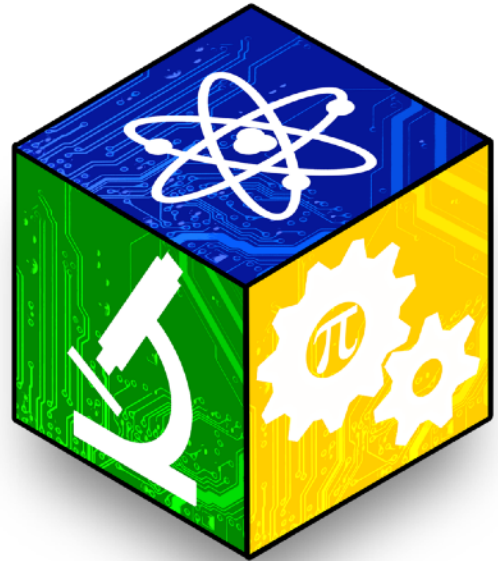


CONNECTICUT
SCIENCE &
ENGINEERING
— FAIR —



76th Annual Fair
March 4-16, 2024

Student Abstracts

Fair Categories

	Life Sciences	Physical Sciences
7th & 8th Grade	LT (1001 – 1999)	PT (4001 – 4999)
7th Grade	L7 (2001 – 2499)	P7 (5001 – 5499)
8th Grade	L8 (2501 – 2999)	P8 (5501 – 5999)
High School	LS (3001 – 3499)	PS (6001 – 6499)
High School Team	LST (3501 – 3999)	PST (6501 – 6999)

Technical Disciplines

AT = Applied Technology	EE = Engineering: Electrical & Mechanical
AS = Animal Science	ET = Energy &
BE = Behavioral & Social	EV = Environmental
BI = Biochemistry	EM = Environmental
CB = Cellular & Molecular	MA = Mathematical Sciences
CBIO = Computational Biology & Bioinformatics	ME = Medicine & Health Sciences
CH = Chemistry	MI = Microbiology
CS = Computer Science	PH = Physics & Astronomy
EA = Earth Science	PS = Plant Science
EN = Engineering: Materials & Bioengineering	

Technical Discipline Composites

Biotechnology	AS, BI, CB, EN, ME, MI, PS
Environmental	EV, EM
Engineering	EN, EE
Sustainability	EA, EN, EE, ET, EV, EM

CSEF Official Abstract and Certification

Word Count

251

2024

Fair Category

LS

Project
Number

3001

Title: The Effect of Red Light and Aloe Ferox Concentrations on Planarian
Regeneration in the Presence of Fresh Spring Water

Student Name(s): N. Bhuiyan

Abstract:

Planarian worms are known for their regenerative ability. By analyzing planarian worms, scientists can learn how to restore human tissue and cells. For example, generating insulin-producing cells for patients with diabetes. This project consists of studying the growth of planarian worms under different treatment groups to discover which treatment has the fastest regeneration rate. The worms are cut in half and put into one of five treatment groups. There is the control, red light, red light with 2% Aloe ferox, Aloe ferox 2%, and 5%. Red light and Aloe ferox are known for their healing properties. They quicken restoration by implementing regeneration practices such as repairing wounds to help prevent metabolic-related diseases or neurodegenerative diseases. While Aloe barbadensis miller harms planarian worms, a different variant of Aloe could potentially benefit the worms. Through research, it was discovered the red light treatment had the fastest regeneration rate, allowing the planarian to grow bigger after amputation. The Aloe ferox treatment groups harmed the planarians and caused them to disintegrate or stop growing. When comparing the control group to red light, there was a higher regeneration rate for red light. However, when analyzed using an ANOVA, these differences were determined to be not statistically significant. By discovering red light as the most effective method with the fastest regeneration rate, planarians can rapidly generate more neoblasts and regenerate amputated body parts or cells in shorter amounts of time. These regenerative practices can be implemented so humans can regrow cells in a short duration.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AS ME CB

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

229

2024

Fair Category

LS

Project
Number

3002

Title: Delivery of Vitamins through the Intraoral Cavity with Toothpaste Using Penetration Enhancers

Student Name(s): M. Choi

Abstract:

Dental health is rarely deemed a significant factor for a healthy life despite its considerable impact on the human body. Many presume that regular dental check-ups and daily toothbrushing are sufficient to prevent oral health diseases, but consuming certain nutrients is also required to fully attain a healthy oral cavity. Nutrients that are necessary for preserving dental health, namely calcium, phosphorus, fluorine, and various vitamins, contribute to the development, maintenance, and repair of oral tissues. Nevertheless, it can be challenging to be conscious of taking such nutrients on a daily basis. In this study, aiming to abolish such inconveniences, vitamins essential for dental health were combined in a toothpaste formulation with penetration enhancers (PEs) to achieve intraoral delivery of the vitamins while toothbrushing. Multiple tests were performed to evaluate the characteristics of the intraoral vitamin-delivery toothpaste (IOVT), such as abrasiveness and antibacterial strength tests. The same tests were also conducted on three different commercial toothpaste formulations to draw comparisons with the IOVT. Thus, to verify the IOVT's penetration capability, a mass transport study, and a transepithelial electric resistance (TEER) value test were conducted using nightcrawlers' skin. The data collected demonstrated congruency between multiple characteristics of the IOVT and those of the commercial toothpaste formulations. The TEER value test result demonstrated the high plausibility of effective intraoral delivery of vitamins, assisted by PEs, as components of the IOVT.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME CB CH

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- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

264

2024

Fair Category

LS

Project Number

3003

Title: Iron-Fortified Corn Husk Biochar Flocculation of Pond Water Phosphates, to Reduce Invasive Macrophyte Plant Growth.

Student Name(s): N. Pendkar

Abstract:

Aquatic invasive plant species from abroad threaten ecosystems by inducing adaptation, causing a lack of natural predators, and harm to native species. 71% of invasive plants in CT are macrophytes, which float on the surface layer, and require essential nutrients like phosphorus, for overall plant health. Biochar, a highly porous, high-carbon structure produced by the pyrolysis of feedstocks, effectively absorbs nutrients like phosphorus. In this research, corn husks, which are an abundant waste product, were fortified with iron, and then turned into biochar, to create a highly-absorbent material for pond-phosphorus removal, via flocculation. To begin, corn husks were pulverized, mixed with FeCl_3 , and pyrolyzed at 400°C . SEM, EDS, and ATR-FTIR analyses highlight the successful integration of iron into the biochar. The phosphate absorbency for the iron-fortified corn-husk biochar (Fe-CH-Biochar) was evaluated via flocculation, both in deionized and simulated pond waters. For the deionized water study, 0.25g of Fe-CH-Biochar was placed in 10ml of 0.016ppm phosphates (an excessive concentration for pond water) for removal of the contaminant via flocculation. The upper, clear filtrate was sampled hourly for 1-5 hours, and each time, the phosphates were measured calorimetrically at 690nm absorbance. Similar experiments were carried for simulated pond water, with initial (extreme) phosphate concentrations of 1.5, 2.5, 5, and 10 ppm, each over a 24-hour flocculation period. Results highlight 67.4% reduction in phosphates for d-water, and 42.1% for simulated pondwater. Combined, these results underscore the efficacy of Fe-CH-Biochar in phosphate absorption in pond water, for eventual remediation of surface, invasive plants.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM PS CB

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- Yes No

CSEF Official Abstract and Certification

Word Count

273

2024

Fair Category

LS

Project Number

3004

Title: Therapeutic Potential of Antibody Drug Conjugates Targeting The Expression of Trophoblast Cell-Surface Antigen 2 (TROP-2) On High Grade Serous Epithelial Ovarian Carcinoma

Student Name(s): A. Davis

Abstract:

