Project ID: 141

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Ananya Asudani
Del Norte High School
Gr. 10

Identification of Genetic Disease Markers Associated with Parkinson's Disease Using the Implementation of a Data Analysis Model

Parkinson's disease (PD) is a neurodegenerative disease. The main cause of Parkinson's disease is the loss of dopamine-producing nerve cells (dopaminergic) resulting in cognitive disturbances. This project demonstrates a successful prototype that will clean a given dataset and then analyze it to identify gene markers for Parkinson's Disease.

AI such as deep learning can be used to accurately narrow down a large dataset. Using unsupervised clustering (K-Means), different genes are grouped into prospective areas. Unsupervised clustering identifies natural groupings among the dataset. Using logistic regression, imbalance is ruled out, creating an accurate model. It allows for the mean expression value for each gene type to be represented. A random forest classifier organizes the dataset allowing for the identification of potential issues. It is beneficial when working with genes due to variables that can occur in the body. Hyperparameter tuning is used to update the parameters of and eliminate skews. Using feature selection indicators of Parkinson's are identified as gene markers. This is a process in machine learning that selects a group of relevant features from a larger set.

The study shows that relevant disease markers are MT-ND3*, GRID2, DLEU1, and HSP90AA1 associated with PD. In this project, genetic markers of Parkinson's disease were found using data that was sampled from the brains of deceased patients. It is helpful for diagnosing patients since some of the genetic markers identified can play a role in the development of PD. Blood tests could be developed to determine whether someone has these biomarkers.

Project ID: 142

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Dhruv Bantval

Canyon Crest Academy

Gr. 9

Motion-Sensor Based Sign Language Recognition Glove

In this engineering project, a prototype for the SignGlove-2 device, an improvement over the previous SignGlove-1 design, is developed to convert American Sign Language to text and speech. A gyroscope and accelerometer are used to track hand movements and detect deflections. SignGlove-2 can decode around 85-90% of words motioned. Along with this, the glove can differentiate between words that have similar hand positioning 75-85% of the time. In conclusion, SignGlove-2 satisfies all the design criteria and is an effective communication tool for the hearing impaired.

Project ID: 143

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Aditya Bisain

Canyon Crest Academy

Gr. 9

Fine-Tuning Segment Anything Model for Thyroid Ultrasound Images

A thyroid is an organ in the neck area which produces hormones to maintain bodily functions. The two approaches for diagnosing thyroid problems are fine needle aspiration(FNA) and ultrasound. But, FNA is intrusive and not ideal for the human body. Thus, the purpose of this project is to train a Segment Anything Mode l (introduced by Meta AI in April 2023) for ultrasound images of thyroids to accurately locate where the thyroid is in the image, and to test whether a fine tuned version of SAM is reliable for the act of locating thyroid nodules.

In this project, I fine tuned the SAM model for a dataset with ultrasound images of thyroids, specifically a DDTI dataset of images which I had found on kaggle.com. After fine tuning and training, I created distinct Google Colab notebooks to store the model's inferences in a folder, and to compare the inferences with the ground truth masks. I had originally worked on Jupyter Notebook, then switched to Google Colab. After fine tuning and training the SAM Vit Base and SAM Vit Large models, I found that the IoU of these models in comparison to the ground truth masks were both about 0.74.

Although the results demonstrate the viability of SAM to locate thyroid nodules effectively, they can also be improved through training with more datasets. Also, this work can be expanded to diagnose whether nodules are malignant or benign based on the features of the nodule.

