure drug. Encapsulating a hydrophilic drug within the hydrophobic matrix, however, is a challenge due to the non-uniform drug precipitates, which contribute to their quick release. Studies have shown that release kinetics of selected solutes from such biodegradable polymeric matrices are not simply driven by matrices, but also that the concentration gradient and the shape of the coating seem to have a more profound impact on the release rate. To solve this problem, Northwestern University BIGMed Lab developed gemcitabine-loaded mesoporous silica nanoparticles (gMSNP), and the nanoparticles were coated onto the stent with biodegradable poly(lactic-coglycolic) acid (PLGA) polymer. Here, the drug release kinetics were tested and evaluated the potential controlled gemcitabine (GEM) release from the stent. GEM loading efficiency onto the silica nanoparticles, drug release kinetics were determined by taking samples of the buffer solution at different time points to measure the drug concentration. Concentration of the drug in each sample was quantified by measuring its UV-Vis Absorbance at 265-300 nm range and comparing to a standard curve.

The data for the drug release collected showed a smaller burst release followed by a near zero-order release for the DES, which shows a constant rate of drug release over time. At 2 weeks after the initial release, the DES had 40 percent less drug released than PLGA loaded with pure GEM precipitates ($p < 0.05$). The project measured improved drug release kinetics of the developed nanocomposite layers on the stent. The measured sustained drug release will eventually reduce the rate of restenosis that can be induced by stents.

Project ID: PHYS 06
8:50a.m. - 9:05a.m.

Title: IMSA CMS - Feldman Cousins
Presenter(s): Michael Vayninger
Mentor(s): Peter J. Dong, IMSA and Lenny G. Spiegel, Fermilab
Abstract/Project intention:
The Feldman-Cousins method was used in this analysis to perform a frequentist analysis which can both provide frequentist coverage for the Bayesian limit and provide another limit to compare to the Bayesian one. The Feldman-Cousins approach unifies upper confidence limits and two-sided confidence intervals. This solves the problem that a prior choice of upper limit or two-sided interval leads to intervals that are not confidence intervals if the choice is dependent on the data. The Feldman-Cousins approach involves sorting Monte-Carlo generated pseudoexperiments by R-value (or likelihood ratio). In the single channel case, this is equivalent to sorting by the generated values, but in the general N-bin case, this involves sorting a number of points in N dimensional space by their R-values. After removing the points with the lowest likelihood, the remaining points define a region in space; from here, it must be determined whether a given point corresponding to the observed value is contained in the defined region. Using the current "box" approximation, a lower limit of 15.47 TeV was found compared to the Bayesian limit of 21.14 TeV. A multi-dimensional convex hull algorithm will be used to raise this limit even further. A convex hull is a vast improvement on a box as it has a much smaller volume which might contain the observed event. This means that the point at which the observed particle enters the region is likely a higher value then a box would approximate, setting a much higher lower limit. The convex hull is implemented via the QuickHull algorithm which generates all of the planes of the convex hull by generating planes to the furthest point recursively. This algorithm has never been implemented for a general n-dimensional case, and once fully implemented will likely increase the frequentist lower limit, perhaps even higher than the Bayesian limit.

Project ID: PHYS 08
8:50a.m. - 9:05a.m.

Title: Setting Limits on Lambda for Contact Interactions
Presenter(s): Ari Fishkin and Ysabel Guan
Mentor(s): Dr**.** Peter Dong, IMSA
Abstract/Project intention:
We will be setting limits on lambda, the energy scale where contact interactions may be observed, on contact interactions in the dilepton channel. Our primary background is from Drell-Yan, and to improve the accuracy of the limit, we are using an innovative new method that looks at contact interactions and Drell-Yan in combination and sets the limits on lambda directly, instead of finding and setting limits based on cross-sections. Previously, we treated contact interactions as a separate process from Drell-Yan. The problem with that method is because some models predict destructive interference, and that can cause our distribution to actually be less than the Standard Model prediction, which cannot be analyzed because there can never be an event that creates a negative number of particles. Our solution to this is by treating the Drell-Yan and contact interaction samples as a single sample and setting a Bayesian limit directly on lambda.

Project ID: PHYS 14
8:50a.m. - 9:05a.m.

Title: ARIADNE: A Technique to Model Superconducting and Mu-metal Magnetic Shielding
Presenter(s): Nicole Wolff
Mentor(s): Andrew Geraci, Nancy Aggarwal and Chloe Lohmeyer; Northwestern University
Abstract/Project intention:
The Axion Resonant InterAction Detection Experiment (ARIADNE) searches for the axion, a theoretical particle arising from Charge-conjugation & Parity symmetry violation. To do so it mediates a spin-dependent force extending beyond the standard model. ARIADNE uses nuclear magnetic resonance to detect an axion exerting a spin-dependent force in a cryostat between a sample of laser-polarized 3Helium nuclei and a rotating tungsten source mass. If the axion is present and acting as a fictitious magnetic field, a transverse magnetization may be detected. To do so, incredible precision must go toward shielding background magnetic noise, requiring superconducting shielding around the sample cell and possibly μmetal shielding around the motor rotating the mass. My work evaluates the shielding effect of a μmetal box around the motor by using Comsol Multiphysics to determine the way it alters the magnetic flux and gradients in a uniform magnetic field. The gradients at a critical position were calculated below 20 μTesla/cm, signaling that 3He must

be pumped down quickly to avoid depolarization. A second set of models found that the superconducting shield around the sample cell distorted the field at critical areas. My calculations for the gradients around this shield provide constraints on the experimental project design.

Project ID: PHYS 19
8:50a.m. - 9:05a.m.

Title: A Search For R Coronae Borealis Type Stars in the All-Sky Automated Survey for Supernovae
Presenter(s): Xander Hall
Mentor(s): Aaron A. Geller and Adam A. Miller, Northwestern University, Adler Planetarium
Abstract/Project intention:
We present the results of an analysis of a search for R Coronae Borealis (RCB) type stars using cataloged light curves from the All-Sky Automated Survey for Supernovae (ASAS-SN), parallax and colour data from Gaia, and Infrared photometry from the Wide-field Infrared Survey Explorer (WISE). RCB stars—carbon rich, extremely hydrogen deficient supergiants—are of immense interest as these stars provide important insight into the late stages of stellar evolution. These stars exhibit up to ~8 magnitude dips in brightness. With their high variability, one would expect these stars to be easy to find and classify. However, there are only ~65 classified RCB stars in our galaxy, despite a predicted ~5000. The discrepancy in these numbers suggests a bias in current RCB search methods. In light of this, we employ a simple search procedure that allows us to rapidly identify candidates while searching for RCB stars. With this process we were able to quickly identify 30 known RCB stars, and identify a previously unclassified RCB candidate. We consider these results, derived from cuts based upon data from ASAS-SN, AllWISE, and Gaia, to demonstrate an efficient and effective algorithm for the discovery of these rare sources.

Session I - 9:10a.m. - 9:25a.m.

Project ID: BHVSO 07
9:10a.m. - 9:25a.m.

Title: Effect of Multiple Variables on Graduation Rate and SAT Average in CPS
Presenter(s): Heldanna Soloman
Mentor(s): Patrick Kearney, IMSA
Abstract/Project intention:
This study used data from 142 CPS high schools for which publicly accessible data was available. The focus on CPS was inspired from its influence in the state and nationwide as the largest school district in Illinois and the third largest in the country. The graduation rates and SAT averages of each school were used as dependent (y) variables with which 5 independent (x) variables could be compared. These variables were chosen in order to determine their effect on the graduation rates and SAT averages of each school, in order to analyze trends across CPS schools. 3 of the values of the independent variables were percentages; these were the percentages of Limited English students, low income students, and attendance. The remaining two were binary (0 or 1) indicators of a CPS-issued safety rating and whether the school is a charter.

Project ID: BHVSO 14
9:10a.m. - 9:25a.m.

Title: Use of Data Analytics to Spot Educational Discrimination
Presenter(s): Padilla, Paola
Mentor(s): Alvarez, Angel, Northwestern Feinberg School of Medicine
Abstract/Project intention:
We utilized data analytics to investigate potential inequitable practices and policies within the Chicago Public Schools (CPS) system that may negatively affect disadvantaged students. We analyzed large datasets to determine if CPS policies and practices have contributed to low performance across different schools in the district. Low student performance tends to be more common among students from low socioeconomic backgrounds, students of color, along with students with disabilities. We focused on factors that contribute to school rankings, standardized testing, and selective enrollment school admissions. We compiled, organized, and analyzed large datasets acquired through Freedom of Information Act (FOIA) requests available online. Unfortunately, CPS refused to comply with our records request, entailing appeals to the Office of the Attorney General. Apart from that, our results highlight several areas of concern involving attendance, standardized testing results, and admission policies for selective enrollment schools in the district. These results complement a just-released investigation concerning potential fraud in the administration of standardized tests by CPS officials. Specifically, we identified a larger number of schools with data anomalies that raise questions of fraud and calls attention to the need for reform in CPS.

Project ID: BIO 02
9:10a.m. - 9:25a.m.

Title: iPSCs: The Future of Modeling and Validation
Presenter(s): Ishaar Ganesan and Bala Ramaraju
Mentor(s): Angel Alvarez, Northwestern Feinberg School of Medicine
Abstract/Project intention:
Introduction: Induced pluripotent stem cells (iPSCs) are generated from adult cells that are reprogrammed into an embryonic stem cell state with the capacity to differentiate into somatic cells. These cells can be differentiated into tissue organoids - 3D cellular structures self-organized to mimic a functional organ - which can be used for disease modeling. In this study, we aim to optimize the production of organoids by first optimizing conditions of cellular isolation, measuring the effect of bioplastics on stem cell growth, and comparing organoids generated from a bioreactor to those produced by conventional suspension cultures. We hypothesize the processing of blood prior to reprogramming will affect reprogramming success, that the material and sterilization process for bioreactor components will influence stem cell growth, and a spinning bioreactor will produce superior organoids to those generated using suspension culture. Methodology: Peripheral blood mononuclear cells (PBMCs) were isolated from patient blood and held at 37º Celsius or ice for four hours to mimic transport conditions. Moreover, we also determined the effects of varying blood volume on PBMC isolation using CPT tubes. Additionally, we tested the toxicity of two different 3D-printed plastics that were sterilized using ethanol or autoclaving by allowing them to leech into stem cell media. Then, iPSC colonies were allowed to expand on these plastic treated mediums. We also tested both autoclaving and using ethanol to determine which was the best method of sterilizing the plastics. This is due to 3d printed plastics being the main structural component of the bioreactor. Unfortunately, we did not have enough time to grow suspended-cultured iPSC organoids or produce organoids using a bioreactor.

Results: It was concluded that transporting the blood at 37º C was more viable than on ice. The PBMCs survived better under neutral temperatures as opposed to cold temperatures due to the physiological changes created by the extreme cold temperature.

Conclusion: Using iPSCs in disease modeling has become more prevalent in the recent past. Thus, determining which method to generate 3d organoids is of great significance to this field. Though we have not been able to prove or disprove our hypothesis, we were able to define important prerequisites to generating iPSCs from PBMCs and bioreactors. The continuation of this study will ultimately answer the question of which method, bioreactor or suspended culture, should be used when creating iPSC-based organoids.

Project ID: BIO 05
9:10a.m. - 9:25a.m.

Title: Utilizing fluorescent gene reporter SORE6 to read OCT4 and SOX2 gene expression in cancer cells
Presenter(s): Delicia Chen
Mentor(s): Elizabeth Tsui, Dr. David Gius, Feinberg School of Medicine
Abstract/Project Intention:
Transcription factors OCT4 and SOX2 have been shown to play key roles in regulating embryonic and adult stem cell populations. SOX2, for example, is expressed early on in embryonic development, aiding in the development of the pluripotent blastocyst, and OCT4 is responsible for helping these embryonic cells maintain this pluripotent state. However, they are often overexpressed in cancer stem cells and are associated with tumorigenic properties including the abilities to proliferate, migrate, invade, metastasize, and resist chemotherapy treatments. There is strong evidence that suggests overexpression of these stem cell transcription factors contributes to tumor formation, development, and relapse following chemotherapy. A fluorescent gene reporter called SORE6 is able to identify cells who demonstrate OCT4 and SOX2 overexpression. Additionally, the SORE6 reporter is able to characterize cancer stem cells (CSCs) based on specific affected signaling pathways, such as the PI3K/AKT pathway. By amplifying copies of the SORE6 reporter and infecting target cancer cells with the reporter gene, the reporter system is able to provide a visual readout for OCT4 and SOX2 gene expression. These measures of gene activity allow for a better understanding of the context of the OCT4 and SOX2 transcription factors in cancer development, progression, treatment and chemotherapy efficacy, and the development of new treatment options.

Project ID: BIO 09
9:10a.m. - 9:25a.m.

Title: Calcium Signaling in Microglia
Presenter(s): Audrey Si
Mentor(s): Murali Prakriya, Megumi Yamashita and Timothy Kountz Northwestern Univ., Dept. of Pharmacology, Feinberg School of Medicine
Abstract/Project intention:
Microglia are macrophage cells found throughout the brain and spinal cord, and they function as the main form of active immune defense in the central nervous system. In a normal, healthy brain, resting state microglia have a ramified morphology. After a pathological event, however, microglia transform into an activated form that has amoeboid morphology, by sensing factors that trigger cellular remodeling into the active state. Receptor-induced Ca2+ signals play a central role in microglial activation and function. Calcium signals are maintained by a process involving store-operated calcium entry (SOCE), namely the opening of plasma membrane Ca2+ channels after the release of Ca2+ from intracellular stores. Once depletion has occurred, stromal interaction molecules (STIM) sense the reduced level of Ca2+ and in response, activates the channel protein Orai and promotes Ca2+ refilling. SOCE dysregulation may trigger a disruption of intracellular Ca2+ signaling in glial cells, resulting in the pathogenesis of neurodegenerative diseases. In many immune cells, SOCE plays a central role to calcium signaling, however, it is not yet known whether this is the case with microglia. We hope to understand the properties of SOCE for microglia activation, and how extrinsic factors such as the bacterial lipopolysaccharide (LPS) protein, which activates microglia, affects SOCE. These studies will help illustrate basic calcium signaling in microglia as well as how the pathway is activated by microglia activation.

Project ID: BIO 12
9:10a.m. - 9:25a.m.

Title: Does the Phospho-state of AZI1's Proline-Rich Region Affect Its Localization to Chloroplasts?
Presenter(s): Ishan Nikam
Mentor(s): DeQuantarius J Speed and Dr. Jean Greenberg, University of Chicago
Abstract/Project intention:
Recognition of microbes or microbial products by plant receptors induces signaling cascades that prime broad-spectrum defense responses to suppress subsequent infections. In the primed state, plants are prepared to activate stronger defense responses more quickly than unprimed plants when challenged by pathogens and other stresses. An essential component of

systemic priming is the protein AZI1, a member of the lipid transfer protein superfamily. Like AZI1, the regulatory kinase MPK3 is essential for priming. During infection, AZI1 accumulates in chloroplast outer envelope membranes via a mechanism that depends on MPK3, which suggests AZI1's localization to chloroplasts is essential for priming defense responses. AZI1's chloroplast association requires a novel bipartite targeting signal that consists of an N-terminal hydrophobic region and an internal proline-rich region (PRR). To better understand the molecular basis of priming, I am making unphosphorylatable and phosphomimetic mutations within the PRR of AZI1. Using Arabidopsis thaliana and Nicotiana benthamiana, I will assess how these mutations affect AZI1's subcellular localization with an emphasis on localization to the chloroplasts.

Project ID: BIO 15
9:10a.m. - 9:25a.m.

Title: Using MALDI TOF-MS and IDBac pipeline to develop a "smart" Vietnamese microbial library for drug discovery
Presenter(s): Angela Wang
Mentor(s): Linh Nguyen, Brian T. Murphy, Dept. of Medicinal Chemistry and Pharmacognosy, College of Pharmacy, University of Illinois at Chicago
Abstract/Project intention:
Microorganisms have provided abundant sources of natural products which have been developed as commercial products for human medicine, animal health, and plant crop protection. Small molecules produced by actinomycete bacteria have been essential components of antibacterial drug discovery. However, the discovery of new drug leads is being outpaced by the development of antibiotic resistance to current medicines. We strive to build a smart library of bacteria using a MALDI-TOF MS-based bioinformatics pipeline (IDBac). Matrix-assisted laser desorption/ionisation time-of-flight mass spectrometry(MALDI-TOF MS) analyzes complex biological systems such as bacterial cells. This technique detects mainly the most abundant and conserved ribosomal protein fractions of bacteria which can be used for classification of the organisms. IDBac is a data acquisition and bioinformatics technique that utilizes MALDI-TOF MS to analyze protein and specialized metabolite spectra recorded from single bacterial colonies picked from agar plates. IDBac ensures that each strain in our library is taxonomically diverse. The collection of aquatic bacteria can be used to generate natural product antibiotic drug-leads for infectious diseases.

Project ID: BIO 32
9:10a.m. - 9:25a.m.

Title: DNA Analysis and Sequencing of Seized Rhino Horns and Toenails
Presenter(s): Shae Burnham
Mentor(s): Mary K. Burnham Curtis, Ph.D., USFWS OLE National Fish and Wildlife Forensic Laboratory
Abstract/Project intention:
Due to years of excessive hunting and black market-driven poaching, rhinoceros population abundance has declined precipitously since the beginning of the twentieth century. Five extant species of rhinoceros exist today - Sumatran, White (northern and southern subspecies), Black, Indian, and Javan rhinoceros. These species are classified as “Critically Endangered” and are protected in their natural habitats. Rhinoceros horn has been a staple of Traditional Chinese Medicines (TCMs) for centuries, but an increase in demand in Southeast Asia and China has driven the market for goods made from rhinoceros horn. Rhinoceros horns are made of keratin, not unlike hair, fingernails, and toenails. There is no documented medical benefit from the consumption of rhinoceros horn or its derivatives. The aim of this study was to document an accurate list of the species of horns held at the NFWFL, obtaining genetic confirmation for the predicted species, and compiling a database of rhinoceros horns that could be used as references for future forensic analyses. The initial round of DNA analysis identified two samples that were misclassified and confirmed another 63 species identifications, including 4 elephants. Low DNA quantity and quality prevented the analysis of 17 additional samples, which will be analyzed at a later date.

Project ID: BIO 38
9:10a.m. - 9:25a.m.

Title: The Effect of Upregulation of the Canonical Wnt Signaling Pathway on Intramembranous Bone Regeneration
Presenter(s): Sabrina Meng
Mentor(s): Dr. Frank Ko, Rush University Medical Center
Abstract/Project intention:
Background: Proper intramembranous bone regeneration is critical for the longevity of orthopaedic implants. It is currently known that the upregulation of the canonical Wnt signaling pathway results in the high bone mass (HBM) phenotype and faster healing of fractures. The goal of this study is to determine whether the upregulation of the canonical Wnt pathway also leads to faster intramembranous bone regeneration following bone marrow ablation surgery.

Methods: Both HBM mice expressing higher levels of Wnt signaling and wild type (WT) mice were used. All mice underwent unilateral femoral bone marrow ablation surgery at 4 weeks old and recovered for 14 days. Histology by H&E staining and regenerated BV/TV by microCT were assessed.
Results: We found that a significant difference in BV/TV values exists between HBM females and WT females, and WT females had a 63% lower bone density than HBM females ($p = 0.011$). No significant difference exists between HBM males and WT males.

Conclusions: This suggests that the upregulation of the canonical Wnt pathway leads to a faster rate of bone regeneration following bone marrow ablation surgery in female mice. These findings also imply that artificially upregulating Wnt signaling in bone surgery patients may lead to a faster recovery time.

Project ID: CHEM 09
9:10a.m. - 9:25a.m.