Ovarian carcinoma is the fifth leading cause of cancer related deaths among women. Epithelial ovarian cancer's (EOC) most common histologic subtype being high grade serous ovarian carcinoma (HGSOC). Glycoprotein Trophoblast Antigen 2 (TROP-2), a cell surface receptor promoting the invasion, metastasis, and proliferation of tumor cells, has been identified in multiple tumor types including EOC. Utilizing antibody drug conjugates (ADC) to target EOC with TROP-2 expression, it was hypothesized that Specialized-ADC: will inhibit growth and induce apoptosis in HGSOC with TROP-2 expression in EOC tumor cells. HGSOC cell lines: OVA-14 and KR(CH)31, were treated with the Specialized-ADCs or Control-ADCs (IgG lacking the cytotoxic payload). Flow cytometry was conducted on stained HGSOC cells (PI). KR(CH)31 (positive expression for Trop-2 (3+)) showed 100% of cells to be non-viable whereas OVA-14 (negative expression for TROP-2 (0)) had 5% of cells non-viable. During in-vitro testing, mice were injected with KR(CH)31 and randomized into experimental groups (n=5) to be given an oral treatment (Vehicle, Control-ADC, Bystander, or Specialized-ADC) once tumor volume reached 0.2cm³. Over 50 days, their tumor volume and life span were recorded twice weekly. The control group's tumor volumes increased (approximately 1.25cm³) and died between day 17-25 of the experiment. The Specialized-ADC group experienced slight tumor volume reduction by day 10 but stayed consistent at 0.2cm³ with all the mice having survived the duration of the experiment. Further experimentation of the Specialized-ADC on HGSOC is being conducted using an Celltiter Glo ATP Assay to confirm the validity of the ADC raw data.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME CB CBIO

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- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LS

Project
Number

3005

Title: Predicting DNA Methylation Using Translocation Times

Student Name(s): A. Mehta

Abstract:

DNA methylation greatly impacts the central nervous system, as it plays a key role in learning and memory. However, research in this field is difficult to conduct, and locating methylated DNA could potentially make it easier (Moore et al. 2013). We believe that methylated DNA can be predicted using Oxford Nanopore Technology (ONT). These nanopores offer an inexpensive, efficient platform that records both signal data and translocation times of passing 6-mers (Wanunu, 2012). Since the structure of methylated DNA is stiffer than normal DNA, we predict that their translocation times should predictably increase, thus allowing us to construct a machine learning algorithm to predict methylation status. To do so, I used pre-processed data from the telomere-to-telomere human genome sequence. Then, I manipulated the data into an x and y list, where each sample of the x_list was a window of translocation times before and after the k-mer being predicted and each sample of the y_list was the methylation status of that k-mer. Despite trying numerous models, including one class SVM, KNearestNeighbors, and Isolation Forest, I was unable to accurately predict methylation with any of these models, leading me to assume one of two conclusions: that DNA methylation is not related to translocation time or my models were poorly built. To investigate, I will reconstruct the x_list to include both negative strand translocation times and methylation status of samples in the window in hopes of constructing a more accurate model.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

CBIO CS

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2. Student independently performed all procedures as outlined in this abstract. Yes No

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LS

Project Number

3006

Title: Spatial Learning and Memory: Finding and Investigating Place Cells in the Hippocampus

Student Name(s): Y. Wang

Abstract:

The hippocampus, nestled in the temporal lobe, is crucial for learning and memory. While conventional hippocampal research focuses on information retention, the Nobel Prize-winning discovery by John O'Keefe and Jonathan Dostrovsky unveiled place cells – neurons firing during navigation through specific environmental points – opening new frontiers for spatial memory.

Contrary to previous labs that track place cells in mice's hippocampi as they navigate open spaces, this lab uses mazes to replicate the mice's natural habitat to explore the learning of more complex environments. Mice, prepared with virus injections and lens implantation, run the same maze, initially learning it and then starting from different locations or running it backward in the following week. Post-process, hippocampus sampling validates the recorded data.

The two mice under observation were able to provide data from place cell tracking. Most significantly, a scatter plot that arranges all the cells recorded in one session in the order of neuron discharge strength and position. Results demonstrated the similarity in cell firing patterns when the mice were told to run the maze in different starting points and the mice's ability to recognize the same environment in reverse. Both mice also needed much less time to familiarize themselves with the maze starting at different locations or in reverse compared to the time it took to learn the maze in the first place, demonstrating familiarity with the maze. These results point to the conclusion that the hippocampus learns the complex environment by mapping it out using place cells.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BE

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

240

2024

Fair Category

LS

Project Number

3007

Title: Methylphenidate Treatment of Parkinson's Disease in Drosophila Melanogaster

Student Name(s): L. Glynn

Abstract:

Parkinson's disease (PD) is a common neurodegenerative disease, and estimates suggest that 1.2 million Americans will be living with the disease by 2030. The most common medications for the treatment of Parkinson's disease, such as levodopa, dopaminergic agonists, and MAO-B inhibitors, all work to either artificially synthesize, imitate, or maintain intracerebral concentrations of dopamine. None of these medications address norepinephrine loss or the related neurodegeneration, as they are understood to be linked to prefrontal norepinephrine and serotonin loss but not a prefrontal dopamine deficiency. Just as dopamine is required for coordinated motor function, norepinephrine is critical for executive function.

In this study, immediate-release methylphenidate was administered orally through the food medium, on the surface of which it will be dissolved, to three experimental groups of otherwise healthy male *Drosophila melanogaster* expressing the G51D SNCA gene. Flies from each group were assessed in the areas of motor speed and function with a climbing assay and an open-field arena test, and executive function was assessed with the optomotor maze.

Drosophila melanogaster expressing G51D-strain mutant SNCA treated with methylphenidate were expected to demonstrate improved motor and executive function over affected and unmedicated flies due to the correction of the neurotransmitter deficiencies that are causative of PD signs and symptoms. If this study finds methylphenidate to improve locomotive ability or executive function in *Drosophila melanogaster*, it may be a viable option for the treatment of Parkinson's disease in human patients.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME BE AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

271

2024

Fair Category

LS

Project Number

3009

Title: Rapid Detection of Stress Biomarker Cortisol via a Molecularly Imprinted Polypyrrole Sensor

Student Name(s): R. Wadhwa

Abstract:

Within 2023, 77% of individuals reported experiencing physical health issues due to stress. Unfortunately, current detection methods for elevated stress are bulky, and require skillful instruments. For these sophisticated tests, cortisol, a common biomarker of stress, is detected. As such, there remains a need for an effective, simple, non-invasive, at-home biosensor for cortisol, so that stress is better managed. This is the goal of the research presented herein. First, a molecularly imprinted polymer (MIP), loaded with cortisol, was fabricated, using ammonium persulfate, pyrrole, and cortisol, while a non-imprinted polymer (NIP) was similarly fabricated, without cortisol, for a comparative control. For the MIP, cortisol was removed, creating cavities for eventual cortisol acceptance and detection, when installed in a biosensor. Ultrasonication instigated ~98% cortisol-loss and cavity creation, which was verified via scanning electron microscopy, ATR-FTIR spectroscopy, and HPLC analysis. Reload of cortisol into receptive cavities of the MIP was carried out using 5mg/ml cortisol solution, which was monitored via HPLC. Analysis of cortisol loss in the MIP-loading solution revealed ~99% of reload of cortisol into the MIP-cavities, based on calculated MIP-cavity capacity. To validate the cortisol-free MIP's electrochemical changes based on cortisol acceptance, MIP current response was measured as a function of purposeful loads of 5 -40ng/ml cortisol, and found to be linear. Re-measure of these same solutions for normal (5 -30ng/ml) and elevated (+30ng/ml) cortisol via MIP-current response, predicted the stress-marker concentration within ~4% error. The developed MIP-based electroanalytical sensor was found to be effective, cost-friendly, and rapid-response, for futuristic point-of-care diagnostic applications.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN ME AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

243

2024

Fair Category

LS

Project Number

3011

Title: Using an AI algorithm to minimize the number of punctures attempted during blood draw or IV insertion.