Project ID: 144

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Rohan Bojja
Del Norte High School
Gr. 9

Nikhil Maturi
Del Norte High School
Gr. 9

Portable Real-Time Machine Learning Asthma Management System for Exacerbation Prediction

Asthma exacerbations are episodes of worsening symptoms and lung function, being unpredictable and causing anxiety in patients. These exacerbations lead to severe symptoms, including difficulty in breathing, chest tightness, wheezing, hospitalization, and possibly death. Early detection of exacerbations is crucial to avoiding severe symptoms. In our study, we developed and tested a wearable chest device to diagnose medications and predict asthma exacerbations based on past episodes. The device comprised multiple algorithms, including respiratory rate, spirometric model, activity intensity, accelerometer, gyroscope data, and other vital signs. In this design, various pieces of circuitry are utilized, such as a Raspberry PI PICO, accelerometer, pulse oximeter, microphone, PI Hat, and environmental variable sensors. We tested on synthetic data created using mathematical modeling and a Large Language Model and cross-validated with a patient with frequent exacerbations. When exacerbations are present, algorithms and model outputs are compared with real-world data, and with qualitative analysis, the device can identify the episode, print a personalized medication diagnosis, and store outputs with memory for automated modifications. The Audio Classification model was tailored toward many respiratory sounds and ended with an accuracy of 90%, and the Spirometric Model used 2500 pieces of synthetic data augmented from 10 consenting patients. Further research is needed to validate the effectiveness in larger samples of patients and explore the other physiological measures of asthma severity. Nevertheless, our study demonstrates the feasibility of a wearable chest device for predicting asthma exacerbations and treatments, significantly impacting asthma management.

Project ID: 145

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Saanvi Dogra
Del Norte High School
Gr. 10

3D Polymer Composite of Porous Silicon Nanoparticles for Peripheral Nerve Regeneration with a BDNF Model

AWARDS:

San Diego Chapter - American Society of Materials International - Senior Division 1st Place

Around 200 million people worldwide have suffered from peripheral nerve damage, caused by physical trauma, autoimmune diseases, infections, etc. However, of these, less than 50% regain effective motor and sensory functions. Due to the limited success and dangers of currently used autografts, the purpose of this research was to develop a minimally invasive 3D polymer scaffold nerve guidance channel loaded with neurotrophin-secreting nanoparticles to improve the rate of peripheral nerve damage recovery through targeted drug delivery. Through molecular docking of four neurotrophins, BDNF was selected for having the highest binding affinity to the TrkB receptor. A flexible, biocompatible polymer was then created through spray nebulization and optimized by experimenting with different polymer materials, nanoparticle sizes, loading chemistries, and attachment of the nanoparticles. The scaffold was submerged in PBS to replicate human conditions during in vitro experimentation to examine the BDNF model protein release over the 2-week regeneration period. A Random Forest Classifier machine learning model was accurately developed to predict the correct BDNF dosage needed to guide implementation of this device in a clinical setting and achieved high performance metrics. The nerve guidance channel successfully achieved an ideal amount of release, high protein activity, and optimal properties after characterization by SEM, making important contributions to the field of nerve regeneration. This research not only lays the groundwork for improved likelihood of complete recovery after nerve damage, but also represents an interdisciplinary approach for targeted drug delivery that could be used for other issues in healthcare.

Project ID: 146

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Kevin Du
Del Norte High School
Gr. 11

David Lee
Del Norte High School
Gr. 11

Multi Compartment Brain Imaging with MRI

We propose a MRI protocol for quantifying major brain components. The protocol includes four sequences: MT-Cones for macromolecular content, STAIR-Cones for myelin water, PDw-Cones for total water, and T2w-Cones for extracellular water. Using these techniques, we quantified proton fractions of macromolecules, myelin water, intra/extracellular water, and free water in 10 healthy volunteers and 2 MS patients on a 3T scanner. Quantitative maps of MMPF, MWPF, IEWPF, and FWPF were successfully generated. We want to see if lesions showed significantly higher FWPF than WM or GM in both groups. Our hypothesis is that this technique enables volumetric quantification of brain components, valuable for assessing neuroinflammatory and neurodegenerative diseases and helping differentiate between healthy and diseased brains.