Title: Design and Synthesis of an Inhibitor of the Hypoxanthine-guanine-xanthine phosphoribosyltransferase (HGXPRT) Enzyme in the Plasmodium falciparum Parasite with Improved Acyclic Immucillin Phosphonates to Prevent Deaths from Malaria

Presenter(s): Vincent Pergrossi and Christopher Bridges
Mentor(s): Dr. John Thurmond, IMSA

Abstract/Project intention:
Plasmodium falciparum, the parasite responsible for the majority of deaths caused by malaria, requires purine to survive. These organisms are able to continually supply themselves with purine by processing hypoxanthine salvage from its host. Without the ability to create its own purine, the Plasmodium falciparum would die, which makes purine starvation a viable method of preventing deaths from malaria. The enzyme in the parasite that allows it to salvage purine is called the hypoxanthine-guanine-xanthine phosphoribosyltransferase enzyme (HGXPRT). By inhibiting this enzyme with S-SerMe-ImmH phosphonate, the parasites will starve. Therefore, better binding affinity between the ligands and their respective binding sites on the enzyme increase the effectiveness of this antimalarial treatment. By using various computer-aided drug design software, primarily SeeSAR, the phosphonate ligands were adjusted to increase their binding affinity. Out of many attempted revisions, a small subset are substantially better than the original ligands. After using online admeTox calculators, these improved ligands showed no signs of breaking any of Lipinski's drug rules, nor did they become drastically more difficult to create in a lab. By making these changes to the phosphonate ligands, the S-SerMe-ImmH becomes an even more potent drug for inhibiting the HGXPRT enzyme in Plasmodium Falciparum, allowing more lives to be saved from malaria. Following the computational identification and analysis of a more potent inhibitor, synthesis of the compound began using a modified version of the original schema. The creation of the final product is underway, and the first two intermediate compounds have been synthesized.

Project ID: CMPS 2
9:10a.m. - 9:25a.m.

Title: Visualizing the Flux Qubit Energy Spectrum
Presenter(s): Sydney Wang and Athena Zheng
Mentor(s): Jens Koch, Northwestern University
Abstract/Project intention:
Quantum computers developed by companies such as IBM and Google utilize superconducting qubits. However, the field of quantum computing is still new, and researchers are working to mitigate the effects of relaxation and decoherence to overall improve algorithmic accuracy. Understanding the effect that adjusting a qubit's parameters has on its behavior is important, so we modeled the flux qubit in a Python program, which was written for the scqubits software library developed by Northwestern. This program allows users to specify values for certain parameters, such as the amount of flux going through the circuit loop as well as the offset charges. When created, the class object of the flux qubit program constructs the Hamiltonian matrix and enables the user to visualize the energy spectrum based on the given flux parameter.

Project ID: CMPS 3
9:10a.m. - 9:25a.m.

Title: Implementing Tensor Flow for Multidimensional Markerless Pose Estimation
Presenter(s): Thakkar, Devraj
Mentor(s): Dr. Craig Weiss, John Disterhoft Laboratory, Northwestern University Feinberg School of Medicine
Abstract/Project intention:
Quantifying behavior is critical to neuroscientific activities to draw correlations between brain activity and specific activations of the body. While videography enables swift recording of animal behavior, it remains an elusive challenge to isolate raw movement pattern data suitable for neurological correlation. While sensors and reflective markers aid systems in recording movement patterns, these physical flags impose an external stress upon the animal which can alter the physiological state of the animal outside of the parameters of the experiment. Therefore, a need emerges for automated processing of video data to obtain markerless pose estimation for maximizing behavior tracking efficiency across multiple species. Our lab is currently implementing a trained machine learning package written in Python, DeepLabCut, to test the efficacy of this process. By building upon tensor flow, the DeepLabCUt package enables human-like accuracy (within 0.05%) with minimal frame training (<200 frames) by allowing the researcher to select and label specific Regions of Interest (ROIs) such as the paws, tongue, etc. The motion of these ROIs can then be analyzed in response to a specific stimulus during free ambulation and can also be correlated to EEG data or neurological stimulation using MatPlotLib to visually present the data.

Project ID: CMPS 8
9:10a.m. - 9:25a.m.

Title: Bin Optimization for Compositeness Limit Generation
Presenter(s): Rustom Ichhaporia
Mentor(s): Dr. Peter Dong, IMSA
Abstract/Project intention:
The study of compositeness theory in particle physics postulates the hypothetical existence of preons, subatomic particles that constitute quarks and leptons. Searches for compositeness collect observed data from particle colliders and compare them to generated data from simulations to create histograms of dilepton invariant mass, evident from subatomic interactions. Data sets that are randomly generated using Monte Carlo simulations are called “toys” and are used as a tool to vary the histogram statistics of the generated data in a repeated, randomized process to determine a theoretical

95% confidence limit for the lambda energy scale at which Compositeness interactions are likely to be seen. We optimized the number and width of the bins that our statistical framework uses to make a faster, more efficient program for data analysis.

Project ID: ENGN 4
9:10a.m. - 9:25a.m.

Title: Discovery of RNAi knockdowns prolonging lifespan in C. elegans using automated
robotic platform
Presenter(s): Chris Teng
Mentor(s): Anthony Fouad and Chris Fang-Yen(PI), Univ. of Pennsylvania
Abstract/Project intention:
The microscopic nematode Caenorhabditis Elegans (C. elegans) presents a sustainable and effective way to study aging. Besides from its fully mapped out genome, short life span, and accessibility, it shares a surprising amount of genetic similarity to humans. This makes it the ideal organism to model how aging works in more complex animals.

Current methods of aging experiments involving C. elegans have substantial room for optimization. Generally, methods involve manual stimulation of the worms that result in low-throughput and error-prone results. In this paper, we present a novel way of conducting aging experiments using an automated robotic imaging device. The robot longitudinally images the worms, which are placed in 24-well plates, to generate activity curves. Analyzing these activity curves allows us to draw up aging metrics to determine both lifespan and health span of the animal. Moreover, the robot is capable of imaging 100 plates, which makes the throughput significantly higher than any other method before.

Using RNA interference to knockdown specific genes, we discovered several novel RNAi phenotypes that elongate lifespan and/or healthspan in C. elegans. While there are many more genes to analyze and screen, the results show the value of automating aging experiments on a large scale.

Project ID: ENVR 3
9:10a.m. - 9:25a.m.

Title: Top-dressing biochar enhances tree growth and decreases sodium leaching in greenhouse experiment
Presenter(s): Brian Wagner
Mentor(s): Dr. Meghan Midgley, Morton Arboretum
Abstract/Project intention:
De-icing salts on roadways are nearly ubiquitous in northern cities during the winter, leading to contamination of the soils adjacent to roadways. These salts (mostly NaCl) often have detrimental impacts on the flora exposed to them, though some species are more sensitive than others. Biochar's large surface area relative to its volume allows biochar to "grab" onto salt, potentially limiting the amount of salt absorbed by plants or leached from the soil. We conducted an 8-week greenhouse experiment to test if biochar (applied either as a top-dressing or mixed into soil) mitigated salt's negative effects on tree seedling growth & physiology and decreased sodium leaching. Given that biochar is relatively expensive, we also evaluated salt addition and biochar effects on four tree species that vary in salt tolerance: Catalpa speciosa (tolerant), Acer saccharum (intolerant), Gleditsia triacanthos (tolerant), and Quercus rubra (intolerant). We found no impact of salt addition on seedling growth, and salt addition did not significantly increase Na leaching until the experiment's final weeks. However, there were differences in different species' growth rates and biochar's effects on growth rates. Trees that received a top-dressing of biochar acquired more below-ground biomass than trees with biochar mixed into the growing medium.

Project ID: MEDH 02
9:10a.m. - 9:25a.m.

Title: The role of beef ingestion in supporting exercise-derived benefits for the muscle-brain interconnect
Presenter(s): Melissa Myint
Mentor(s): Nicholas Burd, University of Illinois, TK Cureston Physical Fitness Research Lab
Abstract/Project intention:
The preservation of muscle mass is needed for physical independence. Effective habits include the performance of regular resistance exercise and ingestion of high-quality dietary protein ingestion at each meal. It has been suggested that the loss of muscle mass and strength extend beyond physical health and may harmfully influence mental performance, cognitive function, and psychological well-being. Therefore, we investigated the impact of resistance exercise and the amount of protein ingested daily on exercise-induced bioactive peptides that have been implicated in cognitive health.

Blood plasma was collected from 41 middle-aged men and women consuming either moderate- or high-protein diets before and after 10-weeks of resistance exercise training. Plasma apelin, irisin, CTSB, and BDNF were assessed by enzyme-linked immunosorbent assays.

I was able to learn new research skills and contributed to human plasma processing, storage, organization, and data entry. Our results show that plasma apelin and irisin increased with resistance exercise training, regardless of the amount of dietary protein intake ($p<0.05$). Plasma BDNF and CTSB did not change with the intervention ($p>0.05$).

Resistance exercise influences only some plasma biomarkers connected to cognition, with no additional impact of eating extra protein during the day.

Project ID: MEDH 05
9:10a.m. - 9:25a.m.

Title: Multilevel Bioinformatic Analysis of Dengue Serotypes and Variations
Presenter(s): Peter Baffoe and Bopo Taiwo
Mentor(s): Dr. Eun-Young Kim, Northwestern Feinberg School of Medicine
Abstract/Project intention:
Dengue is a mosquito-borne disease usually found in tropical environments. Over the past few years, global instances of this disease have drastically increased and nearly half the world has been classified as, "at risk." The purpose of our research project was to identify the homology and phylogenetic relationship among the four-dengue virus (DENV) serotypes circulating in Nicaragua. We used the whole viral genome sequence of the DENV-1, DENV-2, DENV-3 and DENV-4 done by next-generation sequencing. Using bioinformatics tools including Burrows-Wheeler Aligner, SAMtools, and MEGAX, we constructed the consensus sequences of each serotype, identified single-nucleotide polymorphisms (SNPs), and performed the phylogenetic analysis. The phylogenetic tree showed a close relationship of DENV-1 with DENV-3, and DENV-2 clustered with DENV-4. From this research project, the phylogenetic analysis of four DENV serotypes provided a clear, visual representation of similarities and differences in Nicaraguan isolates**.**

Project ID: MEDH 06
9:10a.m. - 9:25a.m.

Title: Effect of Systemic Sclerosis on Myocardial Function, Fibrosis, and Blood Flow Measured by Stress Perfusion Cardiovascular Magnetic Resonance Imaging
Presenter(s): Manasvi Thumu
Mentor(s): Daniel C. Lee, MD, Brandon Benefield, MS,
Northwestern University Feinberg School of Medicine
Abstract/Project intention:
Background: Systemic sclerosis (SSc) is a disease that causes multisystem fibrosis and has a 10-year survival of 50-84%. Death is 5-15 times more likely when the heart is affected. Myocardial fibrosis in SSc may interfere with contraction, relaxation, and microvascular function, resulting in heart failure, ischemia, and arrhythmias. We sought to quantify the effects of SSc on the heart using cardiac magnetic resonance imaging (CMR). Methods: In 11 SSc patients and 11 patients with normal clinical stress perfusion CMR, we measured myocardial perfusion reserve (MPR, ratio of blood flow at stress versus rest), extracellular volume fraction (ECV, a measure of myocardial fibrosis), and left ventricular ejection fraction (LVEF, a measure of systolic function). Results: ECV was significantly higher (29.3±3.7% vs. 23.6±2.8%, $p<0.001$) while MPR (1.6±1.0 vs. 2.0±1.0, $p=0.36$) and LVEF (60.1±8.1% vs.

56.3±5.1%, p=0.12) were similar in SSc patients compared to controls. Conclusions: Although standard imaging metrics like LVEF remain normal in SSc patients, myocardial fibrosis measured by ECV is increased. The range of MPR values in SSc patients may reflect variation in the degree of interstitial versus perivascular fibrosis in individual patients. Future analysis will focus on subendocardial perfusion, which is a more sensitive marker of microvascular dysfunction

Project ID: MEDH 10
9:10a.m. - 9:25a.m.

Title: Phosphate Metabolism in the High Bone Mass (HBM) Mouse Model
Presenter(s): Shruti Shakthivel
Mentor(s): Dr. Ryan Ross, Rush University Department of Cellular and Molecular Medicine
Abstract/Project intention:
X-linked hypophosphatemia (XLH) is the disorder of renal phosphate wasting, and the most common form of heritable rickets (Carpenter, 2011). XLH is characterized by imperfect calcification, softening, and distortion of the bones, usually resulting in bowed legs. Previous research has indicated that XLH patients have increased levels of FGF23 and elevated levels of sclerostin which suppresses bone formation by antagonizing the Wnt-signaling pathway. Wnt signaling is an important mediator of bone mass, and in the High Bone Mass (HBM) mouse model, the G171V mutation activates the Wnt signaling. Since previous research suggests a link between Wnt signaling and FGF23 production with respect to phosphate metabolism. This project utilizes the HBM mouse model to understand how the mutation leads to increased bone mass, how the mutation leads to increased technical function, and the mutation's relation to phosphate metabolism. The HBM genotype was associated with lower Ultimate stress, Pre-yield strain, and Modulus of Toughness. Additionally, Yield stress and Young's Modulus was increased in the HBM mice. The data collected indicates increased toughness and stronger and stiffer material properties of bones in the HBM mice in comparison to the Wild-type mice.

Project ID: MEDH 14
9:10a.m. - 9:25a.m.

Title: Design of EFGR kinase domain inhibitors for the potential treatment of lung and other cancers
Presenter(s): Jodie Meng
Mentor(s): Dr. John Thurmond, Illinois Math and Science Academy
Abstract/Project intention:
In 2018 alone, over 18 million cancer-related cases were diagnosed, and 9.5 million cancer-related deaths occurred worldwide. As a small-molecule drug orally administered for the treatment of lung and pancreatic cancer, erlotinib (Tarceva®) inhibits the phosphorylation of the tyrosine kinase domain in the Epidermal Growth Factor Receptor (EGFR). Inhibition of EGFR reduces the bioactivity of tumor-associated endothelial cells and interferes with signal pathways involved in metastasis and development of angiogenesis. Increase in drug concentration leads to adverse effects, ranging from rash and nausea to gastrointestinal bleeding, perforation, hepatic failure, among others. Therefore, it is desirable to reduce the toxicity and increase potency of the drug to increase its clinical applicability. This study focuses on using structure-based drug design techniques in the early drug discovery process. Computer programs like SeeSar, AdmetSar, SwissAdme, and LabMol allow for the prediction of pharmacokinetic and pharmacodynamic parameters. The goal of the study was to design more advantageous compounds to erlotinib, gefitinib, and a second-generation TKI (compound 1), and provide evidence supporting a computer-aided approach to drug discovery.

Project ID: MEDH 15
9:10a.m. - 9:25a.m.

Title: Preliminary Research on TLR4 mediated signaling, Immunoglobulin Superfamily Protein Family (IgSF), and Killer-cell immunoglobulin-like receptors (KIRs)
Presenter(s): Janna Jann
Mentor(s): Dr. Bhagwati Joshi and Dr. Dolly Mehta, University of Illinois at Chicago, College of Pharmacy
Abstract/Project intention:
Compelling evidence suggests that Gram-negative bacteria is primarily mediated by a recognition molecule, Toll-like receptor 4, also known as TLR4. TLR4 recognizes lipopolysaccharide (LPS) and begins a series of intracellular NF-kappaB-associated signaling events. Through preliminary research analyzing various key components in upstream and downstream signaling, we examined various cellular interactions and researched mutations. Furthermore, we examined examples of Immunoglobulin Superfamily Protein

Family (IgSF) and Killer-cell immunoglobulin-like receptors (KIRs) to look at how the proteins and genes have the potential to assist the inquiry of TLR4 mediated signaling. By seeing the various regulators and transmembrane proteins, we are able to refine the direction of our research to increase our knowledge of the pathway's functionality. This study aims to further our preliminary understanding of various pathways involving IgSF and KIRS and specifically, TLR4 mediated signaling.

Project ID: MEDH 25
9:10a.m. - 9:25a.m.

Title: The Effectiveness of a Cultural Competency Curriculum Taught to Middle School Students
Presenter(s): Grace Federici, Megan Ptak and Aabha Vyas
Mentor(s): Mr. David Lundgren and Dr. Sowmya Anjur, IMSA

Abstract/Project intention:
The experiences that occur in the lives of students nearing adolescence greatly influence the way they choose to act. Therefore, a curriculum was developed for middle school students reaching the age of adolescence, aiming to educate and inform these students on what it means to be culturally competent and the importance of a culturally competent society which they have the ability to influence. Because being culturally competent is such an important life skill, allowing for an understanding of one's own view of the world, the goal is to make it a part of education to develop broader knowledge of culture and how to use it to more effectively communicate even when exposed to only an isolated environment like a middle school. We conducted research testing the effectiveness of this newly constructed curriculum by comparing the results of a survey given to the participants before and after being taught the curriculum. Data collected from these surveys was compared to analyze the impact of the curriculum. Social media is a platform that allows people to share parts of their lives with others. Considering how much information about a person is available online through social media, individuals of all ages are affected by social media. More specifically, their mental health is affected both negatively and positively by the interactions they have while using different platforms. To determine the relationship between students and the effects of social media on their mental health, we developed a survey. However, the survey has yet to be sent out and data that determines if there is a relationship between mental health and social media has yet to be collected.

Project ID: MEDH 28
9:10a.m. - 9:25a.m.

Title: Diagnostic Amyloid Beta Oligomer-Targeted Probes for Alzheimer's Disease
Presenter(s): Nafay Abdul, Sophia Pribus
Mentor(s): Kirsten Viola, Northwestern University
Abstract/Project intention:
Current Alzheimer's Disease (AD) research suggests that early stage biomarkers which instigate memory loss consist of amyloid beta proteins in the oligomer isoform (AβOs). AβOs accumulate early in AD and have been shown experimentally to cause major AD-related pathologies (e.g., tau abnormalities, synapse loss, neurological damage, etc.). However, clinicians are currently unable to image AβO buildup in vivo. MRI is used to quantify brain volume or measure brain metabolism. Available PET probes exclusively quantify amyloid plaques and are not useful for imaging AβOs. With an AβO probe, it would be possible to correlate AβO buildup with emergence of cognitive dysfunction, providing new means to investigate the AβO hypothesis and assess the experimental efficacy of investigational new drugs.

AβOs are now regarded as one of the first toxins to appear in disease progression, and they provide an excellent target for early diagnostic imaging. Our findings suggest that both transgenic mice and non-transgenic dietary risk-factor-induced rabbits are effective models for investigating) accumulation of AβOs. Further, the success of AβO-targeted probes in these in vivo studies suggest they are useful not only for the early diagnosis of AD, but also for future clinical studies.

Project ID: PHYS 07
9:10a.m. - 9:25a.m.

Title: Particle physics systematics and scale conversions with Python
Presenter(s): Grace Yue
Mentor(s): Dr. Peter Dong, IMSA
Abstract/Project intention:
To expand on the IMSA-CMS Collaboration's codebase by adding a mechanism to compute statistical uncertainties and modifying the conventions used in calculating the mass scale.

In the past year, we expanded on our codebase by implementing systematics to compute the statistical uncertainties of results from different energy bins. This was done by using an existing function for statistical uncertainty given a lambda value and using the highest uncertainty per lambda value. We also created another script to quickly translate between the limit on the ultraviolet cutoff ΛT to a limit on the mass scale in the Hewett and HLZ conventions. In addition, we worked on coding a different formula to calculate the form factor based on the number of dimensions in our model. The HLZ (Han, Lykken, and Zhang) parametrization worked correctly for all cases except for the special case n=2 (and the trivial case n=1), so we modified the limit-setting conventions in the code to accurately compute the mass scale.

Session II - 9:45a.m. - 10:00a.m.

Project ID: BHVSO 01
9:45a.m. - 10:00a.m.

Title: Econometric Analysis Between Harmful Air Conditions and Mortality of Respiratory Conditions
Presenter(s): Caitlyn C. Castillo and Ashley M. Homecgoy
Mentor(s): Patrick Kearney, IMSA
Abstract/Project intention:
It is important to be aware of how the environmental surroundings in cities, suburbs, and rural areas affect our physical health, no matter how subtle. One aspect that may have a huge effect is the air being inhaled. In our research, we draw data on particulate matter 2.5mm, as well as CO2 emissions from highway vehicles, off-highway, fuel combustion, industrial processes (including chemical and allied product manufacturing, metals processing, petroleum and related industries, and other industrial processes; solvent utilization; and storage and transportation), and waste disposal and recycling. Our other x-variables in the linear regression include household income and smoking rate. With this data, we use econometric modeling to test for correlation with data on mortality rates from numerous chronic respiratory diseases such as asthma, chronic obstructive pulmonary disease, and lung and bronchus cancer. Both variables include data across 3,000+ counties in the United States, encompassing all states with exception to Hawaii and Alaska. The results of the regression are inconclusive, but the various numbers may lead to qualitative context on whether any of the quantities of particulate matter have an effect on any of the chronic respiratory diseases.