Student Name(s): N. Makin

Abstract:

Vein detection and puncture accuracy are critical in medical procedures such as blood draws and intravenous (IV) insertions. Still, their accuracy can be diminished based on specific characteristics or genes someone has, such as obesity or skin color. With proper technique and an artificial intelligence model, the current limitations can be reduced significantly, creating a safer and less painful experience for the patient. This algorithm would require two main features: detecting the veins through an image and finding the best vein, including the best puncture point. The veins will be detected by having an app with a near-infrared LED attachment scan the arm, which will print out a full image of the entire arm. Its location and size are the two most important features to decide which vein is best. Using a basic algorithm that detects the straightest vein by putting tangential lines to the average slope of the veins, it can pinpoint those specific veins. The best spot to insert the needle is almost always the deepest portion of the vein where it is widest, so the algorithm will also mark those locations. The algorithm will generally focus on finding the three best veins for puncturing: the cubital vein, the cephalic vein, and finally, if necessary, the basilic vein. This will require significant training data, but images like that are readily available. This algorithm can improve patient outcomes by decreasing vein puncture risks and streamlining clinical workflows in various healthcare settings.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

CS EE CBIO

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

177

2024

Fair Category

LS

Project
Number

3012

Title: Hepatic Stellate Cells In Liver Regeneration

Student Name(s): K. Brissette

Abstract:

Hepatic stellate cells, once described as Kupffer cells, are generally quiescent or inactive within the healthy liver. Once activated through injury stimuli, stellate cells transform from fibroblasts into myofibroblasts. Stellate cells' main role is in remodeling the cellular matrix and producing scar tissue through the synthesis of collagen and lamin. Thus allowing stellate cells to contribute to the maintenance of homeostasis within the liver also makes them a large proponent in fibrosis. The fibrotic liver then becomes carcinogenic and is progressively linked to various cancers and tumors, such as hepatocellular carcinoma. Additionally, stellate cells have the ability to stimulate the migration and transformation of nearby hepatocytes through the chemical secretion of chemokines. Gene expression analysis through UMAP (Uniform Manifold Approximation and Projection), a program similar to t-sne processing, could prove useful in identifying patterns of proliferation and production of proteins. UMAP is especially useful in reducing the dimensionality of data while having more simple parameters and operations. Patterns of proliferation capabilities would prove insightful in the aim of better understanding the delicate nature of stellate cells.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME CBIO CB

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

LS

Project
Number

3013

Title: Role of Protein Expression in Diatom Chain Formation

Student Name(s): C. Wagner

Abstract:

Studies have reported the importance and applications of diatom chain formation in phytoplankton such as a decreased death rate and increased photosynthesis; however, the protein responsible for this environmental response is unknown. Diatoms form chains as a reaction to the acidification and turbulence of the ocean because the chains support the cell walls as they weaken from the acidity and their motility increases with length in rough waters. The purpose of this study is to identify the protein responsible for chain formation by triggering protein expression through turbulence and determining concentration through western blot analysis. In this experiment, FAS-1 domain, Cyclin-activating kinase, and PCNA proteins in diatoms will be tested to see the response after being exposed to turbulence through western blot assays. Five groups were exposed to speeds ranging from 50 to 250 rpm at 18°C for 120 minutes and chain length was averaged through random samples without the control group which was not exposed to turbulence but was tested. The goal is to isolate the protein that causes sister cells in the mitosis to not separate and will be successful when the protein concentration increases when exposed to turbulence as compared to the control group. So far, progress has been made in the lysis protocol as difficulties emerged detecting total protein concentration prior to the western blot. Changes were made to lysis protocol such as agitation time and lysis buffer used. If successful, this research will introduce the production of predisposed diatoms to help fight climate change.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CB EN BI

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

238

2024

Fair Category

LS

Project
Number

3015

Title: Non-Thermal Induction of Heat Shock Protein 90 to Mitigate Early Oncogenesis With Preserved HSR

Student Name(s): C. Atkins

Abstract:

It has been proven in previous mouse models that malignant tumor transformation only occurs when heat shock proteins (Hsps) are expressed. Heat shock proteins are only expressed during stress to protect the organism's proteins from denaturing. Common human stressors include fever, diseases, severe injuries and even cancer. Therefore inhibiting Hsps is a promising future cancer therapy, but this therapy would compromise the body's ability to manage denatured proteins in a stressed environment. This experiment aims to induce Hsp90 independently of Hsp70, as Hsp70 accounts for half of all Hsps and is thought to be only thermally activated. By activating non thermal Hsps other than Hsp70, total Hsps would be reduced. Therefore a cancer patient for instance will have some Hsps in place to maintain proteostasis if stress occurs such as a fever, while also limiting the amount of Hsps to reduce the chance of malignant transformation. To determine if a non-thermal stressor would only activate Hsps other than Hsp70, non-thermal UVB and UVC bombardment was used to stimulate Hsps 90 in *Saccharomyces cerevisiae*. Cell counts were taken pre and post UVB and UVC stress with a spectrophotometer to indicate if Hsps were being activated. Preliminary data suggests that UVB stress had little to no effect on yeast cell counts, and UVC stress produced exponential cell growth. Protein electrophoresis was performed to determine Hsps expression. Electrophoresis produced data consistent with Hsp90 with 30 minutes of UVC stress.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BI

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

190

2024

Fair Category

LS

Project Number

3016

Title: Antidepressant-response biomarkers in adolescents: a confirmational study using EEG

Student Name(s): S. Hochman

Abstract:

This study takes previously studied antidepressant-response biomarkers found in adults and examines whether they can be found in adolescents with high self-reported antidepressant-response rates. The two biomarkers are increased theta wave activity in the rostral anterior cingulate cortex and the medial orbitofrontal cortex. Using a 14-channel EEG, I studied high schoolers who filled out a self-reported questionnaire on their perceived response rates to antidepressants based on symptom remission; this was ranked numerically 1-10. The study groups consisted of those who self-reported as 7 or higher (responders), those who self-reported as 3 or lower (non-responders), and a control for adolescents who have never taken antidepressants. EEGLAB was used to run an ICA decomposition and Brainstorm was used for source localization. It is predicted that adolescents, given the ongoing development of their brains, will not exhibit the same biomarkers as adults. By confirming this, researchers can move on to the study of new biomarkers. Given the difficulty in finding biomarkers, studies focused on adolescents are extremely important, as they pave the way for improved treatment procedures for a population with a rising unmet need.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME AT BE

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

266

2024

Fair Category

LS

Project Number

3017

Title: Hydroxyapatite Encapsulation of Avobenzone: Reductions in Transdermal Diffusion and in Photosensitized Degradation of Octyl Methoxycinnamate

Student Name(s): S. Vash

Abstract:

Ozone layer degradation and global warming have led to ~4% increase in sunscreen usage. Two chemical sunscreens, avobenzone (AVO) and octyl methoxycinnamate (OMC) protect against UVA (Ultraviolet-A, 320-400 nm) and UVB (Ultraviolet-B, 280-320 nm). AVO causes toxicological effects such as endocrine disruption after topical application, resulting in transdermal diffusion into blood. Encapsulating AVO in hydroxyapatite (HA) reduces transdermal diffusion. Additionally, OMC photodegrades in the presence of UVA photosensitizer AVO. This degradation results in the need for sunscreen reapplication, consequently increasing diffusion and endocrine disruption. The purpose of this research was to combine HA, AVO, and OMC (HA-AVO:OMC) to immobilize AVO and reduce OMC photodegradation due to UVA-activated AVO. The hypothesis was, if HA encapsulated AVO and OMC are combined, then the HA encapsulation should reduce the transfer of radiant energy to OMC, thus minimizing OMC photodegradation due to AVO. Encapsulation of AVO may reduce OMC photolysis by eliminating direct contact between chemicals. HA-AVO:OMC, OMC alone, and OMC-AVO suspensions were treated with 0-10 minute UVA radiation. OMC absorbance at 310 nm was determined after each exposure and the data was normalized through A_t/A_0 (absorbance at 't' minutes/0 minutes absorbance). Our data shows that OMC-AVO and OMC alone degraded to ~70% of their initial absorbance following irradiation. HA-AVO:OMC did not extensively degrade, remaining within ~85% of the original value. Results indicate HA encapsulation minimizes AVO-induced OMC degradation. By incorporating HA-AVO:OMC into a commercial sunscreen, a safe and effective product capable of UVA and UVB protection with minimal endocrine disruption may be achievable.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