Project ID: 147

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Leanne Fan
Westview High School
Gr. 10

Photobiomodulation on In-Vivo and In-Vitro Wound Models Under Simulated Microgravity for Future Space Travel

AWARDS:

Grand Award - Senior Division Life Sciences – ISEF FINALIST
Association for Women in Science - Winner
Kaiser Permanente Blue Ribbon Award
Scripps "Young Scientist" Award
CSEF Qualified

The ability to land astronauts on Mars will enable humanity's next giant leap. However, studies on astronauts in space show that microgravity disrupts the delicate balance of processes required for wound healing, slowing it down or even stopping it completely in space. This presents a serious risk for long-term space travel. In this study, the use of photobiomodulation (PBM), where light is used to stimulate healing, was investigated as a means to speed up wound healing and kill bacteria in both normal gravity and microgravity conditions. Planarians were selected as a model for tissue regeneration. A 3D clinostat was developed to simulate a microgravity environment and investigated whether PBM influences planarian regeneration rate in microgravity. The results showed a 47.1% increased blastema growth rate at low levels of red light (660nm, 0.38 J/cm2) and near-infrared (850nm) light in normal gravity. The procedure was repeated in simulated microgravity using a 3D clinostat, showing a 17.6% decrease in blastema growth without PBM compared to normal gravity, and 60% increase in blastema growth with PBM(660 nm 0.38 J/cm2). A scratch wound closure assay on cell line DU145 was performed to show the ability of PBM to accelerate wound healing in human cells. A 29.4% increase in cell migration rate and wound closure was observed with PBM. The results suggested that PBM could be effective for wound healing in space or in areas with little access to healthcare.

Project ID: 148

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Isabel Ji

Torrey Pines High School

Gr. 9

Affordable Open Ear Headphone-Based Hearing Aid as an Alternative to $1000 Open-Fit Hearing Aid

AWARDS:

California School Nurse Organization, San Diego - Imperial - Winner

The price of good quality open-fit hearing aids are often in the thousands because of the complexity of algorithms with minimal signal processing, but what if a pair of open ear headphones procure similar results to that of a hearing aid when connected to a phone? Hearing aid price and quality form a give and take relationship: higher quality increases cost and vice versa. My project aims to utilize bone conduction headphones with low latency, high battery, and stereo microphones through bluetooth connection to a phone to effectively simulate similar results to that of a standard high quality hearing aid for a fraction of the price. To simulate, recordings proved that bone conduction sufficiently eliminated the occlusion effect similar to open-fit hearing aids while also reproducing the original speech at high quality. Next, latency of Bluetooth devices are as low as 7.5ms while audio processing takes 1-4ms on recent phones. The standard hearing aid latency is 5-7ms. Thus, the need for research of lower latency on headsets is needed. For spatial noise supression, the speech and noise were played from different angles to demonstrate its importance, with audio from one ear much clearer. Finally, advanced noise reduction algorithms tcan be introduced as recent smartphones have thousands of times greater processing power compared to hearing aids. The algorithm complexity could also be improved with new opportunities to introduce AI/ML. Therefore, these many sub-hypotheses creates a concept of a high quality and low cost hearing aid, increasing accessibbility worldwide.

Project ID: 149

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Isabella Kalapala
Mission Vista High School
Gr. 9

The Mystery of Memory in Alzheimer's

AWARDS:

California School Nurse Organization, San Diego - Imperial - Winner

In "The Mystery of Memory in Alzheimer's," I sought to prove Alzheimer's disease is caused by: poor lifestyle, insulin resistance, and the deterioration of white matter pathways.

First I conducted the: Montreal Cognitive Assessment (MOCA) and Mini-Mental State Examination (MMSE) for a family tree (1 early onset, 1 diagnosed Alzheimer's and 2 relatives). I then created a questionnaire to give people who knew anyone with Alzheimer's, leading 11 people through it. Finally, supported by evidence is white matter deterioration is a cause of the memory loss.