Project ID: BHVSO 08
9:45a.m. - 10:00a.m.

Title: Investigation of Student Inquiry and Research through Media
Presenter(s): Francesca Dumitrescu
Mentor(s): Bill McGrail and Kevin Broy, IMSA Instructional Technology and Media Center
Abstract/Project intention:
At the Illinois Math and Science Academy, almost everyone is familiar with the Student Inquiry and Research program. This program allows students to communicate with mentors and conduct research on topics ranging from neuroscience to psychology. However, not many students understand how it works or acknowledge how much diversity of projects that exists within the program. It is important to highlight the vast differences, and this is made possible through the use of media, whether it is video, audio, or written. This project uses professional video, audio, and editing equipment to interview students and advisors, as well as gather footage on students working on their individual projects. Furthermore, there is a clear distinction of on-campus students at IMSA and off-campus students in the greater Chicago area in order to accommodate for the full range of projects that exist.

The end product of this endeavor was two separate, short documentaries focusing on either on-campus or off-campus SIRs which briefly explain and showcase what it means to be a part of these projects. This project involves science film journalism techniques to effectively convey the depth of the SIR program. By using film journalism to investigate student research, we can learn how to communicate science to a wider community.

Project ID: BHVSO 11
9:45a.m. - 10:00a.m.

Title: High School Socioeconomic Status and Adolescent Political Socialization
Presenter(s): Rohan Upadhyay
Mentor(s): Dr. Robert Bruno, PhD, University of Illinois at Chicago, School of Labor Employment and Relations
Abstract/Project intention:
This study observes the effects of the socioeconomic status of high schools on the political orientations of students. Specifically, it investigates if a correlation exists between the political orientations of students and the wealth of a school district. Wealth in this context is defined as the percentage reached by the school district of a state-assigned adequacy funding target. School districts will be divided into brackets based on their funding adequacy percentage, as indicated on the Illinois Report Card.

The study will use a cross-sectional survey – validated by an expert in the field – across Illinois public school districts. The survey will ask students about their viewpoints on 8 political issues and will gauge how much students agree with specific liberal and conservative positions on each of these issues. Responses will contribute to an index on a scale from 0 to 1, with 0 being more liberal and 1 being more conservative. These values will represent individual political orientations, and their correlation with district socioeconomic status will be measured.

As of now, data has not yet been collected, but this process will be completed by the end of March. The survey will be administered in Innovations High School, East Peoria Community High School, along with Glenbard North, South, East and West High Schools. The total sample size will be 394 students across the six schools. The sample comprises students in social science and government classes, as this study would be most relevant to those classes.

Project ID: BHVSO 15
9:45a.m. - 10:00a.m.

Title: The Given/New Distinction in Sentence Inversion: How Nonstandard Sentence Structure Affects Intonation

Presenter(s): Nathan Shwatal
Mentor(s): Dr. Jennifer Cole, Northwestern University

Abstract/Project intention:
During conversation, speakers must evaluate what they are saying in relation to what has previously been said, the discourse context. Primarily, information is divided into two categories based on this relation: "given" and "new." The "given/new" distinction is invoked in linguistic analysis in two ways. First is the claim that given information tends to be ordered before new information in the sequencing of sentence constituents. Second is the claim that new information is prosodically enhanced, e.g., through intonational features. While these claims imply a default prosodic highlight at the end of a phrase, there has been little research on these claims for sentences where word order does not respect that which is typical of English. This study examines the interaction between information status and word order and their combined effects on prosody in a speech production experiment. College volunteers will read aloud short narratives in which the first sentence sets up a discourse context and is followed by the second sentence which has either standard or inverted word order. Analysis of participants' speech recordings will be based on perceived distinctions in prosodic marking of constituents and through pitch distinctions measured using the audio analysis software Praat. If prosodic marking is driven mainly by information status, we predict prosodic marking of discourse-new words, regardless of their position in the sentence. Otherwise, if prosodic marking is driven mainly by sentence position, we expect the sentence final word to be prosodically enhanced regardless of its information status. Findings from this experiment will inform our understanding of English prosody and its relationship with syntax and discourse structure and may even inform future work on computer-generated speech to enrich syntactic and prosodic variety and thereby improving naturalness.

Project ID: BHVSO 19
9:45a.m. - 10:00a.m.

Title: Causal Relationships in 21st Century Chicago Gentrification
Presenter(s): Alex Sobczynski
Mentor(s): Patrick Kearney, IMSA
Abstract/Project intention:
Since the mid-1990s, gentrification has been a popular area of sociological study, typically in discussion of the immediate and delayed effects of gentrification. There is a general consensus among professionals that gentrification is a natural economic occurrence motivated by low property value in desirable areas and a surplus of capital from investors. However, independent of governmental subsidies and tax incentives, we wanted to find how developers specifically pick from the variety of neighborhoods available to them. Entering into our analyses, we hypothesized that developers in Chicago prefer low property value, closer proximity to the loop (Chicago city center), lower crime rates, and buildings built before 1940. Thus, we have measured the causes of gentrification in Chicago over an eight-year period on a census tract level defining gentrification as an increase in median percent income attributed to housing and weighing the hypothesized factors.

Project ID: BIO 06
9:45a.m. - 10:00a.m.

Title: Effect of a loss of WRC formation on autistic behavior modulation
Presenter(s): Akul Prakash
Mentor(s): Jennifer Rakotomamonjy and Alicia D Guemez Gamboa, Northwestern Feinberg School of Medicine, Guemez-Gamboa Lab
Abstract/Project intention:
It has been recently described that pathogenic variants in different components of the Wave Regulatory Complex (WRC) result in intellectual disability with autistic features and seizures. The WRC is a five-protein complex consisting of WAVE1, CYFIP1, ABI2, NAP1, and HSPC300 that mediates interactions of membrane receptors with the actin cytoskeleton to regulate crucial developmental steps such as neural adhesion and migration. Deletion of ABI2 in mice reduces actin nucleation and produces phenotypes in the brain including deficits in memory and other cognitive skills. Wave1 knockout mice showed behavioral abnormalities, including impaired learning and memory. In this study, I used a mouse model where we introduced point mutations in Abi2 to prevent WRC binding to cell membrane partners. Wild-type, heterozygous and homozygous mice for the Abi2 point mutations were observed in the nestlet shredding animal model to determine if the loss of WRC formation resulted in repetitive behavior reminiscent of obsessive-compulsive disorder or autism spectrum disorders. My results show no

significant differences between genotypes, suggesting that the formation of the WRC does not play a major role in autistic behavior modulation. Further investigation is needed to explore seizure susceptibility and assess behaviors related to intellectual disability in our mouse model.

Project ID: BIO 16
9:45a.m. - 10:00a.m.

Title: Biodiversity of Bacteriophage With the Host Microbacterium foliorum on the Illinois Mathematics and Science Academy
Presenter(s): Ivan Anterola and Ann Lamptey
Mentor(s): Dr. Crystal Randall, IMSA
Abstract/Project intention:
The SEA-PHAGES program began in 2008 with the goal of isolating bacteriophage samples that infect certain host bacteria from the environment. New developments in phage research have found that using phage to target disease causing bacteria may be a legitimate way to treat diseases. Our research group selected four different host bacteria suggested by the SEA-PHAGES program and followed the collection, isolation, amplification, and purification processes provided by the SEA-PHAGES guide. Our study focused on identifying phage that infected the host bacteria Microbacterium foliorum on the Illinois Mathematics and Science Academy. We collected soil samples from the academy campus throughout the school year. We used two different isolation techniques outlined by the SEA-PHAGES program, indirect and enriched, to isolate phage samples. Our results were inconclusive. No phage was able to be isolated with our host bacteria. However, other groups testing that other host bacteria were able to isolate phage, but were unable to replicate it. These findings suggest that further testing must be done. Doing testing when there is a more suitable climate may increase the chance of finding phage. It may also be more practical to switch host bacteria to those that were successful in finding phage.

Project ID: BIO 26
9:45a.m. - 10:00a.m.

Title: Screening Compounds to Identify an Inhibitor of the Dengue NS5 Protein
Presenter(s): Jumobi Arowolo, Brenna Christoffel and Quadri Durojaiye
Mentor(s): Dr. Angie Ahrendt, IMSA
Abstract/Project intention:
Dengue fever is a disease caused by any of the four related dengue viruses. It is a mosquito-borne disease that mainly occurs in tropical and subtropical regions. Approximately 400 million cases of dengue infections occur worldwide while 96 million cases result in dengue fever. Symptoms occur around four to six days after infection and last up to ten days. Furthermore, the dengue virus is classified as a flavivirus. These viruses only encode 10 proteins, one of which is NS5. We are specifically trying to target the NS5 protein in the dengue virus because it is very important to the virus's life cycle. It is a large protein with two enzyme domains; one which is responsible for avoiding human immune response and the other that is vital for RNA synthesis. In our SIR, we used protein thermal shift assays to determine how efficient different compounds were at inhibiting this protein.

Project ID: BIO 43
9:45a.m. - 10:00a.m.

Title: Cell death due to excess GTP and phage activation in B. subtilis.
Presenter(s): Mark Ying
Mentor(s): Dr. Kachun (Danny) Fung and Dr. Jade Wang, University of Wisconsin
Abstract/Project intention:
Guanosine penta/tetraphosphate ((p)ppGpp) is involved with the stringent response in bacteria, and it inhibits RNA synthesis when there is a shortage of amino acids by regulating Guanosine triphosphate (GTP) biosynthesis enzymes. Due to unknown reasons, excess GTP has been observed to kill cells due to a lack of the alarmone nucleotide (p)ppGpp in Bacillus subtilis. The aim of this study was to research the link between GTP and phage activation. GTP is the energy used for transcription and replication. Due to the extremely high rate that these two processes happen in a cell, these processes may meet one another and cause damage to the DNA. It was hypothesized that increased GTP leads to DNA damage through transcription-replication conflict, which causes phage activation and kills the cells. Cells without (p)ppGpp were grown with or without phages, with or without pcrA overexpression (a gene that reduces transcription-replication conflict), and with or without a vector control.

The results of this study found that cells grown in the absence of (p)ppGpp without phages had much higher populations than those grown with phages. It was also found that overexpression of pcrA in cells with phages was able to prevent some, but not all, cell death.

Project ID: CHEM 01
9:45a.m. - 10:00a.m.

Title: Crystal Structures of Large Volume Commercial Pharmaceuticals
Presenter(s): Shivang Bhaskar, Diana Gonzalez
Mentor(s): Joseph T. Golab, IMSA and James A. Kaduk,
North Central College
Abstract/Project intention:
The purpose of this project is to determine the crystal structures of commercial pharmaceuticals using X-ray powder diffraction data and computational chemistry techniques. We have analyzed new compounds and compounds with unpublished structures: ceftriaxone sodium hemiheptahydrate and pimecrolimus. Knowledge of the crystal structure helps rationalize chemical and biological properties, and also facilitates qualitative and quantitative phase analysis. We have solved and refined the crystal structures using Monte Carlo simulated annealing, Rietveld refinement, and density functional theory (DFT) geometry optimizations. We will present the structures and discuss their intermolecular bonding in the solid state, particularly hydrogen bonding. By understanding the structure of these compounds and how they interact with themselves, we can predict how they might interact with human biological pathways, knowledge which is essential in the creation of new pharmaceuticals.

Project ID: CHEM 06
9:45a.m. - 10:00a.m.

Title: Anti-Bacterial Effects of Echinacea Extract Using Kirby-Bauer Antibiotic Testing
Presenter(s): Amelia Churchill, Kristina Williams
Mentor(s): Dr. John Thurmond, IMSA
Abstract/Project intention:
Test the antibacterial effect of Echinacea on Bacillus Subtilis, Enterococcus Raffinosus, Acinetobacter Aylyi, Pseudomonas Putida, Pseudomonas Fluorescens, E.coli, and Tuberculosis.

Echinacea, a plant used in teas and supplements for medical purposes, is rumored to have a significant effect on the immune system and reduce flu and cold symptoms with anti-inflammatory, antioxidant and antibacterial effects. In this study we tested the antibacterial effects of Echinacea on 7 different bacterias: Bacillus subtilis, Enterococcus raffinosus, Acinetobacter aylyi, Pseudomonas putida, Pseudomonas fluorescens, E.coli, and Tuberculosis. To test it, we created 6 extract solutions by shaking 1 gram of echinacea powder with 8 mL of water for 6 hours. We conducted Kirby-Bauer antibiotic testing of each bacteria with our extract. To do this we prepared 7 agar plates and divided them into four sections. One section was left blank while the others contained antibiotic disks. One disk contained 10 µL of ampicillin, one disk contained 10 µL of our extract, and the last one was left blank. After letting the bacteria marinate at 30 and 37 degrees celsius for 24 hours, we compared the results of the extract to the amplicin and blank disks. Through experiment, Echinacea extract has been determined to have minimal to zero effect on the bacteria tested because there was no visible zone of inhibition around the antibiotic disks.

Project ID: CHEM 10
9:45a.m. - 10:00a.m.

Title: Pathogen Resistance in Soil Samples for Drug Discovery
Presenter(s): Saachi Dalvi and Neha Maddali
Advisor(s): Dr. John Thurmond, IMSA
Abstract/Project intention:
Antimicrobial resistance has become a prevalent phenomenon and now poses a great threat to public health. To combat the threat of such diseases, the soil, which has billions of unidentified bacteria, has been used as a source for microbes with pathogenic resistance. This project aims to test for new soil bacteria that exhibit antimicrobial properties against resistant pathogens and can be viable candidates for new antibiotics. In the approach, soil samples were collected, and serial dilutions were conducted to extract individual bacterial colonies. After creating master plates from the isolated bacteria, the samples were screened against seven safe relatives of ESKAPE pathogens utilizing the spread-patch technique. The seven pathogens of focus were Bacillus subtilis, Enterococcus raffinosus, Acinetobacter baylyi, Pseudomonas putida, Pseudomonas fluorescens, Enterococcus coli, and Mycobacterium tuberculosis. In total, seven bacterial samples were found to have significant antimicrobial properties. Four of these samples were resistant against Acinetobacter baylyi, two were resistant against Bacillus subtilis, and one was resistant against Pseudomonas fluorescens. Colonies that showed inhibition of an ESKAPE safe relative will be preliminarily identified using 16s rDNA gene. Further steps include identifying these bacteria as novel or not, and the extraction of the bioactive substances in these samples as possible novel antimicrobials.

Project ID: ENGN 5
9:45a.m. - 10:00a.m.

Title: Solar Cooker Development in Midwestern Climate
Presenter(s): Oliver Bohac, Eugene Lim and Harshini Musku
Mentor(s): Dr. Mark Carlson, Illinois Mathematics and Science Academy
Abstract/Project intention:
About 3.6 million people die annually from drinking contaminated water. An affordable and durable solar cooker to elevate water temperature could help address this problem. We tested five prototypes with both natural and artificial light. Our first designs, using mylar backed by cardboard or foam, had low wind resistance. The next design had a frame made out of ½" PVC pipe that improved durability but did not concentrate the light. Finally, wood lath was curved into a parabola to more effectively focus the light and solve the concentration issue. Our goal was a 17℃ increase in water temperature, and we were able to achieve about 6℃ increase under ideal weather conditions (45℃ with no cloud cover). Continuing testing inside, we were unable to provide adequate light intensity, only getting less than 3℃ difference using 6, 60-watt heat lamps. We conclude that we were unable to adequately test a device that would be usable in equatorial regions without more extensive equipment and controlled conditions.

Project ID: ERSP 1
9:45a.m. - 10:00a.m.

Title: Analysis of the Microbiome of Soil at Various Depths and Locations on the Illinois Mathematics and Science Academy Campus
Presenter(s): Rachel Moreno
Mentor(s): Dr. Melissa Lenczewski, Ph.D., Northern Illinois University and Sarah O'Leary, Illinois Mathematics and Science Academy
Abstract/Project intention:
While the general geophysical properties of the Kane county Illinois area are known, there is not much known about the microbiology. To provide background on the geology, Curry (2001) found that the surficial geology of the Aurora North Quadrangle of Illinois is characterized by three major episodes, the earliest of which arrived around 500,000 years ago. There are no sediments from this period, but it likely makes up large portions of the bedrock. Secondly, the Illinois Episode deposited sediments found in bedrock, and a thin layer rich in organic material around 180,000 to 130,000 years ago. In 2013, Curry, Grimley and Bruegger found that the soil type in the area was l-y, meaning the soil is generally characterized as a silty clay/silty clay loam/clay with some layers of gravel or sand at varying depths, down to 100 feet below the surface. A study done by P.E Brown and T.H Benton (1930)

found that the population of the microbiome decreases as depth of soil increases, with a possible cause being a lack of organic matter in deeper stratigraphic layers.

To further build off of the research, this research aims to look at the specific layers of the area's soil to see how depth, location, and soil type affect the microbiome. Firstly, seven 40 feet deep wells were installed on the Illinois Mathematics and Science Academy Campus next to a water retention pond, and the soil cores of four wells were collected for analysis. Each of the four cores was fully analyzed to classify the soil types and the individual soil gradients. Three of the four cores were also further sampled about every four feet, to be used in DNA extraction to find out more on the microbiome of the area soil at different depths, locations, and soil types. Around 40-50 of these samples were taken, with an additional two water samples from one well, and through the use of a fisher scientific soil DNA extraction kit, DNA was extracted from each. Next, DNA yield was measured using a NanoDrop 2000. With this data, one sample from each depth was chosen to be used in polymerase chain reaction (PCR), using the 16S Illumina Amplicon Protocol as described by the Earth Microbiome Project (2018) and further sequencing, to establish a general picture of the area's microbiome. At this time, these tests are in process, and conclusive results are not yet available, though we predict substantial variance in the microbiome between locations, soil depths, and soil types.

Project ID: MATH 1
9:45a.m. - 10:00a.m.

Title: An Application of Compartmental Infectious Disease Modeling
Presenter(s): Aidan Stueck & Madhav Parthasarathy
Mentor(s): Dr. Patrick Davis, IMSA
Abstract/Project intention:
Compartmental modeling of infectious disease allows researchers to analyze the spread of a pathogen through a population and can contribute to determining optimal control strategies. Using this framework, we modelled the spread of influenza through a closed population of students, as motivated by the 2018 “Flu-pocalypse” that occured at IMSA. The students were sorted into susceptible, exposed, infectious, symptomatic, and recovered compartments of the disease. By utilizing differential equations, we model the flow at which the members of the population exit their respective compartments and transition into the next. These differential equations include several parameters which account for various behaviors of the population members and characteristics of the disease. Using these differential equations, we construct the corresponding Jacobian matrix to systematically determine the value of R0, the basic reproduction number of our model. R0is defined as the average number of new cases of an infection caused by one typical infected individual in a population consisting of only susceptibles; it is calculated by evaluating the dominant eigenvalue of the next-generational matrix of the infected subsystem. If R0>1, an epidemic will occur; and if R0<1, then it will not. In addition to simulating the disease, we proved the existence/uniqueness and non-negativity of a solution to our model given appropriate initial conditions.

Project ID: MATH 5
9:45a.m. - 10:00a.m.

Title: The Influence of Batted Ball Factors on the Home Run Rate of Major League Baseball
Presenter(s): Austin Shwatal
Mentor(s): Chris Jones, Chicago Cubs, IMSA Class of 2002
Abstract/Project intention:
In Major League Baseball, home run rates over the past several years have reached unprecedented, record-breaking levels, leading many to suspect that the composition of the baseball itself is different compared to previous years. Our study attempts to build on previous research confirming differences in ball composition by parametrizing the specific effects this change has had on the outcome of batted balls. To start, we took indoor Statcast batted ball data from 2015 and 2019 (before and after the assumed change in ball) and

analyzed the effects that exit velocity and launch angle have had on the overall distance traveled by the ball. We separated the horizontal and vertical forces on the ball, attempting to locate how specific factors might affect the flight of the ball. From this, we found strong correlations between distance traveled and launch angle, hang time, and distance traveled per each second of hang time. From here, we plan to use these correlations to estimate a specific relationship between exit velocity, launch angle, and distance traveled in order to estimate how the change in ball composition has affect different types of batted balls.