CH ME BI

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

221

2024

Fair Category

LS

Project
Number

3019

Title: Investigating If There Is a Correlation Between Maternal Age At Time Of Pregnancy Loss And The Number Of Trophoblast Inclusions In The Placenta

Student Name(s): C. Stannard

Abstract:

Approximately 23 million miscarriages occur each year worldwide, equating to 44 pregnancy losses every minute. Rates of miscarriage and stillbirths increase with maternal age but often the cause of pregnancy loss is unexplained. Trophoblast inclusions (TIs) are microscopic morphological abnormalities of the placenta due to atypical in-folding of the trophoblast bilayer into the villous core and have been identified in pregnancies with adverse birth outcomes. The purpose of this project was to investigate if increased maternal age impacts the number of TIs found in the placentas of lost pregnancies. It was hypothesized that increasing maternal age corresponds to a greater number of TIs, thus contributing to pregnancy loss. The independent variable was maternal age. The dependent variable was the number of TIs. Data from the Yale University School of Medicine Reproductive and Placental Research Unit was obtained. The student worked with Dr. Harvey Kliman to sort and analyze data from 1,256 cases of pregnancy losses from 922 patients that demonstrated 878 (69.6%) miscarriages and 378 (30.4%) stillbirths. A regression analysis was performed yielding a weak positive correlation between maternal age and number of TIs. The hypothesis can be refuted because there is not likely an age dependent correlation to number of TIs. This data demonstrates that pregnancy losses are due to random genetic problems that may occur at any age.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ME

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

280

2024

Fair Category

LS

Project Number

3020

Title: Oral Delivery of Anticoagulant Dabigatran via a Mg-Micromotor Encapsulant Within a Gastric-

Student Name(s): L. Wang

Abstract:

In this research, a novel, targeted, therapeutic oral delivery system has been designed as a blood-thinning treatment to prevent ischemic stroke, caused by blood clots. Dabigatran (Db), is an anticoagulant medication that inhibits free and fibrin-bound thrombin, however the drug is not able to withstand gastric fluids, and effectively reach the small intestine for absorption. To provide stable and effective delivery of Dabigatran past the stomach acids, Db was uniquely encapsulated on magnesium micromotors, with SiO₂, PLGA, and chitosan layers, producing 30µm Db-PLGA-SiO₂-Mg microparticles. Dissolution studies demonstrate timely release of Db from the microparticles, into the intestinal fluid within 5 minutes. Next, 1mg of these microparticles were incorporated into 80%-starch/20%-baking soda to create a 10mg Db-minitablet (DMT). In a simulated in-vitro experiment within gastric fluid, the Db blood-thinning treatment was successfully delivered to the intestine after withstanding stomach gastric fluid for 1-2 hours. Once in the small intestine, the DMT dissolved, releasing Db-PLGA-SiO₂-Mg microparticles for self-propulsion towards the intestinal walls, for Db absorption. To support the functionality of the encapsulated Db delivery, experiments were designed to measure the blood thinning capability of Db-PLGA-SiO₂-Mg microparticles, versus untreated and free-Db. While untreated-blood coagulated in 5 minutes, blood treated with free-Db coagulated in 11.4 minutes. Finally, analogous-dose Db-PLGA-SiO₂-Mg microparticle-treated blood coagulated in 19.0 minutes, likely due to the microparticle's unique dissolution properties. Collectively, the results of this work highlight the stable delivery of Db-PLGA-SiO₂-Mg microparticles through the stomach gastric fluids, where it then self-propels through the small intestine, where it is quickly absorbed.

**Technical Disciplines Selected by the Student
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ME EN AT

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- Yes No

CSEF Official Abstract and Certification

Word Count

209

2024

Fair Category

LS

Project
Number

3021

Title: The impact of Increasing concentration of one time use Cornstarch based bags on the average height in centimeters of Phaseolus Vulgaris

Student Name(s): P. Dwyer

Abstract:

'Poop bags' are used by many pet owners to clean up after their pets.

If these 'bio based' polyethylene and cornstarch based bags have a negative impact on plant growth and health, this could be a problem that needs to be addressed. If this is true, Phaseolus vulgaris grown in soil containing increasing amounts of polyethylene-based bag material should differ in their height in centimeters compared to control plants grown in the absence of bag material. Different concentrations of cut up squares(2%, 5% and 7%) of the 32% cornstarch based and 68% PE(polyethylene) bags were mixed into soil to create control, low concentration, medium concentration and high concentration.

Throughout the experiment, the height of the plants, Phaseolus Vulgaris, was recorded. Other aspects such as the plant health, ability to grow and other factors were not used for a final decision, but for further discussion. These results will show the impact of littering through 'poop' bags. Many people are fine with leaving a bag on the side of the road. Knowing what the effect of leaving a bag behind is important. When doing this experiment, it became clear that the plants were growing virtually the same. However there were different observable factors talked about during the discussion.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

PS PS

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

227

2024

Fair Category

LS

Project Number

3023

Title: Utilizing Bacillus Subtilis for the Accelerated Biodegradation of Polyethylene Terephthalate

Student Name(s): S. Elkins

Abstract:

On average, society produces 350 million metric tons of plastic waste per year. It destroys habitats, both aquatic and terrestrial, and although it breaks up into smaller pieces over hundreds of years, it never truly disappears. For my project, I wanted to test the presence of the bacteria Bacillus Subtilis on the biodegradation of plastic. My hope was that, when the bacteria was present, a square of Polyethylene Terephthalate would be broken down, and therefore experience a greater weight loss over a 30 day period. I tested this by placing a 1x1 cm piece of Polyethylene Terephthalate into a centrifuge tube with Luria-Bertani (LB) broth and Bacillus Subtilis live culture. I placed these tubes in an incubator set to 37 degrees celsius. Every 5 days I would remove the tubes, extract the squares, soak them in water, dry them, then weigh and record the masses. After 30 days, I calculated the overall weight loss as a percentage (recorded below). When beginning this experiment, I hypothesized that the experimental pieces would experience, on average, a 6% weight loss. After completing the experiment, I determined that the average weight loss was actually about half this, at 3.88%. In conclusion, my hypothesis was, in part, supported by this experiment. While I was off with my hypothesized weight loss, there still was accelerated biodegradation in the presence of Bacillus Subtilis.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BI EM

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

251

2024

Fair Category

LS

Project Number

3025

Title: Sonic Repulsion of Purple Sea Urchins to Reduce Degradation of Nascent Nereocystis Luetkeana Forests

Student Name(s): O. Benison

Abstract:

The explosion of sea urchin populations, particularly in the Pacific Ocean, has destroyed valuable kelp fields. These fields harbor a greater variety and higher diversity of plants and animals than almost any other ocean community, and provide food, shelter, and protection for all kinds of marine life. Prior research has highlighted the effects of ultrasonic noise in elevating stress markers in urchins, but has not investigated the behavioral impacts of these ultrasonic disturbances. Hypothesizing that urchins, being sentient, would move away from a source of stress (i.e., ultrasonic pulses), experiments were designed and executed to establish if behavioral impact could be observed. An ultrasonic processor running at 20kHz was employed to test the urchin response. Various tip amplitudes were applied to a tank with purple sea urchins. All tested amplitudes yielded measurable urchin movement away from the stimulus, with direct relation of movement and 20kHz strength. Using a 15-amplitude cycle, which was effective at causing urchin movement without excessive power or environmental disturbances, various types of fish were exposed to the ultrasonic emissions to explore any unintended consequences of applying the 20kHz stimulus. Both freshwater and saltwater fish were indifferent to the sounds, with no negative impact. Similar findings were seen for kelp blade structures, which were undisturbed by the same 5 cycles of 20kHz stimulus. Combined results of sea urchin movement away from 20kHz stimulus, together with no negative impact on the neighboring organisms, suggest that ultrasonic stimulus is a viable option to protect kelp fields from urchin populations.