In my research, the main pattern was when straining their minds constantly they had a harder time remembering things. More evidence I found in the MMSE and MOCA tests: the Alzheimer's participant didn't have a mentally straining adult life and was not diagnosed until their 90's. A few symptoms of white matter disease: troubles remembering, irregular uraning, problems walking, lack of problem solving skills. All of these symptoms were also symptoms submitted by participants in my testing as well. We can see how it begins with forgetting little daily things. These are signs of improperly functioning white matter. To summarize, evidence shows: stress on white matter begins the process of white matter deterioration.

In conclusion, my hypothesis stands in these areas: Alzheimer's disease can become early onset with heavy mental strain, and can be diagnosed with a large deterioration in white matter. Finally, one's at higher risk of a diagnosis with insulin resistance, APOE4, or any diagnosed diabetes.

Project ID: 150

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Anirudh Kalyanaraman
Mt. Carmel High School
Gr. 11

Fluid Shear Stress Enhances the Metastatic Potential of Human Colon Cancer Cells: A Critical Role of Nitric Oxide

AWARDS:

BD "Advancing the World of Health" - Senior Division 1st Place
Scripps "Young Scientist" Award
CSEF Qualified

The role of Fluid Shear Stress (FSS) on colon cancer metastasis and whether this biomechanical force imparts any biochemical or molecular changes in the circulating colon cancer cells is not well understood. In this work, a bioengineering model is used to simulate the laminar FSS experienced by cancer cells using a parallel plate flow chamber. Exposure of HCT116 (human colorectal carcinoma cells) to physiological FSS, resulted in a significant increase in the metabolic activity and viability, proliferation and colony formation. An in-depth mechanistic analysis identified nitric oxide (NO) as a crucial mechanosensory signaling molecule that confers the pro-oncogenic and pro-metastatic signal to HCT116 cells. Pretreatment of HCT116 cells with nitric oxide synthase (NOS) inhibitor, LNAME significantly reduced HCT116 cell viability, proliferation and colony formation. This raises the possibility of using serum nitrate/nitrite levels as a potential biomarker to aid in the early detection of colorectal metastasis. Experimental data indicate that nitric oxide exerts a biphasic effect in colon cancer progression and metastasis. Low NO concentration (100 nanomolar) released during moderate physical exercise in cancer patients exerts a pro-oncogenic and pro-metastatic signal. However, micromolar concentrations of NO achieved by treatment with NO donor, PAPA- NONOate resulted in significant cytotoxic effect with inhibition of the HCT116 cell proliferation, colony formation and cell viability. Thus, development of efficient drug delivery systems to deliver high NO directly to the primary tumor site may be developed into a therapeutic strategy for arresting primary tumor growth and to prevent colorectal cancer progression and metastasis.

Project ID: 151

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Zinia Khattar
Del Norte High School
Gr. 11

Integrated Stress Response Activation Discovered to Be Predominant Response to Mitochondrial Dysfunction: A Therapeutic Target Advancement

AWARDS:

Grand Award Runner Up #1 - Senior Division Life Sciences – ISEF FINALIST
CSEF Qualified

Our bodies continuously face genetic and developmental stresses and use stress-responsive signaling pathways to promote protective remodeling of the proteome. When persistent upon signaling pathway dysfunction, however, these insults result in pathogenesis. Additionally, the lack of selectively targeting therapeutics has led to considerable interest in defining the molecular mechanisms responsible for regulating cellular proteostasis in response to pathologic insults. As previously discovered, the Unfolded Protein Response regulates global cellular physiology in response to endoplasmic reticulum stress. However, the UPR is not the only response leading to pathogenesis correction; the Integrated Stress Response is another, involving selective phosphorylation of eIF2α kinases for transcription factor activation. Nonetheless, the ISR's role in etiology mitigation remains largely unknown. Post-validation of our gene-set profiling approach using known UPR targets, we monitored the expression of genesets regulated downstream of signaling pathways with perturb-seq datasets from K562 cells CRISPRi-depleted of mitochondrial proteostasis factors. We found the ISR predominantly activated in response to broad-scale mitochondrial disruption. Further, mitochondrial protein processing and targeting were among the notable functions discovered of ISR target genes through Gene Ontology analyses. Our identification of the ISR as the predominant stress-responsive signaling pathway activated by mitochondrial proteotoxic stress underscores a unique opportunity to target the ISR to correct pathologic mitochondrial dysfunction in etiologically diverse diseases like type 2 diabetes, the result of β-cell anomalies due to mitochondrial dysfunction. Ultimately, this viable gene-set profiling approach holds promise for identifying therapeutic targets and biomarkers across the proteome, advancing progress to mitigate cancer, metabolic, and neurodegenerative disease.