Project ID: MEDH 11
9:45a.m. - 10:00a.m.

Title: Testing for a Better Alzheimer's Disease Drug through Reinventing Aricept
Presenter(s): Muyiwa Arowolo, Tony Martin
Mentor(s): Dr. John Thurmond, Illinois Mathematics and Science Academy
Abstract/Project intention:
The pharmaceutical drug "Aricept" (Dopenzil) is used to treat symptoms, specifically confusion and dementia, in patients that have been diagnosed with Alzheimer's disease. Despite abundant research, there is no cure for the disease, but only treatment and remedies for the symptoms, despite the fact that the disease affected 5.8 million Americans as of 2019, and is the 6th leading cause of death in the United States. Because of Aricept's prominence in the Alzheimer's drug industry, our group decided to attempt to improve the efficiency of the drug in the aspects of estimated binding affinity, Lipinski's rule of 5, pharmacokinetics, and lipophilicity by making edits to the Donepezil molecule. We also checked for (PAINS?) and made sure the new molecule would go to the brain via the BOILED egg test. Tests were performed using the Computer-Aided drug design programs Molinspiration, SeeSAR, and SwissADME. After months of drug editing, we made (about 300?) different versions of the molecule, with multiple different orientations in space for most of them. More importantly, we were able to create a molecule that was, essentially, an improved version of the Donepezil molecule. (NOTE: Everything with a question mark is subject to change.)

Project ID: MEDH 16
9:45a.m. - 10:00a.m.

Title: The Proliferation in Different Cell Lines of Glioblastoma Multiforme
Presentor(s): Jade Bates and Claire Difford
Mentor(s): Dr. Sowmya Anjur, IMSA and Dr. Don Dosch, IMSA
Abstract/Project intention:
This paper explores the cell proliferation in different cell lines of Glioblastoma Multiforme (GBM). For this, two different cultures were grown: T98G and U118. A spectrometer was used to analyze what compounds were present in the cell culture. The cell proliferation of the different lines was counted with a hemocytometer. The objective of the study was to determine the correlation between cell proliferation and the compounds present in the GBM cell lines. The information found in this study will help determine why some cases of Glioblastoma Multiforme are more aggressive than others. Ultimately, this knowledge can inform future studies on how to more effectively treat Glioblastoma Multiforme.

Project ID: MEDH 19
9:45a.m. - 10:00a.m.

Title: Vitexin enhances BMP9-induced osteogenic differentiation in mesenchymal stem cells (MSCs)
Presenter(s): Alison Deng and Lily Li
Mentor(s): Dr. Tong-Chuan He and Dr. Meng Zhang, University of Chicago
Abstract/Project intention:
Mesenchymal stem cells (MSCs) are multipotent stromal cells that have the potential to differentiate into a variety of cell types, including osteoblasts (bone cells). MSCs are thus applicable in bone regeneration, which can be used to treat bone disorders and injuries and potentially even bone cancer. To better understand the process of MSC differentiation, we investigated the effect of vitexin on the osteogenesis induced by bone morphogenetic protein-9 (BMP-9) in MSCs. We detected osteogenic differentiation by studying Alkaline Phosphatase (ALP) activity and the Alizarin Red S staining of mineralized matrices when iMAD cells were treated with BMP9 and/or Vitexin. Then, the gene expression of the osteogenic markers was detected by quantitative reverse transcription polymerase chain reaction (qPCR). We found that BMP9 and Vitexin increased the activity of early osteogenic differentiation marker ALP. The activities are more pronounced when treated by both BMP9 and Vitexin than when treated by BMP9 or Vitexin alone. These results indicate that Vitexin potentiates the osteogenesis induced by BMP9 in MSCs and is, therefore, a promising method in bone tissue engineering.

Project ID: MEDH 21
9:45a.m. - 10:00a.m.

Title: The Expression of ERE & NFkB in Breast Cancer Cell Lines
Presenter(s): Bhattacharyya, Utsa
Mentor(s): Frasor, Jonna, University of Illinois at Chicago
Abstract/Project intention:
A devastating disease, estrogen-receptor-positive, or ER+, breast cancer (BC) occurs when ERα (estrogen receptor alpha) is present in the tumors and assists with proliferation. Not only is ERα a factor, but previous studies have shown a correlation between NFkB, a family of transcription factors significant to the treatment of cancer, and ER. Since determining the effects of ER/NFkB activity on ER+ breast cancer cells can be potentially beneficial for treating breast cancer in the future, we conducted a study examining the varying levels of expression with ERE (or estrogen receptor element) and NFkB in ER+ breast cancer cell lines with the goal of finding a clone cell line that was representative of the bulk population. Additionally, our study also examined the characteristics of stem cells, also thought to be the reason behind relapses in breast cancer due to their highly versatile nature. The second goal was to characterize stem cell properties in ER+ breast cancer. To accomplish this, clone cell lines and colonies were grown with transfected plasmids that allowed NFkB and ER activity to be seen with GFP and mCherry respectively. These were monitored over a course of one to two weeks before scanned in Celigo to see the levels of expression in the two different channels. Mammosphere forming efficiency was also calculated as it was another factor in determining which clone line was the most representative of the bulk in addition to the ER/NFkB activity. The results from these scans were graphed, and it is evident that breast cancer cells tend to exhibit significantly more ER activity than NFkB. This has yet to lead us to a concrete conclusion.

Project ID: MEDH 33
9:45a.m. - 10:00a.m.

Title: Investigating Sex-Specific Effects of Gut Microbiome Perturbations on Alzheimer's Pathology
Presenter(s): Bochetty, Shouri and Nalabothu, Siva
Mentor(s): Sangram Sisodia, University of Chicago, Pritzker School of Medicine
Abstract/Project intention:

Current evidence of the microbiome-gut-brain axis suggests that gut microbiome plays a key role in regulating microglial maturation and function. An altered microbiome in the gut has been characterized in Alzheimer's disease (AD). In prior studies, the Sisodia lab has shown that antibiotic cocktail (ABX)-perturbed altered gut microbiome in APPPS1-21 male mice showed reduced brain amyloidosis which were restored after fecal microbiota transplantation (FMT) of age-matched APPPS1-21 mice. This demonstrates a causal relationship between AB plaque deposits and the gut microbiome in AD mouse models. However, the microbiome differences in APPPS1-21 transgenic (Tg) and Wild-Type (Wt) mice and their effects on AB pathology remains unknown. Here I propose FMT transplants of gut microbiome from Tg male mice and Wt male mice into ABX-treated APPS1-21 male mice to investigate any differences in their gut microbiome and the cause of AB pathology.

Project ID: PHYS 01
9:45a.m. - 10:00a.m.

Title: Investigating Systematic Errors in Monte Carlo Simulated Events
Presenter(s): Evan Blad
Mentor(s): Dr**.** Peter Dong, IMSA and Lenny Spiegel, Fermilab
Abstract/Project intention:
The focus of the IMSA-CMS group is on investigating quark compositeness and large extra dimensions as proposed by the ADD theory. An important part of the analysis process is the simulation of the Standard Model through the generation of Monte Carlo events. PDFs, or Parton Distribution Functions, model the probability density of quarks and gluons within protons collided at various energy scales and are crucial in the generation process. Since they are experimentally derived, they contain systematic errors that affect the Monte Carlo generation and are updated frequently. CMS utilized NNPDF LO 2.3 and NNPDF NNLO 3.1 in PYTHIA Monte Carlo simulation in 2016 and 2017 respectively. However, due to known problems with NNPDF version 3.1, it is being reweighted to 2.3. In order to accomplish this task, dilepton invariant mass histograms are plotted from each NNPDF version to compare the shape. Then, functional parameterizations can be used to reweight NNPDF 3.1 and account for systematic discrepancies in our analysis.

Project ID: PHYS 09
9:45a.m. - 10:00a.m.

Title: An investigation into PYTHIA
Presenter(s): Archan Das and Teodor Tchalakov
Mentor(s): Dr. Peter Dong, IMSA
Abstract/Project intention:
PYTHIA is a standardized tool for simulating high-energy physics collisions. It can generate physics events based on different physics models. We can generate events with PYTHIA much faster than we can fully reconstruct them with a detector simulation. These generated events can be analyzed for a generator-level study as if they were results. We are examining distributions of invariant masses in order to find the effect of different physics parameters. Our job is to investigate the effects of the mass scale and number of extra dimensions on the output of PYTHIA when using the ADD extra dimensions model. We are doing this by comparing the invariant mass distributions of the outputs to find out whether our parameter adjustments affected the results.

Project ID: PHYS 13
9:45a.m. - 10:00a.m.

Title: Estimating the Number of Earth-Size Habitable Planets in the Milky-Way Galaxy
Presenter(s): Aaron Calhoun, Ian Fouler, Evie Lee, Manikandan Nagarathnam, Tyler Ptak and Ian Son
Mentor(s): Dr. Eric Hawker, IMSA
Abstract/Project intention:
The number of Earth-sized habitable planets in our galaxy have been determined from the number of Earth-size habitable planets discovered by the Kepler space telescope (KSP) and by understanding Kepler's detection efficiency of these planets. Although the number of Earth-sized planets detected by Kepler is already known, the telescope's instruments are not perfectly precise. Simulations of fake planet transits were created through the manipulation of the Kepler's confirmed null stars and then were analyzed by a trained machine-learning algorithm to determine the detection efficiency of the telescope. The simulated transits were created using characteristics such as planetary and orbital radii within set boundaries, while the machine-learning algorithm was trained on known null and positive stars with exoplanets from the NASA Exoplanet Archive. A scaling factor was found through the combination of the determined accuracy found through the machine-learning algorithm and geometric factor. From this, an estimate of earth-sized planets including those not detected by Kepler in the Milky Way was derived.

Project ID: PHYS 15
9:45a.m. - 10:00a.m.

Title: Scintillation light data from the ProtoDUNE detector
Presenter(s): Smriti Shankar
Mentor(s): Zelimir Djurcic, Ph.D., Argonne National Laboratory
Abstract/Project intention:
The Deep Underground Neutrino Experiment (DUNE) is a neutrino experiment where neutrino beams from Fermilab are to be sent to liquid argon particle detectors at Sanford Underground Research Facility in South Dakota, approximately 1,300 kilometers away. Before the DUNE detectors could be built, a prototype of a single-phase (SP) time projection chamber (TPC) called ProtoDUNE-SP was built. This is currently the largest liquid argon TPC ever built, with about 750 tonnes of liquid argon, and began taking data as of October 2018. In this research project, we collected data from photon detectors integrated into the Anode Plane Assemblies in the ProtoDUNE-SP detector. We analyzed photon-detector data acquired as electronics readout waveforms that consist of a time-ordered sequence of charges collected by photo-sensors. The goal is to explore if different particle species, such as muons and electrons, provide a difference in waveform shapes in terms of detected early and late scintillation light. Therefore we quantified a correlation between the light waveforms from the argon atoms and particle that excited the atoms to identify particle species.

Project ID: PHYS 15 (con't.)
9:45a.m. - 10:00a.m.

Title: Predictions for the DUNE Detector in relation with Proton Decay
Presenter(s): Diego Michel
Mentor(s): Dr. Maury Goodman, Argonne National Laboratory
Abstract/Project intention:
DUNE is expected to complete in 2032 as per the latest DUNE meeting, and with it, it's proton decay research would commence in full. As for preparation for the DUNE project, new limits and extrapolation need to be calculated in order to properly process the data for proton decay. With this paper, new limits, extrapolations for DUNE and Super-K will be calculated for this upcoming project, as well as updated information of the calculation of each detector's efficiency as an extrapolation. Having these values allows for easier access to a decision on the process of priority on proton decay using the detector, as well as reference for finding each proton decay mode's information. This reference sheet contains decay modes retrieved from various papers stated by the Super Kamiokande detector, the IMB detector, and many other sources and papers retrieved from Review of Particle Physics.

Also included are decay modes without preexisting limits, as well as extrapolations for both SKAM (Super KamioKande) and DUNE. If there is a limit stated by IMB, however, not Super KamioKande, then the limit from IMB is given. In this paper also includes the consideration of efficiencies, noting the total, reconstructed, and nuclear efficiencies, as well as rough estimates for pion, eta, and omega mesons.

Session II - 10:05a.m. - 10:20a.m.

Project ID: BHVSO 02
10:05a.m. - 10:20a.m.

Title: The Strictness of Climate Regulation and how it Affects a Country's Greenhouse Gas Emissions
Presenter(s): Lauren Crowe
Mentor(s): Mr. Patrick Kearney, IMSA
Abstract/Project intention:
This project will use a scaled list of different country's environmental policies. This ranks them so the strictest will be differentiable from the least strict. This will be compared against a countries greenhouse gases output while taking into consideration the main industries of the country, size, population, the punishments for violating the environmental laws, and other variables. The goal is to find what type of greenhouse gas regulating is the most effective while taking into consideration that one plan may not be the best for every type of economy and industry.

Project ID: BHVSO 09
10:05a.m. - 10:20a.m.

Title: The Relationship between Prominent Global Religions and Governmental Proceedings, Measured through the Context of Regulations in Women's Statutory Rights
Presenter(s): Gaylen Dimick
Mentor(s): Dr. Eric Smith, IMSA
Abstract/Project intention:
The pervasive suppression of women's legal rights as influenced by dominant civic religious practices, even in governments and judicial systems ostensibly defined as secular, is one aspect of social science research that currently lacks adequate subjection to academic scrutiny. The present study posits ten variable measures of women's rights to serve as binary indicators. Each variable was analyzed by the presence or lack thereof, scored with a 1 or 0 to arrive at a summary score between 0 and 10. This investigation showed that 4 countries held scores of 10, all of which hold no official religion (as in the cases of 12 of the 16 chosen countries). Each other country lacked 1 or more laws that serve to protect inherent female physical, economic, and social rights. These results demonstrate the lack of consistency in governmental secularism's practice versus legal guarantee, a discrepancy explained by the significant influence of dominant state religions' attitudes towards women's rights even in secular government. Further research in this area is necessary to determine an objective methodology to create distinct separation of church and state in both concept and execution.

Project ID: BHVSO 16
10:05a.m. - 10:20a.m.

Title: CRF input to the external globus pallidus
Presenter(s): Narayanan, Ahana
Mentor(s): Qiaoling Cui, Yu Zhang, Northwestern Feinberg School of Medicine
Abstract/Project intention:
Stress results in fight or flight responses. Corticotropin-releasing factor (CRF) is a peptide hormone involved in stress response, and CRF neurons are highly activated by stress. However, it is unclear how CRF neurons are involved in stress-evoked movement. The external globus pallidus (GPe), a nucleus in the basal ganglia that critically control movement, expresses high levels of the primary receptor for CRF, suggesting that it is an entry point for stress-relevant information to reach basal ganglia circuits thereby gating motor output. Paraventricular nucleus of the hypothalamus (PVN) represents a major

source of CRF in the brain. To study the PVN CRF input to the GPe, anatomical, electrophysiological, and behavioral approaches were employed. We found that axons from PVN CRF neurons are present in the GPe. Stimulation of these axons induced inward currents and changed the firing rate selectively in PV+ GPe neurons. Stimulation of PVN CRF axons in the GPe did not appear to regulate movement while striatal inputs, the predominant input to the GPe, play a significant role. Further studies are needed to examine if PVN CRF input is involved in regulating other functions mediated by the GPe.

Project ID: BHVSO 18
10:05a.m. - 10:20a.m.

Title: Phylotechnical Tree at Olduvai Gorge
Presenter(s): Levi Raskin
Mentor(s): Professor Zeresenay Alemseged, University of Chicago
Abstract/Project intention:
To better understand the Oldowan-Acheulean cultural transition.

The Oldowan-Acheulean transition is poorly understood relative to its significance in human evolution and cognition. Understanding the way stone tools changed through time is paramount to understanding the cultural and technological capabilities of early hominins. Previous attempts that describe this transition by using test subjects, are imperfect due to early hominins not having the modern context of technological use and innovation. This study circumvents that issue by describing and analyzing only tool shape in order to better describe the transition between Oldowan and Acheulean cultures. Specifically, it examines Olduvai Gorge lithics from 1.87 ma to 1.27 ma in order to construct a map of the most similar shapes over time. To isolate shape from other metrics, tool size is accounted and adjusted for, material selection was not considered, and two separate geometric invariants were used: major axis divided by the minor axis, and the major axis divided by the maximum thickness. The mapping of these tool relationships implies that scrapers are central to the transition between Oldowan and Acheulean cultures and that slow technological changes in the Oldowan could have allowed for the emergence of the Acheulean large cutting tools (LCTs).

Project ID: BIO 07
10:05a.m. - 10:20a.m.

Title: An ePIC Assessment of Quadriceps Motor Unit Firing Patterns During Isometric Knee Extension: A High-Density Surface Electromyography Study
Presenter(s): Saicharan Voora
Mentor(s): Obaid U. Khurram, Gregory E. Pearcey, and Charles J. Heckman, Northwestern Feinberg School of Medicine, Department of Physiology
Abstract/Project intention:
Central to understanding motor tasks is the motor unit, which consists of a motor neuron and the set of muscle fibers it innervates. Motor neurons are unique in the central nervous system in that their firing patterns can be readily measured and related directly to functional behaviors due to the one to one spike ratio between the motor neuron and innervated muscle fibers. However, these firing patterns vary between the muscles in the human body. The diversity of motor tasks, the structure of the musculoskeletal system, and the synaptic organization of motor commands are the cause for this. In human subjects, these firing patterns have historically been attained using fine-wire electrodes that are inserted directly into muscles to record muscle electrical activity (i.e. electromyography or EMG) during muscle force production. Recent advances in surface EMG array technology have made it possible to record the activity of a great population of motor units non-invasively. This is because modern-day high-density EMG technology can be used in conjunction with blind source separation techniques, which detect repetitive patterns in a signal to allow the discrimination of dozens of individual motor unit action potential trains. Using data from the EMG arrays and a paired motor unit analysis technique, which compares the onset and offset of a high-threshold motor unit to a low-threshold unit, the level of neuromodulatory drive can be estimated. The difference between the two firing rates is delta F (difference in reference unit firing frequency between test unit recruitment and derecruitment) and serves as an estimation of PIC in humans. In the arm, preliminary studies from our lab suggest there is a strong proximal to distal gradient of neuromodulatory drive, likely reflecting the varying behaviors in which the different muscles of the arm are involved. The proximal muscles in the arms have ΔF = ~4-6 spikes/s whereas the distal muscles have ΔF = ~2-3 spikes/s. However, it is unclear if the same proximal to distal gradient is present in the legs as in the arms. Our data indicate that quadricep activation generates motor unit firing patterns indicative of low neuromodulatory drive with ΔF around 1.5 spikes/s and lower leg muscles have ΔF= ~3-5 spikes/s. Thus, these findings suggest that the proximal to distal gradient found in the legs is not analogous to the ones in the arm, which may reflect the impact of task diversity on motor unit firing patterns between the arms and legs in bipeds.

Project ID: BIO 18
10:05a.m. - 10:20a.m.

Title: Phage Discovery
Presenter(s): Sydney Despe and Brennan Shapiro
Mentor(s): Crystal Randall, IMSA
Abstract/Project intention:
In the SEA-Phages SIR, we attempted to discover new phages. Phages are the largest biomass on Earth and influence us globally. It is very important to study phages and their relationship to a host. A phage is a virus that infects and replicates within bacteria and archaea. They are unable to replicate by themselves. They require a bacterial host to reproduce. Phages have important applications in biotechnology and DNA sequences. Phages are specific for hosts. Since the late 19th century, phages have been used as an alternative for antibiotics. They can be used against multi-drug-resistant strains of bacteria. Phages are an important topic of research with diverse applications. We cultured the host and media, and tried to isolate viruses with different methods, such as plaque assays. We experimented with different types of soil, amounts of buffer, and methods of plaque assay. Our group worked with Arthrobacter globiformis, which is one of the species that is found in soil. A. globiformis uses ammonium salt or nitrate as a sole nitrogen source and glucose as a carbon and energy source. A. globiformis dissolves diverse iron complexes effectively and its siderophores have a high iron chelation capacity.