**Technical Disciplines Selected by the Student
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EM EE AS

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- Yes No

CSEF Official Abstract and Certification

Word Count

196

2024

Fair Category

LS

Project Number

3026

Title: Robust Repellants vs. Pesky Pill Bugs

Student Name(s): J. Ouellette

Abstract:

This experiment was designed to test whether a natural oil or a compound repellent works more effectively on repelling pill bugs. To start, I set up 2 pieces of filter paper in a choice chamber. I then placed 6 drops of neem oil on a piece of filter paper and set it opposite to a piece of filter paper with 6 drops of the compound repellent on it. After this was complete, I placed 10 pill bugs in the center of the choice chamber. I closed the lid and started a 20 minute stopwatch. I took photos and recorded the number of pill bugs on each side of the choice chamber every 30 seconds. At the completion of 20 minutes, I gathered my data and documented my findings. The purpose of this experiment was to see which repellent would be longer lasting and more effective. From my findings, the compound repellent functioned better for a shorter period of time, and the neem oil was more effective over a longer period of time. Though they are both effective at repelling, the pure structure of the neem oil outlasts the multiple types of oils in the commercial repellent.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

MI EV EM

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

235

2024

Fair Category

LS

Project Number

3027

Title: Using an Experimental Algorithm to Detect Stress in Homarus americanus in Aquaculture

Student Name(s): E. Cunningham

Abstract:

The North American lobster industry is significant to the overall agricultural economy and the farming families and communities. Lobsters have been successfully grown in aquaculture settings although it is a challenging task, and growing lobsters is a risky time and financial investment for each individual because it takes years for a lobster to reach a harvestable size. Because of these factors, it's critical to promote efficiency in lobster aquaculture and more ethical treatment of farmed lobsters. Managing stress levels in lobsters is important ethically and also because increased stress has been shown to reduce the growth rates of lobsters. Ethical treatment promotes larger lobsters that produce higher revenue for aquaculture farms. This project uses open-source machine-learning tools to create a model for identifying behavioral patterns that indicate increased stress in Homarus americanus. Stressors are introduced to the lobsters and videos of the lobsters are recorded and then analyzed to create movement pattern models using the open-source tools, DeepLabCut and SimBA. The algorithms will pick up on specific movements that indicate stress, and the animals' stress will be quantified using a cortisol ELISA since more cortisol in hemolymph has been shown to indicate higher stress. The use of such a behavioral model, if shown to accurately indicate increased stress, would allow farmers to detect stress more easily, efficiently, and ethically in lobsters and could be further investigated for use on other farmed species.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AT BE AS

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

240

2024

Fair Category

LS

Project Number

3028

Title: Determining How the size of holes within rubber mesh

effect the ability of Emerald Ash Borer Beetles to penetrate Ash Trees Bark.

Student Name(s): S. Knauff

Abstract:

The *Agrilus planipennis fairmaire* (EAB) is an invasive species that endangers multiple species of North American Ash trees. In order to prevent EAB from harming the population of North American Ash, the idea of putting a mesh over the bark of ash trees was finalized. The mesh would prevent the EAB from penetrating the bark and therefore prevent them from eating the tissue of the tree, along with this a comparison between the most effective mold size was introduced. A mold for this mesh was created using CAD and a 3d printer. The 1st molds had a 1/8x1/8 inch box size while the other had a 1/16x1/16 inch box size, both molds were 1/2 inch deep and 2.5 inches wide. After this, both molds were filled with flex seal. After the flex seal hardened the meshes were removed and duct taped onto two separate 2.5 x 2.5 inch areas of an ash tree. Another area was created and was used as the control. Data was taken over a period of 6 days of how many new beetle entry holes were made in each area. The data was analyzed using ANOVA, where it came back with a P value of 1.00. Showing there was no difference between any of the areas. During the period of observation no damage occurred to any area, this means that for the study to be given a clear conclusion a longer term study is needed.

**Technical Disciplines Selected by the Student
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EM EV EN

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5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

LS

Project Number

3029

Title: Effects of Tidal Choking from Culverts on Tidal Marsh Biodiversity
and Soil Respiration

Student Name(s): J. Zapanta

Abstract:

As climate change threatens the stability of ecosystems globally, understanding how to protect ecosystems is increasingly important. Many salt marshes have roads built through them, which often rely on bridge culverts, structures built to allow water to flow under the bridges, to cross the water sections of the marshes. Narrow culverts can restrict a salt marsh's influx of salt water from the ocean. This restriction is known as tidal choking and can harm a marsh's health.

This study analyzes a local salt marsh's health. This marsh has two culverts about 850 feet apart and drains into the Long Island Sound. The marsh was split into three different zones. Zone one: the control zone, the area between the Long Island Sound and the closest bridge culvert, where no culverts restrict saltwater influx. Zone two: the section of marsh between the first and second culverts. Zone three: the section of marsh upstream of the second culvert. In each zone, biodiversity transects, water salinity samples, and soil samples were taken to gather information about the marsh's health. Soil samples were measured for their carbon dioxide production. Then their roots were isolated and their carbon dioxide production was measured. A furnace was used to combust the carbon in the soil samples to determine the total carbon stored.

Analysis is ongoing, but preliminary results indicate soil respiration increases as culverts are present, despite minimal change in salinity. This study will yield useful data for planning future marsh construction projects to have minimal ecological impacts.

**Technical Disciplines Selected by the Student
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EV EM EA

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

243

2024

Fair Category

LS

Project
Number

3031

Title: Predicting drug repurposing capabilities, utilizing off-target effects, through chemoinformatics and bioinformatics-based machine learning models

Student Name(s): A. Choi

Abstract:

In this study, a multi-omics approach was utilized to advance drug repurposing efforts through the prediction of mechanisms of action (MoAs) of small-molecule perturbagens. Transcriptomics data, sourced from the LINCS L1000 database, and molecular structures of small molecules were integrated to form a comprehensive dataset. The transcriptomics data were standardized, normalized, and reduced to 978 landmark genes, while the molecular structures were processed into 2048-dimensional molecular fingerprints. Both datasets were encoded into 256-dimensional latent vectors using deep neural network (DNN) based encoders, alongside the calculation and encoding of molecular descriptors into 256-bit vectors. The resulting feature vectors, concatenated from the transcriptomics and chemoinformatics data, were labeled with the MoAs of the perturbagens, utilizing data from the Drug Repurposing Hub. These labels were pre-processed—clustered to reduce the number of classes—leveraging domain knowledge from literature reviews and GPT-based large language models (LLMs). To address class imbalances, synthetic oversampling of minority classes was performed. The feature vectors were then subjected to training using DNN classification models, designed to predict the probability distribution of each MoA, which uncovers unintended biological pathways activated by small-molecule perturbagens, illuminating secondary interactions indicative of off-target effects. Validation of the model was conducted using an unseen test set, demonstrating consistent accuracy greater than 0.85, thereby evidencing the model's robust predictive capability. This study presents examples of the model's application in drug repurposing efforts, highlighting its potential to significantly impact future research.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO ME CS

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LS

Project
Number

3034

Title: Investigating the Concentration of Glucose in Fruits Before and After Adding Invertase to Determine the Optimal Fruit for Consumption for a Diabetic Patient with Hypoglycemia

Student Name(s): T. Adeniran

Abstract:

Fruits are one of the healthiest food groups, but they still contain sugar. This can be an issue for individuals with diabetes who have to monitor the amount of glucose they are consuming. This project aims to find which fruit has the highest glucose concentration after the enzyme invertase has been added to determine fruits that should be avoided by individuals with diabetes with the exception of a person who is undergoing hypoglycemia. It was hypothesized that an apple would have the highest glucose concentration after adding invertase. During experimentation, a solution containing 10% sucrose was created and a glucose test strip was used to test the amount of glucose in the solution. 15 drops of invertase were added to the solution and it was tested for glucose concentration every 5 minutes until 30 minutes had passed and was subsequently tested every 10 minutes until 90 minutes had passed. It was discovered that at 15 minutes the enzyme was still working at a fairly constant rate. 10 grams of each fruit (apple, strawberry, blueberry, raspberry, banana, orange) was then measured and mixed with 10 mL of water. Each solution was tested initially and subsequently after 15 minutes. It was found that blueberries had the highest initial glucose concentration, while apples and raspberries were tied for the highest glucose concentration after 15 minutes. In conclusion, the data found partially supports the hypothesis. Apples and raspberries should be avoided by individuals with diabetes unless there is a case of hypoglycemia.