Project ID: 152

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Kian Kowsari
Scripps Ranch High School
Gr. 10

Evaluating ML Models for Relative Skin Moisture Measurement to Detect Pressure Injury

Pressure injuries pose a significant health and economic burden, with millions of cases annually leading to severe consequences. Early detection is crucial for prevention, yet the delay between occurrence and visual detection impedes timely intervention. This paper addresses the problem by exploring visible and near-infrared (NIR) reflectance spectroscopy for comprehensive biomarker assessment, including moisture, vital for precise pressure injury detection.

To extract moisture data, the paper employs a multilayer perceptron neural network (NN) and a Support Vector Machine (SVM). Despite challenges with the NN's generalization, the SVM proves effective, showcasing 100% accuracy with reduced complexity. The SVM's capability to determine the distance from the hyperplane is utilized as an indicator of relative moisture levels, offering a promising approach for early pressure injury detection. Experimental results indicate the SVM's superiority in accuracy and efficiency, leading to the decision to use it for calculating relative moisture levels. The study proposes utilizing these values to calculate the variance in moisture levels within a skin area, serving as an early indicator of pressure injury risk.

Future work involves expanding the dataset, incorporating diverse subjects, and obtaining necessary approvals. The presented approach signifies a significant step towards leveraging machine learning for effective pressure injury detection, addressing a critical aspect of healthcare.

Project ID: 153

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Jaelyn Liang
Westview High School
Gr. 9

Computational Immunomimicry for Targeted Cancer Immunotherapy

This project explores a new approach to immunotherapy using parasitic antigens to address common problems with existing therapies. Since its first implementation, immunotherapy has gone on to revolutionize the way cancer is treated. However, current treatment options come with many undesirable outcomes, including tumor heterogeneity leading to ineffective therapy, off-target effects damaging healthy organs and tissues, and drug insensitivity growing over time. This project describes a new way to approach immunotherapy, and counters these issues while enhancing immunotherapy effectiveness. In the methods, BLAST alignments were found between diverse Tumor Specific Antigens (TSAs) and parasite antigens. For each TSA, the alignment with the highest percent identity was chosen to become a peptide sequence, then inputted into a convolutional neural network that outputted an immunogenicity score ranging from 0-1 (0 being not immunogenic, 1 being very immunogenic). Once the immunogenicity was affirmed, PEP-FOLD 4 was used to predict peptide structure, and peptide sequences were inputted into pepATTRACT to visualize the interacting residues with the target cancer antigen. The results of this study provided peptide sequences that specifically target and are effective against a variety of important cancer antigens (therefore solving the issues of tumor heterogeneity, off-target effects, and drug insensitivity), as well as a neural network that can predict the immunogenicity of shorter peptides. While further research is needed to fully validate this as a common method in immunotherapy, it offers positive results, making it a high-potential cancer treatment.

Project ID: 154

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Rhea Rupareliya
Canyon Crest Academy
Gr. 11

