Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Adhya Beesam, Shriya Beesam
High School: Plano East Senior High School
Mentor: Julie Baker
Project Title: Linked Neuro-Fuzzy Inference System: A Novel Approach to Schizophrenia Diagnosis

Schizophrenia is a mental disorder that drastically alters a person's perception and actions until the patient becomes harmful to oneself or to others. The aim of this project was to develop a medical diagnostic inference system to accurately predict the likelihood of a patient having schizophrenia. Based on the PANSS psychiatric assessment results and MRI neuroimaging data, a comprehensive diagnostic tool was created. Three fuzzy logic systems and an ANFIS system were made. The PANSS system determined clusters of PANSS questions and calculated the likelihood based on the score for each cluster. The MRI system segmented the MRIs into grey matter, white matter, and cerebrospinal fluid, and the likelihood was determined based on the volumes of each segment. Initially, a linked fuzzy system was created that took the PANSS and MRI systems and created an overall likelihood based on their outcomes. Later, an Adaptive Neuro-Fuzzy Inference System was created using the same inputs and was determined to have a higher accuracy than the fuzzy system. This project is a tool that can be utilized by psychiatrists to solidify the diagnosis process and hopefully spur an advancement in technology and methods utilized for mental illnesses worldwide.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: William Duke, Nicolas Nahas
High School: Arkansas School for Mathematics, Sciences and the Arts
Mentor: Dr. Lindsey Waddell
Project Title: The Diversity of Coral Species at Coral Gardens, Belize with Video Transects

Coral Gardens is a patch reef system off the coast of Belize that is a known refugia for the threatened branching coral species *Acropora cervicornis* but has not been established as a Marine Protected Area (MPA). *A. cervicornis* serves as a base-building coral that, until recently, dominated reefs throughout the Caribbean. Due to coral bleaching events and coral diseases, reefs around the world have been losing coral cover, which is then replaced by algae. Video transects were used to identify the coral species at Coral Gardens and then estimate the percent coverage by live coral. It was determined that 65% of hard coral cover was *A. cervicornis*. The live coral cover and algal cover were found to be 54% and 27%, respectively. These results show possible improvement at the site over the live coral coverage reported by a previous study, as well as a higher ratio of live coral cover to algal cover than was previously reported for nearby Hol Chan Marine Protected Area. This higher ratio could result from a strategic location at a dip in the barrier reef as well as lower predatory fish populations and thus greater herbivory outside of the MPA.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Prateek Kalakuntla
High School: Texas Academy of Math and Science
Mentor: Mohammad Omary
Project Title: A Novel Luminescent Gold(I)-Based Hybrid System for Sensing Mercury

A vast majority of the 11 million people at risk for mercury poisoning, and the neurodegenerative effects that accompany this toxic heavy metal, inhabit developing countries where new methods of artisanal small-scale gold mining (ASGM) have greatly increased the concentration of mercury in local water sources; however, current mercury sensors are either too unwieldy or too costly to be used in these regions. Using a 3-amino-1,2,4-triazole-5-carboxylic acid in conjunction with a gold(I) precursor in a 1% molecular weight chitosan matrix, I have developed a novel hybrid-phosphorescent system that is sensitive to mercury. In order to quantify system's luminescence, I used a PTI 4000 spectrofluorometer, this data enabled me to optimize the system's sensitivity to mercury and increase its general utility. My system can sense concentrations of mercury between 0.3 and 300 parts per million (ppm). By titrating specific quantities of ethylenediaminetetraacetic acid (EDTA) into the system and synthesizing it in a phosphate-based saline buffer, I have rendered it completely reversible and stable at pH values between 4.0 and 10.0. This system has proved to be biologically-friendly, effective in fresh water media, easy-to-produce, and low-cost, allowing it to fill an important niche in mercury-sensing ecosystem – hence warranting patent filing.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Ankur Khanna
High School: Caddo Parish Magnet High School
Mentor: N/A
Project Title: Shear Heating of Black Hole Accretion Disks