**Technical Disciplines Selected by the Student
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ME BI CH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

242

2024

Fair Category

LS

Project
Number

3035

Title: A Novel Machine Learning Model for Estorus Cycle Classification

Student Name(s): S. Goyal

Abstract:

The estrous cycle modulates the timing of reproductive events and hormonal changes in female mammals, playing an essential role in further understanding the role of neuromodulators in mice. Like the menstrual cycle, the estrous cycle comprises four stages influenced by fluctuating hormone levels. Vaginal cytology, which classifies the four-stage estrous cycle based on three types of epithelial cell concentrations, is the most common tracking method. However, vaginal cytology has limitations as it demands significant time and training. To address these challenges, integrating object detection machine learning provides a promising approach to efficiently determine the estrous stage. Object detection has proven to reduce the time and effort required for identification, decrease variability, and standardize outcomes in similar applications. This study implemented an object detection-based machine learning model by Ultralytics, YOLOv8, to identify different cell types present during various stages of the estrous cycle in mice. The images of diversely prepared samples were annotated using Makesense.ai, an online labeling tool. The dataset comprising 416 vaginal cytology images was obtained from multiple labs, out of which 333 were used for training, 43 for validation, and 40 for testing. The YOLOv8 model attained an accuracy of 93% in identifying each estrous cycle stage. Adopting supervised machine learning for estrous cycle monitoring significantly improved the accuracy and the time required for estrous cycle stage classification with sufficient generalization, outperforming unsupervised models and human accuracy, thereby demonstrating potential advancements in research practices for studies in females.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO CS

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- Yes No

CSEF Official Abstract and Certification

Word Count

237

2024

Fair Category

LS

Project Number

3036

Title: Effects of Vitamin D supplementation on Muscle Function in *C. elegans* with a Mutation in the Dystrophin Gene

Student Name(s): N. Francis

Abstract:

Duchenne muscular dystrophy (DMD), is a genetic disorder affecting 1:3,500 male births, characterized by progressive muscle weakness and wasting (Clinic, 2022). DMD stems from a mutation in the dystrophin gene, a protein involved in muscle cell structure (Duan, 2021). Studies have demonstrated beneficial effects of vitamin D supplementation in improving muscle function in elderly individuals and other muscle atrophy conditions (Zhu, 2020; Veldhuizen, 2020). A positive correlation between vitamin D supplementation and muscle strength was shown in children and DMD mice (Bruce, 2021; Debruin, 2019). To investigate the potential benefits of vitamin D supplementation in DMD, DMD *C. elegans* expressing mutated dystrophin gene were studied (gift: Dr. Nathaniel Szewczyk). DMD *C. elegans* were exposed to varying concentrations of vitamin D3 (0.0001mM-1mM) from 1M solution in ethanol (Schweck, 2023). Locomotive behavior was assessed daily via 30-second thrashing rates (T/30 sec). After 2 days of vitamin D treatment, 5-10 worms were randomly picked daily from supplemented agar plates. Higher concentrations (0.01 mM, 0.1mM and 1mM) of vitamin D showed a significantly increased thrashing rate (34t/30sec, 33t/30 sec, and 42t/30sec, respectively) compared to very low (0.0001 mM) vitamin D concentrations (25t/30sec)($p < 0.05$, one-sided T-test) over multiple days. Increased thrashing rate suggests vitamin D improves muscle function in a *C. elegans* model expressing mutated dystrophin. Additional studies on its effects on muscle calcium levels, longevity, and reactive oxygen species are warranted.

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ME AS ME

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

LS

Project
Number

3037

Title: Assessing the Public's Willingness to Accept Cancer Vaccines

Student Name(s): M. Scanlon

Abstract:

In the U.S. alone, each year more than 64,000 people will be diagnosed with pancreatic cancer, and about 50,550 people will die from this disease. The Pancreas is concealed behind multiple abdominal organs, resulting in difficulty for scanning methods - for instance, computerized tomography scans - to diagnose Pancreatic Cancer. Additionally, awareness of this disease is low; for example, 74% of the UK does not know a single symptom of this form of cancer. Provided with these challenges, it is clear that a proactive approach - such as vaccination - is needed to prevent Pancreatic Cancer. Furthermore, with the advancements in the vaccination field provided by the mRNA-based COVID-19 vaccine developments, the scientific community has a new tool to induce immune responses. One challenge with vaccines is that there has been an increase in hesitancy due to misinformation propagated through social media. Thus, before embarking on creating a ground-breaking pancreatic cancer vaccine, through the creation of a survey I aimed to gauge the public's interest and determine whether those hesitant towards vaccines could be convinced to accept an mRNA-based cancer vaccine. Furthermore, I aspired to determine if hesitancy towards vaccines is regionally based in the U.S. and abroad. It was discovered that the public's awareness about vaccines was relatively high. Additionally, although there was no significant change in the public's openness to vaccinations in a majority of the U.S., in the South there was a decrease in Pancreatic cancer vaccination hesitancy, after providing the participants with statistics on vaccinations.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BE

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

259

2024

Fair Category

LS

Project Number

3040

Title: Optimizing Bone Regeneration: A Novel Atsttrin-Releasing Injectable Hydrogel for Enhanced Osteogenesis in Diabetic Fracture-Derived Bone Defects

Student Name(s): H. Chaudhry

Abstract:

Diabetic bone fractures often progress into permanent non-healing defects due to highly increased inflammation and osteoclastic bone destruction, which significantly limit the body's natural regenerative capacity. This research developed an injectable CS/GO/HEC/ β -GP hydrogel for the localized delivery of Atsttrin to enhance diabetic fracture repair. Atsttrin, an engineered protein, has anti-inflammatory and bone/osteo-regenerative properties by inhibiting TNF α inflammation while stimulating TNFR2-mediated bone regeneration. It was hypothesized that an Atsttrin-releasing hydrogel would effectively promote endochondral bone regeneration in vitro by inhibiting inflammatory signaling while stimulating osteoblast recruitment and stem cell differentiation. Hydrogel property characterization verified an optimal 10 μ g GO hydrogel formulation, with controlled 102% swelling and 8-week degradation along with >90% gradual Atsttrin elution over 2 months, matching the bone healing timeline. Cell differentiation assays confirmed Atsttrin's osteo-regenerative properties with 10-fold greater cartilage matrix generation, 4 times greater expression of cartilage growth genes like SOX-9, 40% higher bone mineralization density, and 8-fold greater expression of anti-inflammatory and osteogenesis-promoting genes like Col-1 and ALP. Overall, this study establishes a promising platform using Atsttrin-loaded hydrogels to enhance diabetic bone repair; it demonstrates a customizable approach that pairs therapeutic compounds like Atsttrin with biomaterial carriers tailored for controlled, localized delivery. The study serves as an in vitro proof-of-concept for translation to in vivo models assessing the platform's clinical viability in living organisms. Finally, this research progresses promising ongoing work harnessing our body's intrinsic regenerative powers to offset serious disease-imposed barriers to healing.