Analysis of Prostate Deformation in MRI During Prostate Cancer Treatment

During prostate cancer treatment, MRI scans are pivotal tools. They aid in pre-treatment prostate and cancer identification, improve targeting accuracy during treatment, and assess treatment effects post-treatment. In clinics, MRI images are routinely used for qualitative assessments of treatment effects. However, the quantitative changes in prostate physiology during treatment remain unclear.Understanding these physiological changes quantitatively and establishing a reportable metric, such as prostate volume difference, can provide physicians with a more objective measure of treatment effectiveness. This knowledge can lead to enhanced follow-up care for patients. Patient physiology changes like rectal gas presence, bladder retention, and natural size variations can affect pre- and post-treatment MRI results. To address this, we will analyze and standardize differences in prostate and tumor size, volume, and center of mass location using pre-existing CT scans. Anticipated results suggest that longer intervals between MRI scans will correlate with greater differences in prostate and tumor size, maximum dimensions, and tumor dimensions pre- and post-treatment. Moreover, significant variations in these parameters are expected between different types of treatments, shedding light on personalized treatment approaches and their effectiveness. In conclusion, MRI scans are invaluable in prostate cancer treatment, and quantifying physiological changes can enhance treatment assessment. Despite uncontrollable factors, this research aims to provide valuable insights into treatment effectiveness and individualized patient care. From the results, we find that the prostate centroid and prostate volume are significantly larger before treatment than they are after treatment. Additionally, for x and y coordinates, we find statistically significant differences, however, for the z coordinate we do not have enough evidence of a statistically significant difference.

Project ID: 155

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Raymond Sheng
Del Norte High School
Gr. 11

An Arduino-Based Platform to Incentivize Consistent Physical Activity with Cryptocurrency Reward

Weight loss has become a global epidemic. While many are able to lose weight for short periods of time, they struggle to maintain motivation and consistency to keep long-term weight loss. To resolve this a hardware-software system is created to allow users to set their own weekly exercise plan, gather GPS data on runs, and output a cryptocurrency token award based on the amount and intensity of the run. The first iteration of the prototype system focused too much on simplicity, hindering the ability to facilitate consistency and motivation in exercise as well as ease of use. The system is redesigned to address the project criteria with the following solutions:

1. Creating a issuance model that incrementally increased token output and prioritizing intensity over distance covered
2. Creating a login system for users to set and track their exercise goals for the week
3. Adding a portable battery pack for safer hardware storage while active

Ultimately, the system was able to collect the requisite data and customize an weekly schedule with which to follow for the week. The user was also given a fair cryptocurrency reward that both motivated greater exercise as well as greater intensity of exercise through both negative and positive reinforcement.

Project ID: 156

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Christina Tian
Westview High School
Gr. 10

IL4/13 Indirectly Inhibits TNF-Induced CFB Expression

AWARDS:

CSEF Qualified

Cancer constitutes a significant health challenge that has garnered extensive attention from the scientific community, driven by a collective pursuit of a definitive cure. A pivotal aspect of cancer pathology lies in the impaired ability of the immune system to eradicate aberrant cells. Specifically, tumor necrosis factor (TNF), a cytokine secreted by inflammatory cells, is thought to be implicated in inflammation-associated carcinogenesis. This prompts the inquiry: can Interleukin 4/13 (IL4/13) serve as a suppressor for the effects of TNF? Furthermore, contemplating whether the potential cessation of IL4/13 secretion would raise the prospect that TNF could be exerted to its full potential in combating cancer cells. The hypothesis for this project is that the addition of IL4/13 to 3T3 fibroblasts will result in a decrease in CFB expression compared to control conditions without IL4/13. The results affirm this expectation, indicating a roughly 30% reduction in CFB expression when IL4/13 is included, compared to treating only with TNF in the 3T3 fibroblasts. The impact of TNF, IL 4/13, and CHX on 3T3 fibroblasts is evident, as the control group shows no expression. Although CHX does affect TNF expression to some degree, its influence is not as significant as that of IL 4/13. Intriguingly, when all three are administered, the expression closely mirrors the combination of TNF and IL 4/13 alone.