This project, Shear Heating of Black Hole Accretion Disks, is the result of a study into black hole thermodynamics, more specifically accretion thermodynamics. The purpose was to study the environment brought about by the close proximity of two co-rotating black holes with aligned accretion disks, the subsequent shear heating of the black holes' accretion disks, and consequently whether that shear heating would have any effect upon gamma ray polarization in such an environment. A system consisting of two 135 gph water pumps in close proximity to each other inside of a 5.5-gallon tank was set up. The two pumps were conjoined at the bodies to ensure the two stayed together and were set up on a stand built of Legos to ensure that they did not move from their set positions. The system's water level was set so that the maximum rotation was obtained around the mouth of each of the pumps. Red food coloring was added and talcum powder sprinkled in strategic locations to track water flow. Using video footage from the system, a vector field was generated to indicate the velocity of each individual talcum powder particle. Using this vector field, shear calculations were carried out on each of the vectors and a graph of the shear generated from the results. The areas of highest shear were found to be directly between the two black holes. With this data's application in space, this could lead to a different gamma polarization from nearby black holes with aligned accretion disks.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Sandra Kong and Saumya Rawat
High School: Highland Park High School, School of Science and Engineering
Mentor: Dr. Alexandra Joshi-Imre
Project Title: Electrochemical Characterization of Shape-Memory Polymer-Coated Interdigitated Electrodes in Vitro

Shape-memory polymers (SMP) are smart materials that change their Young's modulus within a small tunable glass-transition temperature range. This transitioning characteristic tuned to body temperature (37°C) provides a substrate material that easily implants into the body and lessens the mechanical mismatch between current implantable neurotechnology (1-100 GPa) and tissue (1-40 KPa). The reduction of a chronic foreign body response allows for chronic viability as well as a stable connection between the technology and the nervous system. However, an issue with soft materials, such as SMP, is that they provide poor barriers to moisture, oxygen, and ions. In this work, we investigate the insulation properties of shape-memory polymers by conducting 3-electrode electrochemical tests on interdigitated electrodes (IDEs) coated by non-softening, semi-softening, and fully-softening SMP. Results revealed the functionality of two fully-softening IDEs and one semi-softening IDE, indicating that shape-memory polymers can serve as a sufficient insulator for implantable neurotechnology. Additional IDEs will be tested for a longer time period to present tighter standard deviations and measure the polymer's stability. Further research will include the usage of thin-film dielectrics, such as parylene-C and ALD layers, to provide a secondary insulation layer. Our approach offers a novel material that can serve as the substrate base and encapsulant for chronically viable implantable technology for more extensive studies of the nervous system to research and someday treat Alzheimer's, Parkinson's, and other neurodegenerative diseases.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Megan Liu and Kevin Zhou
High School: Highland Park High School
Mentor: Dr. Steve McKnight
Project Title: Activation Mechanism of NAMPT, a Therapeutic Target for Neurodegenerative Diseases

Neurodegenerative diseases, such as Alzheimer's disease and Parkinson's disease, are debilitating conditions caused by progressive degeneration and/or death of neuronal cells. The P7C3 class of chemicals has been identified as potential therapeutic compounds that can treat a variety of neurodegenerative diseases. Previous studies showed that P7C3 compounds act by targeting nicotinamide phosphoribosyltransferase (NAMPT) and activating its enzyme activity, thereby enhancing the synthesis of nicotinamide adenine dinucleotide (NAD) and promoting neuronal cell survival. However, the mechanism for how P7C3 activates NAMPT is not known. In this study, by carrying out alanine scan mutations on NAMPT, we identified the P7C3 binding site on NAMPT that is critical for P7C3 to bind. Mutations of this site on NAMPT also blocked its activation by P7C3, indicating that P7C3 activates NAMPT by binding to this site. In addition, we also identified a disordered loop on NAMPT near the P7C3 binding site that is essential for its activity. Together, our results provide mechanistic insights into the mechanism of NAMPT activation by P7C3 class of compounds, which will allow better design of NAMPT-targeting compounds for treating neurodegenerative diseases.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Kailash Raman
High School: Sandra Day O'Connor High School, Phoenix, Arizona
Mentor: Joseph Rheinhardt, Arizona State University
Project Title: Versatile, Efficient, and Facile Functionalization of Poly(*p*-phenylene oxide) via Azide-Alkyne "Click" Chemistry