Technical Disciplines Selected by the Student
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CSEF Official Abstract and Certification

Word Count

159

2024

Fair Category

LS

Project Number

3043

Title: Energy Yield Potential of Tree of Heaven (*Ailanthus altissima*) Plants in Various Stages of Growth using a Plant Microbial Fuel Cell

Student Name(s): D. Dembele, D. Dembele, D. Dembele

Abstract:

This study evaluates the energy yield potential of the invasive Tree of Heaven (*Ailanthus altissima*) at various growth stages using a Plant Microbial Fuel Cell (PMFC). Recognized for its rapid proliferation in North American ecosystems, this species contributes significantly to biomass through its unutilized organic excretions in the rhizosphere, which are metabolized by microorganisms to release electrons. The PMFC setup involved planting *Ailanthus altissima* in containers equipped with an anode and cathode to facilitate electron flow from microbial reactions at the root level to generate electricity. This bio-electrochemical process aims to harness the tree's invasive growth traits for energy production, addressing the dual challenges of managing its spread and contributing to sustainable energy solutions. Preliminary results suggest the viability of this method for low-energy applications, potentially offering a novel approach to both invasive species control and renewable energy generation in the context of rising global energy demands and the search for sustainable alternatives to non-renewable resources.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

PS EN MI

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LS

Project
Number

3044

Title: Gender-Related Differences in a Murine PCSK9 and HFD Model of Atherosclerosis

Student Name(s): L. Shah

Abstract:

Cardiovascular diseases are the leading cause of death worldwide, taking an estimated 17.9 million lives annually. Although these stats are frightening, there are several predictors and known risk factors to aid in identifying diagnosis early on. One such cardiovascular condition, atherosclerosis, is the buildup of fats, cholesterol, and other substances in and on the artery walls called plaque. There are several factors that can induce atherosclerosis including high cholesterol and triglyceride levels, and gender, which also affects the intensity of atherosclerosis. It is hypothesized that males are more prone to developing atherosclerosis, especially at an early age. In addition to susceptibility, gender also affects the characteristics of the plaques, cholesterol levels, and body weight. To test this, male and female C57BC/6 mice were sacrificed and the heart tissues were isolated, sectioned, stained, and imaged at the aortic root to assess the plaque buildup. A total cholesterol and triglyceride assay was performed to assess the makeup of the plaque. The results show the male mice had a stronger onset of atherosclerosis in terms of lesion area, cholesterol, and triglyceride levels. The purpose of this work is not to explain why there is a difference between the sexes, but to highlight that there is a difference in plaque characteristics between the sexes. With this new knowledge on the gender differences in atherosclerosis, we can begin to develop personalized therapies that can be applied to either males or females, and can be safely and effectively used in the entire population.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

LS

Project Number

3045

Title: An IoT-based Elderly Fall Detection System, Integrated with a Mobile App for End-to-End Emergency Alert Communication

Student Name(s): A. Zhao

Abstract:

Among an estimated 56.4 million people aged 65 and older living in the United States, 21.8% of them lived alone. Furthermore, with 50 billion dollars spent on hospital fees, how

the elderly get immediate help right after falling is a key issue. Therefore, fall detection and emergency alerts to elderly family members and caregivers are critical to senior's life quality. This research project aims to design and develop an IoT-based Elderly Fall Detection System, integrated with a mobile app for emergency alert communication. The IoT-based fall detection hardware system includes a Raspberry Pi Pico W, supporting Bluetooth, an MPU6050 motion sensor, and an OLED SSD1306 for displaying testing results. The MPU6050's 3-axis accelerometer and 3-axis gyroscope sensor data and functionality are extensively studied with sensor calibration procedures to improve sensor accuracy. After researching, I concluded that free fall height is the key factor for fall detection. Accordingly, I designed a drop height-based fall detection algorithm implemented by Python codes and validated the effectiveness by attaching the IoT testbed to my waist. Next, by using the MIT App Inventor software, I developed a fall detection mobile app. After implementing the BLE central role via MIT AI2 in the mobile app, and the BLE peripheral via Python in the Pico W, I validated that Pico W can send the fall height data to the mobile app via the BLE UART data communication. Further, I developed SMS and Email functionalities in the app for emergency alerts in this project.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

CS AT

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- Yes No

CSEF Official Abstract and Certification

Word Count

226

2024

Fair Category

LS

Project Number

3047

Title: Measuring the Correlation between Air Quality and Respiratory Diseases

Student Name(s): J. Sorbello

Abstract:

This study investigates the potential association between air quality and the prevalence of respiratory diseases in four US states: Maine, Connecticut, Pennsylvania, and Colorado. To answer this question, data was collected on Air quality and Disease prevalence from 2000 -2020. For air quality, data from the Particulate Matter 2.5 (PM 2.5) scale and the Ozone (O₃) scale were collected and for respiratory diseases, prevalence of Asthma and Chronic Obstructive Pulmonary Disease (COPD) was collected. Data was analyzed using spreadsheets, graphs, and an R² value to identify trends and to see if a correlation exists between the air quality levels and respiratory disease prevalence. It was originally hypothesized that as air quality levels were at higher values (higher PM2.5 and O₃ concentration) there would be a higher prevalence of Asthma and COPD than when the air quality levels were lower. Data analysis did not reveal a strong correlation between air quality and disease prevalence across the selected states of study. The average R² value for the relationship between the PM 2.5 values and the COPD/Asthma prevalence values was 0.329. For O₃, the average R² for the relationship was a very similar 0.315. This represents a very low correlation between the two variables which shows that there may not be as high of a correlation between higher PM 2.5/ O₃ values and Asthma/COPD than was originally hypothesized.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME

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- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LS

Project
Number

3048

Title: The Prevalence of Gluten Contamination in Supposedly Gluten-Free Food

Student Name(s): T. Cline

Abstract:

Celiac disease, which causes the immune systems of sufferers to attack dietary gluten (Panda & Garber, 2019), affects one out of every 141 people in the United States. Individuals with Celiac disease face severe gastrointestinal issues caused by the inflammation of the small intestine (Caio et al, 2019). Celiac can also lead to more serious conditions, such as non-Hodgkin's lymphoma (Osorio, Mejías, & Rustgi, 2019). Since no treatments besides eliminating gluten ease the symptoms of Celiac sufferers, the identification and labeling of gluten-free foods is paramount for those affected by the condition (Gessendorfer, Koehler, & Wieser, 2009). Unfortunately, contamination of gluten can happen at every phase of food preparation and production, leading to the presence of gluten in foods meant to be gluten free (Thompson, Lee, & Grace, 2010). If "gluten-free" foods from restaurants, bakeries and grocery stores, I hypothesized that foods ordered from restaurants would have the highest rate of contamination due to the presence of gluten in the great majority of restaurant kitchens. We tested a large variety of meals, pastries, snacks, and ingredients, all of which was advertised as gluten free. We tested foods from various sources with a GlutenTox Pro testing kit and found that 56% of samples from restaurant foods claiming to be gluten-free contained gluten, whereas no store-bought foods or foods from bakeries tested contained gluten. Our results suggest that the rate of contamination of food prepared at restaurants is high enough that Celiac sufferers risk experiencing symptoms every time they eat out.