Project ID: 157

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Ryan Wang
Westview High School
Gr. 9

Low-Cost Home-Use Wearable Kit to Predict and Prevent Sports Injuries

Injuries can have extensive negative effects, impacting both athletes and the general population. Therefore, prioritizing injury detection and prevention measures are crucial. While surgical and nonsurgical treatments exist, medical instruments are often costly and impractical for home use, requiring specialized knowledge for operation. This research prototypes a low-cost home-use wearable sensor kit to detect muscle contractions and fatigue. As a part of the kit, AI algorithms were developed to predict injuries based on a player's muscle fatigue data detected by sensors and the player's injury history. The research found that electromyography (EMG) and galvanic skin-response (GSR) sensors effectively detect muscle fatigue. GSR sensors are commonly used in lie-detector tests, also capable of identifying sweat and nervousness, presenting an innovative approach to muscle fatigue detection. Sensor data was collected using the Arduino platform. Random Forest Regressor AI algorithm is used since it is less susceptible to noise and effective in creating a robust model. Experimental results confirm a correlation between muscle contraction, fatigue, and injury, showing higher muscle soreness and fatigue indices increase injury probability. These findings align with real-life athlete injury patterns. In contrast to current wearable sensor technologies which primarily focus on recording sport load or muscle contraction but lack injury prediction capabilities, this study showcases the effectiveness of a low-cost, at-home kit for detecting muscle fatigue and forecasting injuries through advanced AI algorithms. The findings of this research hold significant promise in mitigating the risk of sports-related injuries, offering a valuable tool for athletes and sports professionals alike.

Project ID: 158

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Sydney Zhang
Westview High School
Gr. 11

Design and Usability Study of a Point of Care mHealth App for Early Dry Eye Screening and Detection

AWARDS:

Grand Award Runner Up #2 - Senior Division Life Sciences

Office of Naval Research - Senior Division Winner

Dry eye disease (DED) is the most common eye disease with few effective methods clinically available for early diagnosis. Importantly, significantly increased eye blink rate and partial blinks have been well documented in patients with DED. In this project, the author designed a point-of-care mHealth App "EyeScore", which uses blink rate for in-home DED diagnosis.

EyeScore was designed to utilize an iPhone for a 1-minute in-app recording of eyelid movements. The use of 6 facial landmarks, eye aspect ratio (EAR), and derivatives enabled a comprehensive analysis of video frames for determination of eye blink rate and partial blink counts. Instead of using a fixed value EAR threshold (which led to many false results of blink counts from DED patients), two personalized dynamic EAR thresholds were created for full and partial blinks. Smartphone videos from 10 DED patients and 10 controls were analyzed to optimize dynamic EAR-based thresholds, with blink results in 100% agreement with manual counts. Importantly, a clinically relevant algorithm for the calculation of "eye healthiness score" was created, which took into consideration eye blink rate and other risk factors for DED. This 10-point scale score can be measured anytime at home and successfully led to the identification of 3 individuals with DED conditions from normal controls. Thus, 30% of healthy individuals may subject to positive DED, suggesting DED is significantly underdiagnosed and insufficiently treated. Thus, EyeScore can be validated as a valuable mHealth App for early DED screening, detection, and treatment monitoring.

Project ID: 159

Senior Division

Biomedical/Health Sciences, and Biomedical Engineering

Eshika Pallapotu
Del Norte High School
Gr. 10

Creating Novel Cancer Vaccines for Breast Cancer Using IPSC-derived Antigens

Goal: A vaccine that targets multiple shared antigens.
One antigen alone may not be able to generate a sufficient effect and durable anti-tumor immune response to mediate tumor rejection Therefore using iPSC+CpG vaccine that could inhibit tumor relapse.
Procedure:

a. Seeing how the PBS will affect the mouse
b. Injecting the iPSC(undifferentiated)+CpG beforehand to see if it can help to suppress the cancer.
c. Modeled the cancer tumor for a few weeks.
d. Created experiments to test where the tumor and the cancer cells would proliferate in an efficient and accurate manner.

Changes: Having constructive plans and designing the project with a more hard based timeline, would have provided me with more accurate results.
Results: I found that when co plating the cancer cells and the fibroblasts, I was able to increase the efficiency and the proliferation rate of both cell line. The morphology of both cells changed as well.