Project ID: BIO 27
10:05a.m. - 10:20a.m.

Title: A Search for Inhibitors of HGXPRT Using Protein Thermal Shift Assays
Presenter(s): Akanksha Garg, Rachna Gupta, and Hannah Xu
Mentor(s): Dr. Angela Ahrendt, IMSA
Abstract/Project intention:
Malaria is a bloodborne disease primarily spread by mosquitoes. In 2017, there were an estimated 217 million cases of malaria worldwide, many of which were in third-world countries. Even though there are drugs that can combat malaria, they are not accessible to most consumers in need because of their high cost and, even if a consumer can access these drugs, they have low efficacy rates. HGXPRT is a purine salvage enzyme synthesized by malaria-causing parasites that is essential for their survival. Studies conducted in the past have concluded that neutralizing HGXPRT is an essential part of finding an affordable cure for malaria. This study focused on introducing different molecular compounds to HGXPRT to find a potential drug to combat malaria. The effectiveness of each one was tested through a protein thermal shift assay, in which a shift in the melting temperature between the free enzyme and the enzyme-compound mixture indicated that the enzyme was binding to the compound. The goal of this study was to identify specific compounds as potential drugs to combat malaria and to provide the scientific community with this data.

Project ID: CHEM 02
10:05a.m. - 10:20a.m.

Title: Crystal Structures of New Citrate Salts
Presenter(s): Jerry Hong and Nilan V. Patel
Mentor(s): Joseph T. Golab, IMSA and James A. Kaduk, North Central College
Abstract/Project intention:
The purpose of this project is to determine the crystal structures of Group I ammonium citrates using X-ray powder diffraction data and computational chemistry techniques. We have analyzed new compounds: diammonium potassium citrate, diammonium sodium citrate, disodium hydrogen citrate monohydrate, and dipotassium hydrogen citrate monohydrate. Knowledge of the crystal structure helps rationalize chemical and biological properties, and also facilitates qualitative and quantitative phase analysis. We have solved and refined the crystal structures using Monte Carlo simulated annealing, Rietveld refinement, and density functional theory (DFT) geometry optimizations. We will present the structures and discuss their intermolecular bonding in the solid state, particularly hydrogen bonding.

Project ID: CHEM 04
10:05a.m. - 10:20a.m.

Title: Engineering pH dependent binding interactions anti-caffeine VHH camelid antibodies with ionizable amino acid side chain substitutions
Presenter(s): Dana Stanecki
Mentor(s): James R. Horn, Hyeyoung Eom, Northern Illinois University
Abstract/Project intention:
Protein engineering grows every day as more opportunities emerge to engineer proteins with specific functions. Engineering pH dependent proteins are of specific interest because they can then be used in various environments. With a goal of creating a reverse control switch for pH dependent proteins, a variety of mutations in anti-caffeine were created and studied, with particular interest in the mutant Y61D. Using isothermal titration calorimetry, the stoichometry, enthalpy, entropy, and binding constants were found in a variety of anti-caffeine VHH and caffeine interactions. A range of pHs from 4.0 to 7.4 were studied in appropriate buffers. By introducing aspartic and glutamic acid residues into the homodimer interface of the caffeine-anticaffeine, we were able to engineer pH-dependent proteins that bind well at low pHs.

Project ID: CMPS 4
10:05a.m. - 10:20a.m.

Title: Encoder-Decoder Frameworks for Translation Between Human and Mouse Proteins
Presenter(s): Jacob Levine
Mentor(s): Aly Azeem Khan, University of Chicago
Abstract/Project intention:
Over the last few years, increased computational power from technologies such as CUDA has allowed data scientists to build larger and larger models. One area that has significantly benefited from these improvements is machine translation, where models based on deep neural networks have replaced more traditional statistical techniques due to encoder-decoder methods. We attempt to apply these translation methods in an immunology context, where often reactions between proteins are tested in model organisms such as mice instead of humans, and therefore being able to “translate” between mouse proteins and their human analogues can help predict whether the same reactions will occur. We test various convolutional and RNN encoder-decoder frameworks on this task, and replace the linguistically-inspired translation accuracy metrics with biologically-inspired protein similarity metrics. While our models still clearly need improvements, our preliminary results represent a first step towards this ability.

Project ID: CMPS 6
10:05a.m. - 10:20a.m.

Title: Machine Learning Datasets and Algorithms through "Duckietown" Vision Systems

Presenter(s): Ajay Jayaraman
Mentor(s): Dr. Matthew Walter, Toyota Technical Institute at Chicago, Robotics Intelligence through Perception Lab

Abstract/Project intention:
In order for robots to safely navigate their environments, they must be able to utilize a variety of sensory input to determine proper actions to take. Through the use of advanced perception algorithms, robots are able to analyze multi-modal observations about their environment. The Duckietown project serves as a way to simulate this artificial intelligence process on a simpler and accessible platform. The Duckietown platform uses a tangible robot comprising of a Raspberry Pi and PiCamera along with a chassis. The other primary aspect of the project are the Duckietowns themselves, which are environments filled with other Duckiebots trying to traverse a cityscape. I work to better understand the software platform created for Duckietown, initializing and controlling the robot using Python through Ubuntu Linux. We heavily utilize ROS (Robotics Operating System) and Docker (a container platform). The Duckietown Project was conceived as an MIT graduate class in 2016 and has since then become a worldwide multi-university program. I have been attempting to use this platform to create an image dataset. Using other datasets from Kaggle, a machine learning/data science community, I have been working to develop different image processing algorithms to recognize patterns. This project is building up to incorporating this image recognition system into a Duckiebot and running it live.

Project ID: CMPS 9
10:05a.m. - 10:20a.m.

Title: A Machine Learning Approach to Predict Schizophrenia from SNP-Array Based Genomic Data

Presenter(s): Chandra Gangavarapu
Mentor(s): Jubao Duan Ph.D. and Subhajit Sengupta,
NorthShore University HealthSystem

Abstract/Project intention:
There has been growing interest in using machine learning to improve disease detection, and although identifying mental illnesses such as Schizophrenia is being pursued, diagnostic methods have remained largely qualitative. This project aims to use genomic wide array data to predict schizophrenia. Various machine learning procedures using Python and TensorFlow were conducted on a dataset of 5334 subjects' genomes from 17262 loci provided by NorthShore University HealthSystem. A linear dimensional analysis (LDA) was run on the raw data, revealing that variables were collinear. Next, various support vector machine (SVM) tests were also conducted, and the RBF kernel resulted in an average accuracy rate of 72.97%. A convolutional neural network is being designed to further improve the accuracy. While the neural network currently produces a lower accuracy rate than that of the SVM, it can be improved using different parameters and set-ups. The LDA indicates that the dataset must undergo dimensional reduction to improve accuracy. Since the target accuracy rate lies above 95%, further steps would be to improve the CNN and to utilize different machine learning techniques such as Random Forests on the same genomic data to further improve the accuracy rate.

Project ID: ENGN 6
10:05a.m. - 10:20a.m.

Title: Purifying Water with Egg Patties and Silver Nitrate
Presenter(s): Declan Creaney, Aaron Fanjoy and Brandon Smith
Mentor(s): Dr. Mark Carlson, IMSA
In the developing world, finding clean water can be very difficult; this issue causes the death of 3.5 million people every year. Our objective is to produce a viable water filter for the developing world that costs less than 20 dollars, has a bacterial kill rate of at least 99%, and obtains a flow rate of 2 L/hr - an important mark that allows families to satisfy their daily needs through nightly operation. Filtration is achieved through a scouring pad base soaked in albumin, which binds to silver nitrate to provide antibacterial properties. At present, all copies of the current design have exceeded the criteria of the objective. Our best filter obtained a flow rate of 3.35 L/hr and a kill rate of 99.9%. Work is ongoing to determine the useful lifespan of the filters as it will impact the cost to potential users.

Project ID: ERSP 2
10:05a.m. - 10:20a.m.

Title: Evaluating the Accuracy of Hydrogeological Field Test Kits
Presenter(s): Phillips, Ethan
Mentor(s): Melissa Lenczewski, Northern Illinois University
Abstract/Project intention:
Research the effectiveness of several hydrogeological field test kits, including the Hach Spectrophotometer, and the Exact Micro 20.

In this study, three Exact Micro 20s and one Hach Odyssey Spectrophotometer were tested using five solutions of known concentrations made by mixing anion standards of nitrate, nitrite, sulfate, phosphate, fluoride and chloride with deionized water. Each field test kit was used to measure the concentration of each substance in each of the standardized solutions three times. An ion chromatograph was used once with each standardized solution to confirm the calculated concentration.

The results of this study indicate that the accuracy of a test kit depends on the substance being tested and proximity of the concentration to the low and high levels of the testing range. Specifically, the kit test results were less accurate for nitrate, nitrite and chloride and when the concentration present was close to the limits of the test kits' stated detection limits. This research should be continued by testing cations, and taking more data for anions, and will be useful for those relying on the test kits to understand the quality of water as measured in the field, since these test kits have not previously been evaluated.

Project ID: MATH 2
10:05a.m. - 10:20a.m.

Title: On the cross section of minimal bands orthogonal to the sides of a polygon
Presenter(s): Matthew Niemiro
Mentor(s): Michael Keyton, Former IMSA faculty, Advisor/Mentor
Abstract/Project intention:
If Q is a k-gon, the well of Q is the set of all points X for which a perpendicular through each side of Q passes through X. Equivalently, the well of Q is the cross section of the k bands of minimal width which are each orthogonal to a side of Q and fully contain their associated side.
When k=3, the well of Q is trivially non-empty. We establish conditions for existence of wells in cases where k=4 and consider cases where k>4. Conditions for convergence of the sequence of polygons obtained by recursively constructing wells are also established, as well as properties of the centers obtained in the case of convergence. We conclude with a consideration of related constructions and topics for extension.

Project ID: MEDH 01
10:05a.m. - 10:20a.m.

Title: Community Mobility as a Predictor of Cognitive Performance in Stroke Recovery
Presenter(s): Monika Narain
Mentor(s): Dr. Shira Cohen-Zimerman, Ph.D. and Dr. Jordan Grafman, Ph.D., Cognitive Neuroscience Lab, Shirley Ryan Ability Lab, Chicago
Abstract/Project intention:
Community mobility is an instrumental activity of daily living that measures the ability of an individual to independently travel and navigate his or her neighborhood and community. This study investigated community mobility, specifically in the differences in the types of locations an individual travels to, as a predictor of cognitive performance using GPS after stroke. Using the Configurable Integrated Monitoring Service (CIMON) smartphone application, the mobility of 20 participants were tracked for 90 days, followed by an intensive battery of standardized cognitive testing. We identified coordinate clusters using Google Maps and developed a location categorization model based on the North American Industry Classification System (NAICS) that can be used in future studies. Our results yielded a few significant correlations between location and cognitive variables; however, more testing is needed before any definitive conclusions can be affirmed.

Project ID: MEDH 12
10:05a.m. - 10:20a.m.

Title: The Antimicrobial Properties of Z. officinale mixed with Zeolite Clinoptilolite Nanoparticles
Presenter(s): Emily Atkinson, Saachi Kumar and Julianna Padilla
Mentor(s): Dr. John Thurmond, IMSA
Abstract/Project intention:
There is a need for new antimicrobials, as there is an increase in existing antibiotics failing due to antibiotic resistance. In this experiment, we used the Kirby-Bauer method to test the antimicrobial properties of nanoparticles, specifically zeolite clinoptilolite, mixed with gingerol extracted with common solvents. Solvents we used to extract the active compound in ginger were ethanol, methanol, and deionized water. There were two methods used to extract the active compound in ginger. Bacteria utilized were B. subtilis, E. raffinosus, A. baylyi, P. putida, P. fluorescens, and E. coli. Results demonstrate that when ginger extracted with ethanol is combined with zeolite clinoptilolite into a nanoparticle, it exhibits antimicrobial properties against Acinetobacter baylyi, a bacteria that causes various diseases from urinary tract infections to secondary meningitis.
Keywords: antimicrobial, nanoparticles, gingerol, bacteria

Project ID: MEDH 13
10:05a.m. - 10:20a.m.

Title: Computer Aided Drug design to inhibit HIV protease
Presenter(s): Alyssa Daniels
Mentor(s): Dr. John Thurmond, Illinois Mathematics and Science Academy
Abstract/Project intention:
Darunavir is a drug often used to treat HIV/AIDS (Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome. Darunavir inhibits the HIV protease. The protease cleaves the viral protein, allowing the virion to fully mature. The primary goal of this study was to use Darunavir as a template to design a drug with optimized binding affinity. Molecular modeling programs SeeSAR, admetSAR, and SwissADME served as tools to design molecules and measure medicinal properties such as binding affinity, ligand-lipophilicity efficiency, interactions within the molecule, absorption, distribution, metabolism, excretion, toxicity, and synthetic accessibility. Using these programs, the 10 best compounds were determined based on binding affinity. The binding affinity of Darunavir was approximately 5.073x1018 nanomolar. The binding affinity of the best molecule was approximately 1.944 nanomolar, improving the binding affinity by over 2.610x1018 times. These findings may provide insight for designing drugs for HIV/AIDS, as well as the Computer Aided Drug Design process in general.

Project ID: MEDH 17
10:05a.m. - 10:20a.m.

Title: Materials and Methods for Identifying the Efficacy of Curcumin and Boswellia Serrata in Treating Glioblastoma Multiforme
Presenter(s): Maddy Chow and Rachel Tin
Mentor(s): Dr. Sowmya Anjur, IMSA
Abstract/Project intention:
Indian frankincense has been used for decades as an anti-inflammatory agent to treat various chronic inflammatory diseases. This plant, in conjunction with radiation therapy, has been found to prevent cellular proliferation, induce apoptosis, and reduce the size of tumors. Turmeric (Curcumin), before being tested on GBM, already had beneficial effects. Though it is not a treatment on it's own, it works to rid a GBM's resistance towards certain treatments, like Temozolomide. We have seeded U87 cells in plates and created serial dilutions of the treatment to determine concentration necessary to kill 100% of cells and 50% of cells. After infusing the cancer cells with our indian frankincense treatment, we determined the percentage of cells that died and continued narrowing down the concentration until the proper dosage has been determined. Future plans include testing the effects of resveratrol, icarian, and bittersweet. All of which are natural ingredients that have been observed to have a positive effect on glioblastoma multiforme.

Project ID: MEDH 20
10:05a.m. - 10:20a.m.

Title: Chemoresistant Ovarian Cancer Cells
Presenter(s): Winny Liu
Mentor(s): Tong-Chuan He and Ling Zhao, The University of Chicago
Abstract/Project intention:

Randomized 19-nucleotide RNA (N19) library sequences were stably inserted into bone cancer cells and treated with lethal doses of chemotherapy drug nutlin3a. The surviving cells were selected and next-generation DNA sequencing of the nutlin3a resistant cell pool identified highly enriched N19 sequences, which are designated as nutlin3a-resistant transcripts or NRTs. The ability of these NRTs to recapitulate nutlin3a resistance in nutlin3a sensitive human cancer lines were tested. The results show that NRT2, NRT7, NRT10, and NRT15 were found to confer such resistance phenotype. In this study, we tested if NRT2, NRT7, NRT10, or NRT15 in human ovarian cells can confer resistance to paclitaxel. These NRTs were inserted into ovarian cancer cells and treated with varying concentrations of paclitaxel. The results show that NRT15 can confer resistance in ovarian cancer cells.

Project ID: MEDH 26
10:05a.m. - 10:20a.m.

Title: Connectivity of Basal Ganglia and Cerebral Cortex in Primary Progressive Aphasia

Presenter(s): Srilalana Appasani
Mentor(s): Borna Bonakdarpour MD, Northwestern University

Abstract/Project intention:
Primary progressive aphasia (PPA), a neurological syndrome in which there is an eventual loss of language control, is the result of degeneration of the left lateralized language network. Structural neuroimaging studies have discovered the major sites of atrophy in each of the subtypes: PPA-G (aggramtic), PPA-L (logopenic), PPA-S (semantic). Functional imaging techniques have also been helpful in revealing patterns of language network abnormalities, so that metabolism in regions of interest can be analyzed. Resting state fMRI is utilized because it is sensitive to polysynaptic pathways in the brain and helps explore the anatomy and connectivity of neurocognitive networks. However, there has been a paucity of research studies investigating the role of basal ganglia in PPA. Basal ganglia has only recently been shown to be affected by the underlying causes of PPA in cases. Therefore, the current study used these imaging techniques to examine the connectivity between basal ganglia and the cerebral cortical regions involved in language processing in [all variants] of PPA. The patients that were included in this study were first clinically classified to be a variant of PPA through behavioral analyses. Therefore, the study compares patients of all three variants of PPA and non-affected healthy individuals and identifies the differences in basal ganglia and cortical connectivity in variants of PPA and their correlation with specified symptoms.

Project ID: MEDH 34
10:05a.m. - 10:20a.m.

Title: DNA Damage Response to High Nitric Oxide Exposure in A549 Cancer Cells

Presenter(s): Samira Cheruku
Mentor(s): James Radosevich, Univ of IL at Chicago, College of Dentistry

Abstract/Project intention:
A comparative analysis was conducted between high NO adapted (HNO) A549 cells and parental A549 cells to reveal significantly altered gene expression levels as a result of adaptation to NO. Previous reports by this laboratory demonstrated increased NO overexpression by tumor cells lead to further tumor progression. HNO cells are characteristically more aggressive and resistant the genes: ATF2, EME1, MSH2, MUS81, RAD9A, TIPIN, XPC, could potentially be involved in the resulting phenotype developed by HNO cells. These genes are essential to the intra-S DNA Damage checkpoint, a mitotic cell cycle checkpoint that slows DNA synthesis in response to DNA damage by the prevention of new origin firing and the stabilization of slow replication fork progression. Previous studies have shown that Nitric Oxide is overexpressed in human tumors and produces a poor outcome. In high Nitric Oxide adapted (HNO) cells, signal transduction in response to DNA damage is altered. We focused on determining what genes are associated with the response to DNA damage from high nitric oxide exposure. Understanding the genetic profile of aggressive tumors could lead to a change in how therapeutic approaches will be defined.

Project ID: PHYS 02
10:05a.m. - 10:20a.m.

Title: Generating Limits on the Scale of Compositeness
Presenter(s): Elkin, Nikita
Mentor(s): Dr. Peter Dong, IMSA
Abstract/Project intention:
The theory of compositeness proposes the idea that the fundamental particles described in the Standard Model are composed of particles called preons. Our analysis focuses on a new method of generating theoretical limits on the energy scale Λ at which compositeness can actually be observed. Lower limits of 95% confidence are set by calculating the Λ at which one could observe a non-resonant enhancement in the dilepton invariant mass spectrum when compared to the current Standard Model prediction.
Destructive interference can cause a yield that is lower than the Standard Model prediction in some of the signal bins, making it challenging to interpret contact interactions as a signal process. We have implemented a system of lambda parameterizations that combines the yields of the signal and Drell-Yan processes as a function of 1/Λ^2 and then sets a limit directly on Λ. Our approach ensures that the total number of events will always be positive. We have also made major headway in deploying the expected limit generation framework to CMS (Compact Muon Solenoid Experiment) CRAB, a collection of parallel processing computing farms.

Project ID: PHYS 10
10:05a.m. - 10:20a.m.

Title: Mass Resolution and Acceptance * Migration
Presenter(s): Ellyn Hu and Eva Tuecke
Mentor(s): Dr. Peter J. Dong, Illinois Mathematics and Science Academy
Abstract/Project intention:
We analyzed acceptance * migration and mass resolution for generator-level versus reconstructed particles from events generated by a contact interaction (CI) Monte Carlo simulation. Our goal was to reconstruct plots from 2017 data showing muons in GenSim and Reco stages. We looked at the effects of detector reconstruction on our ability to measure key variables for the analysis, which is needed for estimates of systematic uncertainty. When looking at Acceptance * Migration, we found migration that increases as invariant mass increases. Similarly, we saw greater error as invariant mass increases, demonstrating lower resolution. This is due to the fact that invariant mass is dependent on energy and momentum, and higher-momentum particles are more difficult to measure due to their straighter path in the detectors.