Functional polymers with tailored physicochemical properties are currently attracting tremendous attention because of their use in diverse applications, such as fuel cell membranes, biomaterials, and organic semiconductors. However, most conventional methods for post-polymerization synthesis of functional polymers work only with a limited range of functionalities or require rigorous reaction conditions. Herein, a versatile, efficient, and facile method for post-polymerization functionalization of poly(*p*-phenylene oxide) using azide-alkyne "click" chemistry is presented. Poly(*p*-phenylene oxide), a widely available polymer with high glass transition temperature and excellent chemical stability, was modified with a diverse array of functional groups through a mild, three-step synthesis. The polymer was first brominated using NBS, and then functionalized with azide groups by nucleophilic substitution. The resulting polymer finally underwent 3-hour copper(I)-catalyzed azide-alkyne "click" cycloaddition reactions at room temperature with a variety of alkyne functionalities. This pathway was used to functionalize poly(*p*-phenylene oxide) with alkane, aromatic, organometallic, and ether moieties. Synthesis of these functional polymers was confirmed by FTIR and ^{1}H-NMR characterization. Post-polymerization functionalization by azide-alkyne cycloaddition was thus shown to have high functional group tolerance and occur rapidly in mild conditions. The "click" functionalization process is therefore a potentially powerful tool for synthesis of diverse functional polymers.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Kavita Selva
High School: Clear Lake High School, Houston, TX
Mentor: Dr. Xiao-Fen Li
Project Title: From Nano Defects to Mega Power:
Zirconium-doped Trapped Field (Gd,Y)BaCuO Superconductor Tapes for High Power Wind Turbine Generators

Trapped-field magnets made with thin film (Gd,Y)$Ba_2Cu_3O_x$ superconductor tapes incorporating $BaZrO_3$ nanocolumnar defects have been investigated as an alternative to permanent magnets for use in high-power wind turbine generators. It was found that a crisscross arrangement of arrays of stacked superconductor tapes yielded more uniform trapped magnetic field profiles and a lower decay rate of the trapped field compared to a straight arrangement. Also, the magnitude of the trapped magnetic fields increased with increasing number of tapes in the stack as well as with decreasing thickness of individual tapes. While the superconductor tape stacks with 7.5 mol% $BaZrO_3$ trapped a higher field at 77 K, tape stacks with 25 mol% $BaZrO_3$ trapped higher fields at all lower temperatures. The trapped magnetic fields increased nearly linearly with decreasing temperature, reaching peak values as high as 4.5 Tesla at 30 K, much higher than that possible with permanent magnets. Using such strong trapped-field magnets, power levels of nearly 14 MW could be generated in the wind turbines which is about seven-fold higher than that of typical wind turbines. Such high-power wind turbines would greatly improve the economics of wind energy and spur the growth of this renewable energy source.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Byron Xu
High School: William P. Clements High School
Mentor: Dr. Warren Wood
Project Title: Direct Determination of Ocean Temperature Profiles from Seismic Oceanography

Oceans play an essential role in global warming, and profiles of ocean temperature versus depth are a subject of great scientific interest. Currently, ocean temperature profiles are determined using expendable bathythermographs (XBT) or other devices that record measurements as they descend down the ocean. While these devices offer high precision and vertical resolution, they suffer from low horizontal resolution. Seismic oceanography, in contrast, allows for imaging of the ocean at a high horizontal resolution. An inversion method has been used to quantitatively determine sound velocity and temperature from seismic data, but the method still requires some physical measurements to be recorded along with the seismic survey. This study developed a new methodology to quantitatively determine, with a horizontal resolution of 50 meters, temperature and velocity profiles directly from seismic data without depending on on-site measurements. The results were consistent across the data set and matched well with XBT measurements with a mean difference of -0.09 °C. The average uncertainty in temperature is estimated to be 0.35 °C. Because this methodology does not require on-site physical measurements, it offers a potential for the reuse of legacy seismic data, collected over half a century, to help understand global ocean processes.

Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Sarah Zhao & Lana Chen
High School: Vestavia Hills High School
Mentor: Chris Klug
Project Title: *Identification of Long Non-coding RNA Genes Important for Normal Hematopoiesis and Leukemogenesis Using Bioinformatics Tools*

A large number of long non-coding RNA (lncRNA) genes has been discovered via sequencing human genome. To investigate the functions of lncRNA genes poses huge opportunities as well as challenge to medical science field. In this project, we interrogate important lncRNA genes that may be associated with normal and abnormal leukemogenesis from publically available databases. The data mining and statistical analysis are performed by R program and oracle SQL code. We have discovered a few lncRNA genes: linc00028, linc00637 and RP13-1032I1.7 that may be important for leukemogenesis. Linc00028 and linc00637 may be regulated by transcription factor RUNX1, and linc00637 may activate p53-mediated apoptosis. By clustering genes of acute myeloid leukemia patients in TCGA database, we found unique lncRNA signature genes specifically associated to distinct groups of leukemia patients with PML-RAR alpha, FLT3 mutation and AML1-ETO (aka RUNX1-ETO) respectively. Given that 60,000 lncRNA genes have been discovered, our analysis tools will select the most relevant lncRNA genes to perform wet experiments first. The strategy we designed may be used to study the role of lncRNA genes in other types of cancer in addition to leukemia.