Session II - 10:25a.m. - 10:40a.m.

Project ID: BHVSO 03
10:25a.m. - 10:40a.m.

Title: Impact of Economic Socialization and Biosimilar Availability on International Price Discrimination
Presenter(s): Ella Foes
Mentor(s): Patrick Kearney, IMSA
Abstract/Project intention:
Both prescription and OTC drug prices in America are often shockingly higher than in other countries, but for uncertain reasons. Many studies attribute this to patent expiry law and price controls (Lanjouw 2005; Vondeling et al 2018), but this study builds upon previous scholarship to suggest that relative price discrimination is largely dependent on the socialization of each country's economy and the availability of biosimilars or generic replacements, rather than solely on patent expiry.

This study examines drugs under the U.S. Medicare Part B, comparing U.S. prices with those of the country in which the brand name drug is sold at its lowest price (U.S. Department of Health and Human Services 2018). The number of biosimilars or generic replacements available per each version of brand name drug currently on the U.S. market as approved by the FDA were compared to the price multiplier in the U.S. versus the lowest cost country. Economic socialization of each low cost country was measured by the percent of total medical spending done by individuals, private insurance, and compulsory/government spending.

Project ID: BHVSO 10
10:25a.m. - 10:40a.m.

Title: Dungeons and Dragons and the LGBTQA+ Community
Presenter(s): Samuel Rabideau
Mentor(s): Tracy Townsend, IMSA
Abstract/Project intention:
This study focuses on the connection between identity formation, particularly for the LGBTQA+ community, and tabletop roleplaying games (TTRPGs), such as Dungeons & Dragons. The goal of this research is to find whether there is a difference between the experiences of the people that identify as LGBTQA+ compared to those that identify as heterosexual and cis gendered while playing the roles of characters in TTRPG's. This study was conducted via interviews with ten students on the IMSA campus, all of whom had experience playing TTRPGs. Participants in this research were split into two groups of five each of those within and outside of the LGBTQA+ community. The results of this study are inconclusive, due to the sample size, but there were some trends among those interviewed. While those that identified as straight/cis mostly answered that their gender/sexual identity was unimportant to their experiences playing TTRPGs, participants who identified on the LGBTQA+ spectrum all answered that their gender/sexuality was important to their experiences playing TTRPGs. The most important takeaways are the questions that can be further researched, such as seeing if a larger sample size could provide better results, or if the age group of participants (15-18) affected the answers in a significant manner.

Project ID: BHVSO 17
10:25a.m. - 10:40a.m.

Title: Food odor perception during different times of day in males and females
Presenter(s): Ruchi Patel
Mentor(s): Thorsten Kahnt, Assistant Professor in Neurology, Northwestern Feinberg School of Medicine; Ken and Ruth Davee Department and Jana Tegelbeckers, Postdoc. Fellow
Abstract/Project intention:
Odor perception varies with gender, state of the subject, or context of when someone perceives an odor (Doty 1975; Moskowitz 1976). This is especially true for behavioral relevant odors such as food odors. But so far little is known about the influence of certain conditions of the subject when odors were evaluated, such as time of day and hunger levels. Therefore, in this study I aimed to observe whether correlations between pleasantness and intensity ratings of food odors differed for males and females. To do so, I examined pleasantness and intensity ratings taken from 4 different studies that were

previously performed at the Kahnt Lab. An olfactometer was used to study the human reward system, decision making, and odor perception as people can love or hate certain food only by their odor. Preliminary results show that there is a positive correlation between pleasantness and intensity ratings, indicating that the value of an odor can be manipulated by changing its strength. There is no effect of gender in the ratings of the food odors however. Ongoing analyses will further evaluate the influence of the time of day, time not eaten, and hunger levels on these ratings.

Project ID: BIO 01
10:25a.m. - 10:40a.m.

Title: Investigation of Bacterial Carbonic Anhydrase Stability
Presenter(s): Yatri Sutaria
Mentor(s): Dr. James Horn, Dakota Grote, Northern Illinois University
Abstract/Project intention:
The purpose of this study was to investigate the stability of Bartonella henselae carbonic anhydrase in an effort to design screening methods for potential inhibitors. Although several carbonic anhydrase inhibitors, such as acetazolamide and ethoxzolamide, are marketed drugs, new carbonic anhydrase inhibitors may be used to potentially combat bacterial infections. In this study, the thermal stability of B. henselae carbonic anhydrase was evaluated using a fluorescence thermal shift (FTS) assay to determine the enzyme's melting temperature (TM).
Data from the initial buffer screen showed that the Tm of B. henselae carbonic anhydrase was around 80°C under a variety of conditions. Due to the high Tm value, which can complicate FTS assays evaluating ligand binding, methods were explored to decrease the stability of carbonic anhydrase. Investigation of known inhibitors, acetazolamide and ethoxzolamide, was conducted to investigate their stabilization of carbonic anhydrase. The results of this study will help guide the development of an effective screening method for potential carbonic anhydrase inhibitors.

Project ID: BIO 08
10:25a.m. - 10:40a.m.

Title: The Effects of Probiotics through Maternal Administration in the Gut Development of Pups
Presenter(s): Nikhilesh Gupta
Mentor(s): Dr. Erika Claud, University of Chicago
Abstract/Project intention:
Probiotics have been found to be useful in reducing necrotizing enterocolitis in preterm infants. However, many times these infants are unable to absorb the probiotics due to the poor ability for some microbes to finish colonizing the gut. Early microbial colonization has shown the potential to improve the immune system in infants and therefore is crucial to the short- and long-term well-being of the infant. A mouse model was used to understand how treating the damps with the probiotics could affect the gut microbiota and the small intestinal development of the pup. Markers such as enteroendocrine cells, goblet cells, and Paneth cells throughout the villi and crypts of the sectioned tissues through typical immunofluorescent and enzymatic stainings were used to describe levels of the immune responses and stages of development in the small intestine. The stainings indicated that the probiotics facilitated the development of these cells and promoted the integrity of the immune system and inflammatory response towards threats. These results indicate that probiotics may be administered through the damp and may be a safer method to reduce necrotizing enterocolitis in preterm infants.

Project ID: BIO 22
10:25a.m. - 10:40a.m.

Title: An Analysis on the Effects of Inhibitors on Cathepsin D in Glioblastoma Cells
Presenter(s): Alao, Lola; Gandhi, Sriya
Mentor(s): Dr. Sowmya Anjur
Abstract/Project intention:
The objective of our research project is to develop a simple method for detecting cathepsin D in GBM cell lines. In order to investigate this question, we created a project proposal involving a inhibitor cocktail, T-98G glioblastoma cells, bovine serum, and well plates. Cathepsin D is a marker for the deadly cancer, so our investigation aims to test the impact of inhibitors on the cancer. Can we reduce the growth of Glioblastoma by adding a mixture of inhibitors? Once our glioblastoma cells stably have grown, we will create a lysis buffer to mix in with an inhibitor cocktail and then perform a colony formation assay on the strains to determine cell count. We are creating a buffer in order to allow the cells and inhibitors to mix in the most optimal environment. Our specific inhibitor cocktail is composed of Pepstatin A and other compounds because prior knowledge suggests that Pepstatin A has the potential to block the growth of Cathepsin D, as it has with other cancer cell markers. Cell count will tell us how the inhibitor cocktail affects growth, as it is supposed to block the autoactivation of Cathepsin D.

Project ID: BIO 28
10:25a.m. - 10:40a.m.

Title: The Thermal Stabilization of Rubisco Activase in Maize
Presenter(s): Ethan Haque, Nathan Joseph
Mentor(s): Dr. Angela Ahrendt, IMSA
Abstract/Project intention:
Maize yield in plantations can decrease by 40% when exposed to 85° F temperature. The enzyme Ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco) is one of the most abundant enzymes on the planet and is involved with the first major steps of photosynthesis. However, without the help of the enzyme Rubisco activase, the sugars formed by Rubisco during carbon fixation would bind to the active site of Rubisco and stop its function. Due to this, Rubisco activase plays a critical role in photosynthesis. However, it is highly thermally unstable. At just a few degrees above the enzyme's optimal temperature, Rubisco activase denatures, which drastically slows photosynthesis and decreases crop output. As global temperatures increase, this problem becomes more exaggerated, leading to even lower crop yields. The goal of this study is to use site-directed mutagenesis to introduce mutations in maize Rubisco activase and to identify any stabilizing mutations using protein thermal shift assays. These mutations will ultimately be combined to create a stable variant enzyme.

Project ID: BIO 29
10:25a.m. - 10:40a.m.

Title: Using Thermal Shift Assays to Identify Inhibitors of the Isocitrate Lyase-1 Protein in Mycobacterium Tuberculosis
Presenter(s): Shikha Adhikari and Pouravi Banerjee
Mentor(s): Dr. Angela Ahrendt, IMSA
Abstract/Project intention:
Tuberculosis is an airborne respiratory disease that has a high latency period and is caused by the bacteria Mycobacterium tuberculosis. Nearly one third of the world's population today is infected with this bacteria and approximately 1.3 million people experience tuberculosis related deaths every year. In this study, we chose to examine the isocitrate lyase-1 (ICL-1) protein as a possible target for the treatment of tuberculosis. We took this approach because ICL-1 allows the Mycobacterium tuberculosis bacteria to skip some of the steps in the KREBS cycle, which gives it the ability to survive in low-oxygen environments. The inhibition of ICL-1 could prevent the bacteria from becoming active within the human immune system. Different compounds were tested using a protein thermal shift assay to determine their efficacy in binding to the ICL-1 protein.

Project ID: BIO 33
10:25a.m. - 10:40a.m.

Title: The role of Amyloid-beta oligomers in the developing CNS
Presenter(s): Ashley Koca and Shreya Pattisapu
Mentor(s): Samuel Bartley, Northwestern University
Abstract/Project intention:
The buildup of Amyloid-beta oligomers (AβO) is regarded as a central toxic event in Alzheimer's disease. Recently, AβOs have been found in the developing chick retina but do not cause a disease state. Conserved by evolution, the functional role of these AβOs in retinal development is not currently known. Our team in the Klein lab has found that these AβOs are transiently expressed, appearing in retinal layers associated with nerve cell death as well as synapse formation. Using an ex-ovo culture method and intravitreal injections, we can manipulate the expression of AβOs in the chick retina to observe developmental changes. Chick embryos are grown outside of the eggshell to E9 and receive an intravitreal injection of either a BACE-1 inhibitor or an AβO antibody. The eyes are then dissected at E15 and stained with antibodies for fluorescence microscopy. Our team has found that inhibiting AβO function between E9-E15 induces significant disruptions in retina lamination, forming omega and polyp-like protrusions dubbed "gibba". Our current project goal is to close the injection-dissection window to determine the "critical window" of gibba formation.

Project ID: BIO 35
10:25a.m. - 10:40a.m.

Title: The Influence of Various Drug States on the Responses to External Stimuli through Simulation in a Rodent Model
Presenter(s): Hiteshi Patel
Mentor(s): Maria Virginia Centeno and Dr. A. Vania Apkarian, Northwestern Feinberg School of Medicine
Abstract/Project intention:
Opioids are consistently prescribed as pain management drugs for patients. However, the physiological impact of opioids on the brain are not very well understood, specifically in determining the neurotransmitters affected by the drugs. Morphine, a narcotic analgesic, is used to treat severe pain by changing how the brain feels and responds to pain but it is unknown exactly how the drug alters the brain. Hence, a nociceptive assay was performed on rodent models in order to characterize the physiological effects of morphine. A group of rats were injected with morphine and saline or a combination of levodopa and carbidopa to determine their basic pain-based reflexes. A traditional two-hour infrared tail flick test was administered to measure the pain reflex time, with a baseline test taken previous to injection. A distinction was also made between male and female rats and this comparative model was tested multiple times.

Project ID: BIO 40
NOTE: This presentation will not take place.
Title: Exploring the Potential of Cucurbiturils as Host Compounds in Host-Guest Complexes
Presenter(s): Shrutika Gupta, Shambhavi Punjala and Carolina Seoane
Mentor(s): Dr. Laura Kopff, IMSA
Abstract/Project intention:
Cucurbiturils (CB[n]) are macrocyclic compounds made from glycoluril monomers. They have the potential to act as host molecules in the formation of host-guest complexes with an array of substrates, including amino acids, hydrocarbons, and halogenated aromatic compounds. Cucurbit[6]uril (CB[6]) and Cucurbit[7]uril (CB[7]) were synthesized and characterized with melting point and solubility data. Their ability to act as host complexes with both coumarin-1 dye and biphenyl was explored using UV-vis spectroscopy. We synthesized CB[6] and CB[7] compounds and made eleven solutions to figure out when combined how the absorbance peaks might change. Three solutions of Coumarin 1 dye and ethanol with concentrations of 50mM, 20mM, and 10mM, four solutions of both CB[7] and CB[7]were made with concentrations of 100mM, 50mM, 20mM, and 10mM. UV-vis spectral analyses were then performed on every individual solution and on combinations of every concentration of the cucurbiturils with every concentration of the coumarin-1 dye.

Project ID: CHEM 03
10:25a.m. - 10:40a.m.

Title: Molecular Modelling and Synthesis of PDE4 Inhibitors
Presenter(s): Ishani Tarafdar
Mentor(s): Dr. Timothy Hagen, NIU
Abstract/Project intention:
The phosphodiesterase 4 (PDE4) enzyme, which is responsible for hydrolyzing cAMP in immune cells and the central nervous system, is one of eleven PDE families ranging from PDE1 to PDE11. PDE4 is implicated in a number of conditions such as psoriasis, plaque psoriasis, chronic obstructive pulmonary disease, schizophrenia, and depression, making it a promising target for pharmaceutical development. Current PDE4 inhibitors on the market such as Otezla, Crisaborole, and Daxas target inflammatory diseases like psoriasis, atopic dermatitis, and COPD. Ligands which act as inhibitors of PDE4 and have high binding affinity to the active sites, thereby increasing levels of cAMP in immune cells, are being investigated to treat patients with these conditions. Through molecular docking experiments, a common method used in drug design, we bound different proposed benzothiazole inhibitors to the binding site of a crystallized PDE4 structure. Using the results of the experiments conducted with AutoDockTools, we were able to determine preferred poses of the ligands as well as their predicted binding affinity to PDE4. In addition, we performed the synthesis of benzothiazoles by Hugerschoff's reaction at different times and temperatures to optimize the yield. The resulting compounds were characterized by TLC and NMR.

Project ID: CHEM 05
10:25a.m. - 10:40a.m.

Title: Ginkgo Biloba
Presenter(s): Cagnolatti Courtney, Darbro Emma and Kaneps Linda
Mentor(s): Dr. John Thurmond, IMSA
Abstract/Project intention:
As more bacteria and diseases are being discovered and spread throughout the human population, there is a larger need than ever for new antibiotics, which have caused many drug manufacturers to turn to alternative sources of potential antibiotics, such as natural products. The purpose of this study was to examine and determine whether the herbal medicine, Ginkgo Biloba, has any antimicrobial properties. The results varied as we used different combinations and methods of extraction and testing procedures. However, through our data, we determined that Ginkgo leaf in a methanol extract and Ginkgo in an ethanol extract produced the best results for this study. Our procedure included extracting the organic compounds from gingko leaves and pill concentrates with grinding and mixture with ethanol and methanol. Then we used the extract to test it against different ESKAPE pathogens: the most successful cases being Bacillus subtiliis and Acinetobacter baylyi. A major problem faced was determining whether our Ginkgo solution did not work or if we had a faulty plate due to observing our faulty Ampicillin control. Our conclusion is that Ginkgo Biloba has some medicinal properties that could help in killing bacteria. This project requires more combinations of solutions to use and bacteria to pick out to strengthen this claim and have more conclusive data.

Project ID: CMPS 5
10:25a.m. - 10:40a.m.

Title: Effects of Hypertension and Diabetes in the Chicagoland Area
Presenter(s): Breanna Yang
Mentor(s): Dr. Marynia Kolak, University of Chicago
Abstract/Project intention:
The Social Determinants of Health are economic and social factors that significantly influence individuals' health and lifestyles. In this study, we look for correlations between SDOH data at the census tract level and patient data about hypertension and diabetes between 2012-2017 in the Chicagoland area. We identified patients with hypertension through their ICD diagnosis code, antihypertensive prescriptions, and median blood pressure values by year. Likewise, patients with diabetes were identified through their ICD diagnosis code, diabetes medication prescription, median blood glucose level by year, and median A1C level by year. We ran spatial cluster analyses to assign LISA (local indicators of spatial association) categories for each year for each disease. These categories are used to identify hotspots, clusters, and outliers. We found that prevalence rates for patients with hypertension and diabetes had a strong correlation with high rates of disability status, minority population, and home ownership. In Chicago's South Side, high foreclosure risk was found to be associated with high rates of hypertension and diabetes. Using spatial analyses to identify relationships between disease rates and SDOH data, can reveal clusters and populations in need of care, which can be used for policy change, healthcare distribution, and future work.

Project ID: MATH 3
10:25a.m. - 10:40a.m.

Title: Comparing Network Sampling Methods
Presenter(s): Alec Chen
Mentor(s): Lulu Kang, Illinois Institute of Technology
Abstract/Project intention:
Abstract: Networks can be used to analyze systems in the real world, however they are often too large for our computers to analyze within a reasonable amount of time. A solution to this is network sampling methods. These are just ways of sampling a smaller "representative" network that we can analyze. Being representative means that the sample retains certain characteristics of the original network. Because there are many characteristics, it means many different things for a sample network to be representative. I looked at three common sampling methods, being random degree node, random edge induced, and snowball sampling, and compared them based on how similar they were to an arbitrary original network for fundamental characteristics, degree and clustering coefficient.

Project ID: ENVR 1
10:25a.m. - 10:40a.m.

Title: Ceramic Water Purification
Presenter(s): Duncan Osmund, Charles Schreiber, Grace Smith, Arthur Wang
Mentor(s): Dr. Mark Carlson, Illinois Mathematics and Science Academy
Abstract/Project intention:
Many people in the developing world have no option but to drink from contaminated sources that potentially contain waterborne illnesses which are the cause of 3.4 million deaths per year. The goal of this project is to create ceramic filters that can filter at least two liters per hour and have a bacteria kill rate of 99%. Filters are made to be fitted on to the end of a PVC pipe. Filters of varying mixtures of terracotta clay and sawdust are fired and then painted with silver nanoparticles. The flow rate and kill rate of the filters are measured with an E. Coli solution. Our results reveal that there are trade-offs between the flow rate and kill rate of different filter dimensions. More data is needed to optimize our design, but the best filter thus far was 1.3cm thick (after firing) with a flow rate of 1.85 L/hour (extrapolated from the time taken to filter 100mL) and a kill rate of 99%. Regarding composition, the most effective ratio of sawdust to clay so far has been 1:1. Work is ongoing to consistently meet our desired parameters.

Project ID: ENVR 4
10:25a.m. - 10:40a.m.

Title: Drug Discovery: Antimicrobials from Soil Samples
Presenter(s): Megan Lee, Katya Romanov, and Gowri Warikoo
Mentor(s): Dr. John Thurmond, IMSA
Abstract/Project intention:
Superbugs, harmful bacteria that are resistant to most known antibiotics and antimicrobials, are becoming more and more of a problem in the modern world. Since known drugs are not effective in killing these bacteria, there is an absolute need for the discovery of new drugs. Though there are corporate pharmaceutical companies developing new drugs, many of these companies are focused on products that will make them the most money rather than what is required by society, leading to many neglected diseases still plaguing the world. The purpose of this study is to identify possible new antimicrobials from soil samples inside and out of the IMSA campus. The samples were diluted to isolate their different bacteria, and Master Plates were made from these colonies. These Master Plates were subjected to Spread-Patch testing to test for any visible inhibition against safe-to-handle ESKAPE pathogens and Mycobacterium Tuberculosis. Over twenty zones of inhibition were spotted against the specific bacteria, though more testing is needed to see if the samples will produce the same results with different bacteria. Active samples were then run through 16S rRNA gene PCR testing verified by Gel Electrophoresis. Samples will be sent for gene sequencing and further analyzed.

Project ID: ENVR 6
10:25a.m. - 10:40a.m.

Title: Interactions between Plants and Soil within Prairie Ecosystems
Presenter(s): Richard Jun
Mentor(s): Dr. Wesley Swingley, Northern Illinois University
Abstract/Project intention:
This project attempts to comprehend the interactions between plants and soil within ecosystems, as our current understanding of plant-plant and plant-soil interactions is incredibly convoluted due to difficulties in isolating specific species of plants within an ecosystem over extended periods of time. By observing various plots within the Nachusa Grasslands, including both controlled combinations of plant species and monocultures, we can gain a more concrete understanding of how the phylogenetic and functional diversity of plants can influence prairie ecosystems. There are a number of ways that this influence can be quantified and measured: changes in pH, organic matter composition, analysis of microbial soil communities and nitrogen, carbon, and sulfur content. This newfound understanding of plant-soil and plant-plant interactions has a wide variety of practical applications within our world and the diverse environments within it. For example, one possible application of this knowledge lies in its ability to restore damage sustained by certain ecosystems, such as prairies. Consequently, the research done in this project may help prevent and reverse the loss of biodiversity in order to achieve diverse organismal communities that contribute to more desirable ecosystem functionality.

Project ID: MEDH 07
10:25a.m. - 10:40a.m.

Title: Identification of Cell Types That Harbor Cytomegalovirus DNA in Acutely and Latently Infected Mice Spleen

Presenter(s): Aneesh Maganti
Mentor(s): Xue-feng Liu, Michael Abecassis,
Northwestern Feinberg School of Medicine

Abstract/Project intention:
Background: Cytomegalovirus (CMV) is a ubiquitous β-herpesvirus that infects the majority of humans. Primary CMV infection may be asymptomatic or manifests as a self-limited febrile illness in immunocompetent individuals. After primary infection, CMV persists as a latent virus predominantly within the splenic cells (splenocytes) in a dormant state, which then serves as reservoir for reactivation and transmission to susceptible individuals, such as solid organ transplant (SOT) recipients. It is an important cause of morbidity (leading to rejection of an organ) and mortality after SOT. There is controversy regarding which cell types that harbor viral DNA during acute and latent stages of CMV infection. The purpose of our experiment was to study the different splenic cell types that harbor the viral DNA during the acute and latent CMV infection utilizing a murine model.

Hypothesis: We hypothesized that most splenocytes will harbor viral DNA in the acutely infected mice, whereas only a few types of splenocytes will harbor viral DNA in latently infected mice.
Methods: We isolated splenocytes from acute as well as latently infected mice. The splenocytes were then sorted into different cell types. DNA was extracted and the concentration measured from sorted splenocytes utilizing Q-PCR with primers and probe specific for MCMV genome. Mouse cellular GAPDH served as internal control.

Results: Majority of the myeloid cells (monocytes, macrophages, dendritic cells, granulocytes and eosinophils) and all the stromal cells (sinus lining cells, endothelium, fibroblasts harbored MCMV in the latent stage. However, none of the lymphoid cells (T, B, and NK cells) harbored the virus in the latent stage.

Conclusions All types of sorted splenocytes harbor viral DNA in acute infection, but only myeloid cells and stromal cells harbor viral DNA in latently infected mice. These results indicate that MCMV have broad tropism in the spleen in acute infection, and only can establish latent infection in certain cell types. Modification of experimental protocol to further refine the isolation of CMV DNA from different splenocytes is currently being pursued at CTC. Further studies in this area will allow accurate therapies to be developed and directed to prevent reactivation of latent CMV infections in SOT recipients.

Project ID: MEDH 27
10:25a.m. - 10:40a.m.

Title: Effect of *exoU* vs *exoS* genes in *Pseudomonas aeruginosa* bloodstream isolates on *Galleria mellonella*

Presenter(s): Prarthana Prashanth
Mentor(s): Dr. Alan Hauser, Northwestern Feinberg School of Medicine

Abstract/Project intention:
Pseudomonas aeruginosa is a highly antibiotic-resistant bacteria causing hospital-acquired infections. It utilizes a Type 3 Secretion System and four effector proteins (ExoS, ExoT, ExoU, and ExoY) to carry out its infections. Past studies in mice have shown that ExoU strains are the most harmful causing immediate cell lysis. However, almost all studies researching P. aeruginosa have been conducted using the lengthy and expensive mouse model. Recently, researchers are looking to the cheaper, easier, and quicker Galleria mellonella model as an alternative. This study analyzed the effects of the exoU gene versus the exoS gene being present in P. aeruginosa on the survival of G. mellonella. Larvae between 250-350mg were injected with three different dilutions (10 larvae per dilution) of each P. aeruginosa strain and were scored after 18 hours of incubation. This process was repeated for 96 strains of P. aeruginosa and strains were binned based on high, medium, and low virulence. The results of this research reject the hypothesis, with the exoS gene being more virulent than the exoU gene in G. mellonella. These results are contrary to past studies on mice, therefore suggesting that the Galleria model requires further research to effectively replace the mouse model.

Project ID: MEDH 35.
10:25a.m. - 10:40a.m.

Title: Myoelectric Computer Interface Training for Reducing Co-Activation and Enhancing Arm Movement in Chronic Stroke Survivors: A Randomized Trial

Presenter(s): Siva Nalabothu and Ishaar Ganesan
Mentor(s): Dr. Marc Slutzky, Northwestern Feinberg School of Medicine

Abstract/Project intention:
Abnormal muscle co-activation has been identified as a significant factor behind upper extremity impairment of the arm after stroke. From previous study, we developed a myoelectric computer interface training paradigm, which maps surface electromyographic signals to cursor movements, to train stroke survivors to reduce abnormal muscle co-activation. This study found the paradigm effective as a tool for chronic stroke rehabilitation. We then modified this original paradigm into four distinct groups: a two-muscle feedback group, a single-muscle feedback control group, a three-muscle feedback group, and a group in which patients were instructed to increase their reach range. We have evaluated the three-muscle feedback group with both acute and chronic stroke survivors, measuring functional scores and performance within the training software. For chronic stroke patients, the three-muscle group engendered greater gains than the two-muscle paradigm group, and all groups outperformed the control. Our current results establish the effectiveness of the two-muscle feedback paradigm and the three-muscle feedback paradigm in reducing abnormal co-activation in chronic stroke survivors.

Project ID: PHYS 03
10:25a.m. - 10:40a.m.

Title: Creating a Framework for the Generation Monte Carlo Limits on Large Extra Dimensions
Presenter(s): Daniel Lee
Mentor(s): Dr. Peter Dong, IMSA
Abstract/Project intention:
The ADD theory predicts that there are 4+n dimensions by extending spacetime with compactified spatial dimensions which gravity could propagate through. Our analysis focuses on generating real limits on the ultraviolet cutoff Λ, which represents the maximum energy limit on the theory calculations. When Λ is higher, the smaller the effects predicted by the theory will be at low energies. Because of the compactness of these additional dimensions, the ADD model predicts clustered resonant spikes in the invariant mass plot from the decay of virtual gravitons which blur together to effectively look like a non-resonant enhancement.
Because the compositeness theory also predicts a non-resonant enhancement in the dilepton invariant mass spectrum, the ADD theory can theoretically make use of its limit setting software. The compositeness theory limit setting software has implemented a system of lambda parameterizations that combines the yields of the signal and Drell-Yan processes as a function of $1/\Lambda^2$ and then sets a limit directly on Λ. I am currently adapting the compositeness framework so it correctly calculates the limits on Λ according to ADD.

Project ID: PHYS 11
10:25a.m. - 10:40a.m.

Title: Parameterization of Lambda Dependence
Presenter(s): Ming Huang and Brady Williams
Mentor(s): Dr. Peter Dong, IMSA Teacher
Abstract/Project intention:
We worked on the parameterization of Λ for contact interactions to create a yield curve of expected number of events as a function of Λ for each lepton type, detector location, helicity, interference, and invariant mass bin. A theoretical function for the number of events based on Λ can be created for the contact interaction extension to the Standard Model being tested, but it does not consider the effects of the detector causing incorrect reconstruction of particle quantities. Monte Carlo algorithms create data for certain values of Λ reconstructed by a detector simulation which we generalize into a function for any Λ. These parameterizations are used by the limit setting group to compare to data generated from the CMS experiment and determine if there are any significant differences from the Standard Model.

Project ID: PHYS 17
10:25a.m. - 10:40a.m.

Title: Gravitational Lensing with Generative Adversarial Networks
Presenter(s): WonJun Park, Roshan Thekiniath and Tejo Velagapudi
Mentor(s): Brian Nord, Fermilab, University of Chicago
Abstract/Project intention:
We present a new method to simulate gravitational lensing using model-assisted generative adversarial networks (MAGAN) developed by Alonso-Monsalve and Whitehead (2018). The MAGAN is trained to emulate Lenstronomy simulations created by Birrer et. al (2015). The network model is used to save time in generating large datasets of gravitational lensing. MAGANs are neural networks with parameter inputs to target specific features that the network should generate. Our research shows the feasibility of this method and an analysis of the accuracy of our MAGAN after certain training steps, comparing its training and run time to Lenstronomy. The majority of our training time is spent simulating images in order to train the neural network, and lies in the ray tracing step of the Lenstronomy package, placing a bottleneck on accuracy with lower training iterations possible in a given amount of time. The trade-off in training time does result in progressively more accurate images produced by the MAGAN, and at a faster runtime than Lesntronomy.

Session III - 11:00a.m. - 11:25a.m.

Project ID: BIO 36
11:00a.m. - 11:25a.m.

Title: IN SILICO DEVELOPMENT OF EPITRANSCRIPTOMIC ASSAYS FOR RAT BRAIN

Presenter(s): Nair, Krishnachandra
Mentor(s): Monsheel Sodhi Ph.D., Department of Molecular Pharmacology and Neuroscience, Loyola University, Chicago

Abstract/Project intention:
An epitranscriptomic process known as RNA editing produces adenosine (A) to inosine (I) substitutions in RNA that are catalyzed by ADAR enzymes. Even though online databases have extensively annotated sequence information for the human and several strains of mouse, there is a dearth of sequencing data for the rat. In this project, we have mined information from RNA editing databases, such as RADAR and REDIPortal in addition to screening the scientific literature, to build a more comprehensive list of potential RNA editing events that are non-synonymous, in the rat brain. We now provide updated information from the latest genomic assembly of rat cDNA sequence. We identified 30 previously reported sites and discovered 33 novel RNA editing sites in the rat brain. This updated list covers over 35 genes across 18 different chromosomes. After composing this list, we designed PCR assays for these RNA editing sites in the rat, using Primer3 software. Subsequently, the RNA sequencing data generated will be analyzed in reference to the rat transcriptome by utilizing the STAR and Burrows-Wheeler Aligner package. The overall goal for this project is to test if RNA editing is differentially altered in the adult rat brain after exposure to psychological stress.

Project ID: ENVR 5
11:00a.m. - 11:25a.m.

Title: *Ab Initio* Molecular Orbital Calculations as a Tool for Chemistry Guided Breeding to Create Novel Flower Colors

Presenter(s): Mara Adams, Maxine Alexandre-Strong
Mentor(s): Dr. Jayaraj Alappat and Katie Pederson, Ball Horticultural Company, West Chicago, IL

Abstract/Project intention:
Flower breeders search for novel hues that do not currently exist in their germplasm and in the market. One of the most important requirements for a novel flower variety is color stability, which is determined by the molecular stability of the pigment rendering that color. Some flowers, such as orange geraniums, are particularly susceptible to fading. Ab initio molecular orbital calculations use quantum mechanics to calculate the electronic energy of a given molecule, which indicates its stability. In this project, these calculations were performed for different anthocyanins using Gaussian 16W program. Anthocyanins are made up of anthocyanidins, sugars, and acyl groups. Six anthocyanidins, three sugars, and seven acyl groups were combined to create 126 different anthocyanin molecules. Electronic energies were computed for each molecule. Increasing the number of hydroxyl and methoxy groups correlated with decreasing electronic energy which suggests increasing stability. These calculations could help breeders to optimize parent selections to design crossing blocks. As continuation of this project, progenies from crossing blocks will be evaluated for their stability using UV radiation to test/ validate the hypothesis.

Project ID: MEDH 30
11:00a.m. - 11:25a.m.

Title: Exploration of the auditory system and the prevention of chemotherapeutic ototoxicity
Presenter(s): Zahra Vasi
Mentor(s): Dr. Claus-Peter Richter and Dr. Xioadong Tan, Northwestern Medicine
Abstract/Project intention:
Cisplatin is a frequently prescribed drug for cancer therapy that causes ototoxicity which damages the ear and leads to hearing loss. Cisplatin facilitates DNA cross linking which results in cell death of replicating cells but also increases ROS levels in the body, causing cell death of any affected cells. In the inner ear, this cell death results in hearing loss. A Chinese drug, Honokiol, has been shown to prevent hearing loss from Cisplatin by protecting mitochondria and preventing the death of healthy cells from ROS activation. This study aims to identify the effects of Cisplatin and Honokiol on the auditory system through hearing tests and analysis of ion concentrations in the inner ear to determine the mechanisms and sites of action for these drugs. We hypothesize that there is a fingerprint of ion concentration changes in the inner ear caused by Cisplatin and Honokiol. The X-Ray Fluorescence Microscopy is used as a mapping technique at a nanometer lateral resolution to study ion concentrations in the cochlea samples. Our results show the concentrations of copper, potassium, zinc, sulfur, calcium, chlorine and phosphorus in our samples. We are currently collecting more data on ion concentrations of samples treated with Honokiol and Cisplatin.

Project ID: MEDH 31
11:00a.m. - 11:25a.m.

Title: The Design and Effect of a Wearable Myoelectric Computer Interface to Reduce Abnormal Co-Activation After Stroke
Presenter(s): Torin Kovach
Mentor(s): Dr. Marc Slutzky, Northwestern Feinberg School of Medicine
Abstract/Project intention:
Abnormal co-activation, the incapacity to independently activate one's muscles, has been identified as a significant factor behind upper extremity impairment of the arm after stroke. In a previous study, we developed a myoelectric computer interface (MyoCI) training paradigm, which maps electromyographic (EMG) signals to cursor movements, to help train stroke survivors to reduce abnormal co-activation. This study found the paradigm potentially effective as a tool for chronic stroke rehabilitation. We then modified this original paradigm into four paradigms for distinct subject groups: 1) the original group, providing feedback for two muscles, 2) a control group, providing only a single muscle feedback, 3) a group providing feedback for three muscles, and 4) a group instructing players to reach out with their arm during training. We are evaluating these four paradigms with both acute and chronic stroke survivors, measuring functional scores as well as performance within the training software. So far, in chronic participants, the 3-muscle group has produced greater gains than the original paradigm group, and all groups have outperformed the control. Our current results support the original paradigm and the 3-muscle paradigm as effective tools to reduce abnormal co-activation in chronic stroke survivors, while the reach group requires more evidence to make such a distinction.

Project ID: PHYS 18
11:00a.m. - 11:25a.m.

Title: Analyzing VBF Jet Topology in CMS Level-1 Trigger at High Luminosity LHC
Presenter(s): Aryan Vaidya
Mentor(s): Dr. Richard Cavanaugh and Dr. Zhenbin Wu, Univ of IL at Chicago
Abstract/Project intention:
Following the discovery of the Higgs boson in 2013, various studies have been made in order to examine the effects and related collisions that produce it. For High-Luminosity experiments at the LHC, the most important of these types is Vector Boson Fusion (VBF). These VBF jets tend to align in the region of the CMS detector most closely related to pileup jets, however, making them difficult to trigger using the CMS's Level-1 Trigger. The study aimed to use a combination of MonteCarlo generated data and LHC recombined jets in order to map the topology of VBF jets in this region. By analyzing different reconstruction methods, the study yielded a steady topology of the VBF mechanism and its occurence in the HL-LHC.

Session III - 11:30a.m. - 11:55a.m.

Project ID: BIO 37
11:30a.m. - 11:55a.m.

Title: Functional Dynamics of Nucleoli and its Associated Genome through Differentiation
Presenter(s): Aaron Rodrigues and Kurt Leano
Mentor(s): Sui Huang, MD, PhD, Northwestern Feinberg School of Medicine
Abstract/Project intention:
The nucleolus is one of the most notable constituents of the nucleus, being the factory of ribosome synthesis. For such vital cellular organelles, nucleoli are grossly understudied; the multi-functional nature of the nucleolus and its holistic influence on cellular metabolism remain unclear. In this study, we analyze the functional association between the nucleolus and various differentiation processes by evaluating correlations between nucleolar quantity, nucleolar area, and cellular specialization. Utilized cell models include keratinocyte grafts, virally reverse differentiated cells, induced pluripotent stem cells, myoblast cells, and neuroblast cells. Nucleoli in cells of different stages of differentiation were compared within each system; parallels drawn between these systems may illustrate the relationship between cellular differentiation and nucleolar structure.

Project ID: BIO 39
11:30a.m. - 11:55a.m.

Title: The Effect of Genetic and Pharmacologic Loss of Notch4 on Angiogenesis

Presenter(s): Krishna Thakkar
Mentor(s): Dr. Naiche Adler, Kitajewski Lab, University of Illinois at Chicago College of Medicine

Abstract/Project intention:
Notch signaling is critical to the formation of blood vessels, and although the role of Notch1 has been well characterized, less is known about Notch4 and the degree to which its function overlaps with Notch1. In order to quantify the effects of removing Notch4, Notch4 mutant mice were generated via use of CRISPR/Cas9 and Notch4 function was inhibited by an anti-Notch4 neutralizing antibody. The vasculature of postnatal retina from control animals was compared to either knockout or anti-Notch4 treated mice on measures of radial outgrowth, tip cell count, front density, capillary density, large vessel count, branching, and large vessel diameter. The experimental groups were then compared to each other to understand the degree to which pharmacologic inhibition recapitulates the genetic knockout phenotype. Our data shows a statistically significant reduction outgrowth and vein diameter in pharmacologic nulls and a trend towards increased tip cell density. This makes sense in the context of established literature and offers an explanation for why loss of Notch4 reduces tumor perfusion and growth, given that slower vessel growth and smaller vessels would impede blood flow and perfusion to tumors.

Project ID: ERSP 3
11:30a.m. - 11:55a.m.

Title: Detecting Ghosting Artifacts in Telescope Images using Machine Learning
Presenter(s): Michelle Wang
Mentor(s): Chihway Chang, University of Chicago/ Fermilab
Abstract/Project intention:
When unwanted artifacts appear in telescope images, whether through imperfect optics, faulty image sensors, cosmic ray hits, or airplanes and satellites, it becomes difficult to process the images for data as the artifacts can confuse data-processing programs. An artifact that is especially difficult to avoid is the ghosting artifact or the ghost, which is caused by scattering and internal reflections of light of the telescope's mechanical and optical components. Because large cosmological surveys collect thousands of images per night, it's extremely time-consuming to search for and manually label the images with artifacts. In our study, we used data from the Dark Energy Survey to construct a machine learning model for distinguishing ghosts automatically. This paper details the model's structure and training process and presents the images used for training and validation. The model's performance was compared with that of the ray-tracing program currently being used for distinguishing ghosts.

Project ID: MATH 4
11:30a.m. - 11:55a.m.

Title: Description and Count of the Extended Symmetric Space of SO(3,p)
Presenter(s): Raman Aliakseyeu, Natalie Oliven, Ethan Thieme
Mentor(s): Dr. Ellen Ziliak, Benedictine University
Abstract/Project intention:
Our goal is to investigate a Special Orthogonal group of 3 by 3 matrices modulo p, denoted SO(3,p). Such matrices can be used in a multitude of fields, such as physics, chemistry and computer science. We began by generalizing the notion of symmetry as it pertains to matrices. For this investigation, we will use an inner automorphism of order two which is defined as theta(X) = MXM^{-1}. For a specific involution matrix M, we provide a count and description of the elements of the Extended Symmetric Space of 3 by 3 matrices defined as R = {X in SO(3,p) | theta(X) = X^(-1)}.

Project ID: MEDH 32
11:30a.m. - 11:55a.m.

Title: Machine learning prediction of glioblastoma patient one-year survival using clinical and genomic data

Presenter(s): Andrew Du
Mentor(s): Warren McGee, Jane Wu; Department of Neurology, Northwestern University Feinberg School of Medicine

Abstract/Project intention:
This study aimed to use machine learning to predict one-year survival for primary glioblastoma (pGBM) patients using data (n = 175) from the Chinese Glioma Genome Atlas (CGGA). Logistic regression (LR), support vector machine (SVM), random forest (RF), and ensemble models were used to select predictors for overall survival (OS) and to classify patients into those surviving less than one year and one year or greater.

With respect to OS, significant ($p < 0.05$) correlation was found with age (negative), radiotherapy (positive), and chemotherapy (positive). IDH1 mutation and 1p19q codeletion showed insignificant correlation with OS. However, IDH1 mutation showed significant negative correlation with age. Thus, further study may reveal long-term prognostic value.

Correlation analysis was performed on mRNAseq FPKM data to select for significance. LR, SVM, and RF classifiers were compared and combined in a weighted soft-voting ensemble classifier, using weights of 0.125, 0.125, and 0.750, respectively. The ensemble model had the highest accuracy (AUC = 0.654, F1 = 0.799). LR and SVM appeared to underfit the data, while RF appeared to overfit the data. In the ensemble model, the overfitting tendency of RF appeared to be counteracted by the underfitting tendencies of LR and SVM while maintaining high accuracy.

Presentation Schedule Reference List | IMSAloquium 2020

Student		Session	Time	Project ID
Nafay	Abdul	I	9:10 AM	MEDH 28
Mara	Adams	III	11:00 AM	ENVR 5
Shikha	Adhikari	II	10:25 AM	BIO 29
Pascal	Adhikary	I	8:50 AM	CMPS 1
Vibhav	Adivi	I	8:50 AM	BIO 04
Oluwadamilola	Alao	II	10:25 AM	BIO 22
Maxine	Alexandria-Strong	III	11:00 AM	ENVR 5
Raman	Aliakseyeu	III	11:30 AM	MATH 4
Mohamad Hasan	Almousawi	I	8:50 AM	ENGN 3
Ivan Paul Thaddeus	Anterola	II	9:45 AM	BIO 16
Eliza	Apavaloaiei	I	8:50 AM	CHEM 08
Sri Lalana	Appasani	II	10:05 AM	MEDH 26
Jumobi	Arowolo	II	9:45 AM	BIO 26
Muyiwa	Arowolo	II	9:45 AM	MEDH 11

Klaybis	Asllani	I	8:50 AM	ENGN 1
Emily	Atkinson	II	10:05 AM	MEDH 12
Peter	Baffoe	I	9:10 AM	MEDH 05
Pouravi	Banerjee	II	10:25 AM	BIO 29
Alexander	Bantchev	I	8:30 AM	HIST 1
Milica	Barac	I	8:30 AM	BIO 10
Jade	Bates	II	9:45 AM	MEDH 16
Pratibha	Bhalla	I	8:50 AM	BIO 21
Nishant	Bhamidpati	I	8:30 AM	MEDH 03
Shivang	Bhaskar	II	9:45 AM	CHEM 01
Utsa	Bhattacharyya	II	9:45 AM	MEDH 21
Evan	Blad	II	9:45 AM	PHYS 01
Shouri	Bochetty	II	9:45 AM	MEDH 33
Oliver	Bohac	II	9:45 AM	ENGN 5
Patrick	Borse	I	8:30 AM	MATH 6
Christopher	Bridges	I	9:10 AM	CHEM 09

Riley	Brutto	I	8:30 AM	BIO 17
Shae	Burnham	I	9:10 AM	BIO 32
Courtney	Cagnolatti	II	10:25 AM	CHEM 05
Aaron	Calhoun	II	9:45 AM	PHYS 13
Micah	Casey-Fusco	I	8:30 AM	MEDH 03
Caitlyn	Castillo	II	9:45 AM	BHVSO 01
Daniel	Chacon	I	8:30 AM	HIST 1
Saivasudha (Vasu)	Chalasani	I	8:30 AM	MEDH 23
Delicia	Chen	I	9:10 AM	BIO 05
Alec	Chen-Spelman	II	10:25 AM	MATH 3
Samira	Cheruku	II	10:05 AM	MEDH 34
Gnadeep	Chintala	I	8:30 AM	BIO 13
Madeleine	Chow	II	10:05 AM	MEDH 17
Brenna	Christoffel	II	9:45 AM	BIO 26
Amelia	Churchill	II	9:45 AM	CHEM 06
Declan	Creaney	II	10:05 AM	ENGN 6

Lauren	Crowe	II	10:05 AM	BHVSO 02
Saachi	Dalvi	II	9:45 AM	CHEM 10
Alyssa	Daniels	II	10:05 AM	MEDH 13
Emma	Darbro	II	10:25 AM	CHEM 05
Archan	Das	II	9:45 AM	PHYS 09
Rhiannon	Davids	I	8:30 AM	HIST 1
Alison	Deng	II	9:45 AM	MEDH 19
Alana	Depaz	I	8:50 AM	ENVR 2
Sydney	Despe	II	10:05 AM	BIO 18
Claire	Difford	II	9:45 AM	MEDH 16
Gaylen	Dimick	II	10:05 AM	BHVSO 09
Andrew	Du	III	11:30 AM	MEDH 32
Francesca	Dumitrescu	II	9:45 AM	BHVSO 08
Paul	Dunlap	I	8:30 AM	HIST 1
Quadri	Durojaiye	II	9:45 AM	BIO 26
Sonia	Edassery	I	8:30 AM	BIO 10

Nikita	Elkin	II	10:05 AM	PHYS 02
Adrian	Fanjoy	II	10:05 AM	ENGN 6
Grace	Federici	I	9:10 AM	MEDH 25
Ari	Fishkin	I	8:50 AM	PHYS 08
Isabella	Foes	II	10:25 AM	BHVSO 03
Ian	Fowler	II	9:45 AM	PHYS 13
Sttefy	Gabriel	I	8:30 AM	MEDH 18
Sriya	Gandhi	II	10:25 AM	BIO 22
Ishaar	Ganesan	I	9:10 AM	BIO 02
Ishaar	Ganesan	II	10:25 AM	MEDH 35
Jayavignesh (Jay)	Ganesan	I	8:30 AM	BIO 23
Chandra	Gangavarapu	II	10:05 AM	CMPS 9
Akanksha	Garg	II	10:05 AM	BIO 27
Diana	Gonzalez	II	9:45 AM	CHEM 01
Jackson	Grotke	I	8:30 AM	CHEM 07
Ysabel	Guan	I	8:50 AM	PHYS 08

Jimmy	Guo	I	8:30 AM	ENGN 2
Nikhilesh	Gupta	I	8:50 AM	BIO 31
Nikhilesh	Gupta	II	10:25 AM	BIO 08
Rachna	Gupta	I	8:30 AM	CMPS 7
Rachna	Gupta	II	10:05 AM	BIO 27
Xander	Hall	I	8:50 AM	PHYS 19
Maahum	Hamayat	I	8:50 AM	BIO 24
Ethan	Haque	II	10:25 AM	BIO 28
Maximillian	Hellrung	I	8:30 AM	BIO 23
Ashley	Homecgoy	I	9:45 AM	BHVSO 01
Jerry	Hong	II	10:05 AM	CHEM 02
Ellyn	Hu	II	10:05 AM	PHYS 10
Ming	Huang	II	10:25 AM	PHYS 11
Rustom	Ichhaporia	I	9:10 AM	CMPS 8
Janna	Jann	I	9:10 AM	MEDH 15
Ajay	Jayaraman	II	10:05 AM	CMPS 6

Nathan	Joseph	II	10:25 AM	BIO 28
Richard	Jun	II	10:25 AM	ENVR 6
Isha	Kadakia	I	8:50 AM	BIO 41
Linda	Kaneps	II	10:25 AM	CHEM 05
Meghana	Karan	I	8:50 AM	BIO 11
Ashley	Koca	II	10:25 AM	BIO 33
Torin	Kovach	III	11:00 AM	MEDH 31
Saachi	Kumar	II	10:05 AM	MEDH 12
Zoe	Kurzweil	I	8:50 AM	BIO 19
Elizaveta	Kuzmina	I	8:30 AM	BIO 30
Ann	Lamptey	II	9:45 AM	BIO 16
Samantha	Lazcano	I	8:50 AM	MEDH 24
Peter	Leahy	I	8:30 AM	BHVSO 05
Kurt	Leano	III	11:30 AM	BIO 37
Daniel	Lee	II	10:25 AM	PHYS 03
Evelyn	Lee	II	9:45 AM	PHYS 13

Matthew	Lee	I	8:30 AM	MEDH 08
Megan	Lee	II	10:25 AM	ENVR 4
Jacob	Levine	II	10:05 AM	CMPS 4
Mingyang (Lily)	Li	II	9:45 AM	MEDH 19
Eugene	Lim	II	9:45 AM	ENGN 5
Jason	Liu	I	8:30 AM	ENGN 9
Winny	Liu	II	10:05 AM	MEDH 20
Marcus	Ludwig	I	8:50 AM	ENGN 1
Neha	Maddali	II	9:45 AM	CHEM 10
Aneesh	Maganti	II	10:25 AM	MEDH 07
Ayan	Mallik	I	8:30 AM	PHYS 04
Sreyansh	Mamidi	I	8:30 AM	PHYS 12
Anthony	Martin	II	9:45 AM	MEDH 11
Rachel	Mason	I	8:50 AM	CHEM 08
Michael	McKelvie	I	8:30 AM	PHYS 05
Jodie	Meng	I	9:10 AM	MEDH 14

Sabrina	Meng	I	9:10 AM	BIO 38
Diego	Michel	II	9:45 AM	PHYS 15
Rachel	Moreno	II	9:45 AM	ERSP 1
Cynthia	Mu	I	8:50 AM	BHVSO 13
Elizabeth	Murphy	I	8:50 AM	BIO 14
Harshini	Musku	II	9:45 AM	ENGN 5
Melissa	Myint	I	9:10 AM	MEDH 02
Manikandan	Nagarathnam	II	9:45 AM	PHYS 13
Krishnachandra	Nair	III	11:00 AM	BIO 36
Siva	Nalabothu	II	9:45 AM	MEDH 33
Siva	Nalabothu	II	10:25 AM	MEDH 35
Monika	Narain	I	8:30 AM	BIO 25
Monika	Narain	II	10:05 AM	MEDH 01
Ahana	Narayanan	II	10:05 AM	BHVSO 16
Matthew	Niemiro	II	10:05 AM	MATH 2
Ishan	Nikam	I	9:10 AM	BIO 12

Natalie	Oliven	III	11:30 AM	MATH 4
Maxwell	Orr	I	8:30 AM	HIST 1
Duncan	Osmund	II	10:25 AM	ENVR 1
Namit	Padgaonkar	I	8:30 AM	BIO 13
Julianna	Padilla	II	10:05 AM	MEDH 12
Paola	Padilla	I	9:10 AM	BHVSO 14
Shreenithi	Palamuthy	I	8:30 AM	MEDH 22
Brandon	Park	I	8:50 AM	MEDH 29
JuWon	Park	I	8:30 AM	BIO 34
WonJun	Park	II	10:25 AM	PHYS 17
Madhav	Parthasarathy	II	9:45 AM	MATH 1
Hiteshi	Patel	I	8:50 AM	MEDH 04
Hiteshi	Patel	II	10:25 AM	BIO 35
Krisha	Patel	I	8:30 AM	BIO 03
Nilan	Patel	II	10:05 AM	CHEM 02
Ruchi	Patel	II	10:25 AM	BHVSO 17

Shreya	Pattisapu	II	10:25 AM	BIO 33
Philip	Paulson	I	8:50 AM	BIO 19
Vincent	Pergrossi	I	9:10 AM	CHEM 09
Ethan	Phillips	II	10:05 AM	ERSP 2
Akul	Prakash	II	9:45 AM	BIO 06
Prarthana	Prashanth	I	8:30 AM	BIO 25
Prarthana	Prashanth	II	10:25 AM	MEDH 27
Sophia	Pribus	I	9:10 AM	MEDH 28
Megan	Ptak	I	9:10 AM	MEDH 25
Tyler	Ptak	II	9:45 AM	PHYS 13
Roman	Putnam	I	8:30 AM	CHEM 07
Kayla	Quigley	I	8:50 AM	BHVSO 06
Samuel	Rabideau	II	10:25 AM	BHVSO 10
Bala	Ramaraju	I	9:10 AM	BIO 02
Levi	Raskin	II	10:05 AM	BHVSO 18
Alana	Rock	I	8:50 AM	BIO 24

Aaron	Rodrigues	III	11:30 AM	BIO 37
Katerina	Romanov	II	10:25 AM	ENVR 4
Charles	Schreiber	II	10:25 AM	ENVR 1
Moksh	Shah	I	8:50 AM	CMPS 1
Shruti	Shakthivel	I	9:10 AM	MEDH 10
Smriti	Shankar	II	9:45 AM	PHYS 15
Emily	Shao	I	8:50 AM	BHVSO 13
Brennan	Shapiro	II	10:05 AM	BIO 18
Austin	Shwatal	II	9:45 AM	MATH 5
Nathan	Shwatal	II	9:45 AM	BHVSO 15
Fania Audrey	Si	I	9:10 AM	BIO 09
Brandon	Smith	II	10:05 AM	ENGN 6
Grace	Smith	II	10:25 AM	ENVR 1
Alexandra	Sobczynski	II	9:45 AM	BHVSO 19
Heldanna	Solomon	I	9:10 AM	BHVSO 07
Ian	Son	II	9:45 AM	PHYS 13

Kodai	Speich	I	8:30 AM	PHYS 12
Dana	Stanecki	II	10:05 AM	CHEM 04
Abigail	Stevenson	I	8:50 AM	ENGN 7
Aidan	Stueck	II	9:45 AM	MATH 1
Yatri	Sutaria	II	10:25 AM	BIO 01
Bopoade	Taiwo	I	9:10 AM	MEDH 05
Saisu	Talasu	I	8:50 AM	BIO 42
Ryan	Talusan	I	8:30 AM	ENGN 8
Ishani	Tarafdar	II	10:25 AM	CHEM 03
Samantha	Taylor	I	8:30 AM	BIO 17
Teodor	Tchalakov	II	9:45 AM	PHYS 09
Chris	Teng	I	9:10 AM	ENGN 4
Vaishnavi	Tetali	I	8:50 AM	MEDH 09
Devraj	Thakkar	I	9:10 AM	CMPS 3
Krishna	Thakkar	III	11:30 AM	BIO 39
Abhiram	Thati	I	8:30 AM	BIO 17

Roshan	Thekiniath	II	10:25 AM	PHYS 17
Ethan	Thieme	III	11:30 AM	MATH 4
Manasvi	Thumu	I	9:10 AM	MEDH 06
Rachel	Tin	II	10:05 AM	MEDH 17
Ethan	Tse	I	8:30 AM	ENGN 2
Eva	Tuecke	II	10:05 AM	PHYS 10
Rohan	Upadhyay	II	9:45 AM	BHVSO 11
Aryan	Vaidya	III	11:00 AM	PHYS 18
Xander	Van Horn	I	8:30 AM	BIO 17
Zahra	Vasi	III	11:00 AM	MEDH 30
Michael	Vayninger	I	8:50 AM	PHYS 06
Tejo	Velagapudi	II	10:25 AM	PHYS 17
Sachin	Vijayaraj	I	8:30 AM	BIO 23
Saicharan	Voora	II	10:05 AM	BIO 07
Aabha	Vyas	I	9:10 AM	MEDH 25
Brian	Wagner	I	9:10 AM	ENVR 3

Angela	Wang	I	9:10 AM	BIO 15
Arthur	Wang	II	10:25 AM	ENVR 1
Jaden	Wang	I	8:30 AM	BIO 17
Michelle	Wang	III	11:30 AM	ERSP 3
Sydney	Wang	I	9:10 AM	CMPS 2
Gowri	Warikoo	II	10:25 AM	ENVR 4
Benjamin	Weber	I	8:30 AM	CHEM 07
Asha	Wiggs	I	8:30 AM	MEDH 18
Brady	Williams	II	10:25 AM	PHYS 11
Kristina	Williams	II	9:45 AM	CHEM 06
Nicole	Wolff	I	8:50 AM	PHYS 14
Grace	Wulffraat	I	8:30 AM	BIO 30
Hannah	Xu	II	10:05 AM	BIO 27
Breanna	Yang	II	10:25 AM	CMPS 5
Mark	Ying	II	9:45 AM	BIO 43
Grace	Yue	I	9:10 AM	PHYS 07

Athena	Zheng	I	9:10 AM	CMPS 2
Derek	Zhu	I	8:30 AM	BHVSO 12

Mentor List | Student Inquiry and Research

Argonne National Lab
John Domyancich
Zelimir Djurcic

Ball Horticultural Corp
Jayaraj Alappat

Benedictine Univ
Ellen Ziliak

Chicago Cubs
Christopher Jones

Fermi Lab
Jim Annis
Richard Cavanaugh
Chihway Chang
Brian Nord
Lenny Speigel

Illinois Institute of Technology
Lulu Kang

Illinois State Univ
Wolfgang Stein

Loyola University Chicago
Aaron Lauve

Loyola University Med Ctr
Monsheel Sodhi

Morton Arboretum
Colby Borchetta
Chuck Cannon
Silvia Alvarez-Clare
Meghan Midgley

North Central College
Frank Harwath
James Kaduk

Northern Illinois Univ
Timothy Hagen
James Horn
Kevin Martin
Mel Lenczewski
Wesley Swingley

NorthShore Univ HealthSystem
Jubao Duan

Northwestern Chicago Proton Ctr.
Steven Laub

Northwestern Univ, Evanston
Randall Berry
Jennifer Cole
Aaron Geller
Andrew Geraci
Jens Koch
Kirsten Viola
Samuel Bartley

Northwestern, Feinberg
Angel Alvarez
Apkar Vania Apkarian
Borna Bonakdarpour
Gemma L. Carvill
Savio Chan
Qiaoling Cui
Ramana Davuluri
David Gius
Alicia Guemez-Gamboa
Charles J Heckman
Sui Huang
Thorsten Kahnt
Eun-Young Kim
Dong-Hyun Kim
Caroline Le Poole
Daniel C Lee
Xue Feng Liu
Jones Parker

Murali Prakriya
Claus-Peter Richter
Arun Sharma
Marc Slutzky
Craig Weiss
Jane Wu

Northwestern, Lurie
Suraj Cherian

National Fish and Wildlife Forensic Lab - Ashland, Oregon
Mary K. Burnham Curtis

Rush University
Animesh Barua
Meghan Moran
Ryan Ross

Southern Illinois Univ, Edwardsville
Yadong Wang

The University of Chicago
Marisa-Luisa Alegre
Zeray Alemseged
Pradeep Chintagunta
Jean Greenberg
Tong-Chuan He
Aly Khan
Marynia Kolak
Sangram Sisodia
Matthew Walter
Lixing Yang
Tong-Chuan He

University of Illinois
Nicholas A. Burd

Univ of Illinois at Chicago
Naiche Adler
Robert Bruno
Ali Djalilian
Jonna Frasor
Mohsen Issa
Irena Levitan
Dolly Mehta
Linh Nguyen
Abhijit Phakatkar
James Radosevich

Univ Penn
Anthony Fouad

University of Wisconsin
Jue Wang

IMSA
Jessica Amacher
Patrick Davis
Don Dosch
Lee Eysturlid
Eric Hawker
Laura Kopff
David Lundgren
William McGrail
Eric Smith
Tracy Townsend
Michael Keyton
John Thurmond
Crystal Randall
Mark Carlson
Sowmya Anjur
Angie Ahrendt
Peter Dong
Patrick Kearney

Cover designed by Oluwadamilola Alao, IMSA student, April 22, 2020.