Technical Disciplines Selected by the Student
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ME

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

260

2024

Fair Category

LS

Project Number

3050

Title: Implementation and Evaluation of Feature-Extraction-Based Logistic Regression Analysis for Accessible and Computationally Efficient Cervical Cancer Diagnosis

Student Name(s): E. Joseph

Abstract:

Current cervical cancer detection methods, whether traditional or AI-based, face challenges in accessibility and accuracy. Conventional techniques, such as the pap-smear examination, require substantial laboratory infrastructure and physician assessment to visually identify cancerous lesions in samples, thus limiting their feasibility in economically disadvantaged regions. Prior research regarding the implementation of machine learning for biopsy classification has predominantly utilized deep convolutional neural networks (CNNs), machine learning models that directly process digital images of biopsy samples. Despite their performant nature, such systems are computationally intensive and lack transparency due to their underlying complexity and “black-box” nature, constraining their practical deployment. This research project aims to address these challenges by developing an accessible, transparent, and computationally inexpensive machine-learning-based system for detecting and classifying cervical cancer from biopsy samples. To achieve this, an approach departing from deep learning techniques was devised, driving the development of an algorithm utilizing the OpenCV computer vision library to isolate cells within a biopsy sample and extract relevant cellular features. Subsequently, a logistic regression model optimized to be smaller, less complex, and significantly less resource-intensive than prevalent CNNs was trained on the extracted data. A traditional CNN was also implemented via the VGG-16 pre-trained architecture and trained directly upon biopsy images to establish a baseline for comparison. Evaluation of both models revealed the novel logistic-regression-based model outperformed the prevalent CNN in overall accuracy, training speed, and computational efficiency. Furthermore, testing to assess the applicability of the logistic regression model on inexpensive, low-resource, and accessible computational systems proved viable.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME CS CBIO

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- Yes No

CSEF Official Abstract and Certification

Word Count

260

2024

Fair Category

LS

Project
Number

3051

Title: Influence of Two Mycelium Strain and Growth-Medium Combinations on the Chemical Composition and Morphology of Bio-Scaffolds and its Implications

Student Name(s): E. Krasnoff

Abstract:

Currently, most cases of organ failure or severe injury are treated with organ transplants. However, considering both the lack of available donors and occurrences of organ injury and transplant failure, there is a need for alternative solutions. Tissue engineering attempts a better solution. There are two main types of tissue engineering: seeding a scaffold with human cells or implanting healthy cells into failing tissue. This study explores the newly expanding method of creating scaffolds using biomaterials, analyzing the growth of a unique mycelium strain-growth medium combination.

Mycelium, the vegetative root of fungi, is emerging as a promising alternative to synthetic materials. Mycelium, which is composed of well-organized interconnected fibers, has been shown to be a cost-effective, all-natural bio-scaffold whose properties are tunable based on the strain-substrate combination. Recent research suggests that the entire fibrous structure can be used as a bioscaffold after only inactivation with an autoclave.

This study uses the one-step process of inactivation with autoclave. The viability of combinations of *Lentinula edodes* and *Pholiota nameko* cultured in either Potato Dextrose Broth (PDB) or d-glucose enriched PDB was assessed by determining their morphologies and chemical compositions. The majority of these strain-medium combinations demonstrated a porosity range with the potential to facilitate cell migration, adhesion, and ECM production, and the spectra revealed similarities between these samples and other strains of mycelium. Given the tunable properties of mycelium and the cheap cost of growth, mycelium has the potential to become the next go-to material for creating bio scaffolds for tissue engineering.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LS

Project Number

3052

Title: Determining the Ability of Different Mosses and Plants to Remove Algae-Causing Phosphates and Nitrates From Water

Student Name(s): E. Cannon

Abstract:

When phosphates and nitrates enter bodies of water, algae blooms form, covering the surface and diminishing water quality by hindering sunlight for underwater plants. In addition, when the algae die, the oxygen in the water is consumed, making it extremely difficult for aquatic life to survive. This study assessed mosses and plants' ability to mitigate these pollutants due to their leaf and root structures. A fertilizer solution containing phosphates and nitrates was added to water and the initial levels of these nutrients were recorded, then a sample was set aside to be used as a control. Five mosses in triplicate were then exposed to the polluted water and the water was tested for the pollutants over periods of time. It was expected that the *Polytrichum commune* would remove a significant amount of the pollutants from the water. After testing, it was found to be successful, but the moss that performed best was the Fruiting Moss. Plants were also introduced in a separate trial. Five different species were tested the same as the moss. It was hypothesized that the plants would be able to use their roots to absorb the pollutants, similar to the moss's ability to absorb through their leaves. King's Choice Ivy was the most effective. This experiment implies that mosses, and possibly plants, can be used along the shoreline to remove the algae-causing pollutants before they enter the water. Water will become safer to swim in, and will become environmentally stable for the habitats of marine life.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

PS EV EA

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

163

2024

Fair Category

LS

Project
Number

3054

Title: Optimizing Laterite Soil Microbial Fuel Cells for Community-Centric Electricity Generation in Tropical Underdeveloped Regions

Student Name(s): N. Edwards

Abstract:

In tropical developing regions like Sub-Saharan Africa and India, where access to electricity is a critical challenge for nearly half the population, a breakthrough emerges from the red laterite soil abundant in these areas. Rich in iron and resilient to fierce climates, this soil presents a unique opportunity for sustainable energy production.

The study explores the potential of using this resource in Microbial Fuel Cells (MFCs). Through experimental setups, synthetic laterite soil composed of various concentrations of clay soil, iron filings, aluminum sulfate, and water, higher iron concentrations exhibited increased voltage outputs in the MFCs. This discovery underscores the value of iron as a crucial component for any soil in MFC applications.

Iron-rich laterite soil MFCs can also bolster agricultural productivity, offering a potential solution to combat world hunger. The significance of addressing energy poverty in these regions cannot be overstated. By harnessing the affordability and accessibility of red laterite soil, a sustainable pathway to meet this pressing need is provided.

**Technical Disciplines Selected by the Student
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EV ET BI

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

266

2024

Fair Category

LS

Project Number

3055

Title: Development and In Vitro Verification of a Polymersome for Blood-Brain Barrier Transport Through a Novel Machine Learning Model

Student Name(s): A. Malkin

Abstract:

Across neurological drug development, researchers struggle with the high selectivity of the blood-brain barrier (BBB), where most drugs are unable to pass from the blood into the brain. As such, drug-treatment of Alzheimer's, Parkinson's, brain cancer, and strokes remains difficult. Recent research identified polymersomes (polymer-based vesicular shells) as an avenue for transport of otherwise non-BBB-permeable drugs across the BBB. However, the number of discovered BBB-traversing polymersomes remains low, and they are not able to carry all drugs. Recently, machine learning has emerged as a powerful tool in medicine. This research developed a machine learning model to identify likely polymer candidates for polymersomic drug-delivery across the BBB. The model was programmed in Python using TensorFlow and trained on 7,807 molecules from the B3DB-database. It achieved 93% accuracy and identified 13 encapsulation candidates. The top candidate for BBB permeability, ammonio methacrylate (AM), had never been considered for BBB permeability before. To validate the model, a polymersomic nanoparticle (AM-DOX) was developed by encapsulating doxorubicin (DOX, an anti-tumor drug) with AM, for eventual passage across an in-vitro BBB model (parallel artificial membrane permeability assay). 500 μ M-DOX and 500 μ M-AM-DOX were separately introduced to the BBB model for 24 hours at 37 $^{\circ}$ C. While DOX was predictably unable to penetrate the BBB, the AM-DOX nanoparticle successfully passed, producing an equilibrium 250 μ M concentration surrounding the barrier. This was validated via UV-Vis and ATR-FTIR spectroscopies, providing compelling evidence for a new, effective BBB-encapsulation polymer, identified via machine learning, to deliver treatments for a wide array of neurological disorders.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO ME EN

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

214

2024

Fair Category

LS

Project
Number

3058

Title: Determining How Different Factors Correlate To Amount Of Sleep

Student Name(s): N. Spellman

Abstract:

The goal of this research project is to determine the different factors that correlate to poor sleep quality and patterns with the use of the information gathered from several high school participants and various article and website sources. A short sleep survey consisting of 14 questions related to a person's sleep habits was conducted to find out how much caffeine and sugary drinks they drink, how much they exercise, use of technology, work hours, etc. Before sending out the survey, participants were required to sign a consent form prior to filling the survey out. Once all forms were turned in, the factors were then compared to the average amount of sleep each participant gets a night to find the correlation between the different factors. The survey was sent out to mainly high school students as that was the target audience. All the data collected from the survey showed no significant difference comparing the amount of sleep to the different factors chosen. These results show that there is no real huge impact that these factors have on a person's amount of sleep. Although there was no real significant difference comparing the different factors, if there were more participants of different ages there could have been a larger or more noticeable difference in the data collected.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BE ME AT

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

233

2024

Fair Category

LS

Project Number

3059

Title: A Novel AI-Driven Approach for Identifying Invasive Plant Species

Student Name(s): S. Natarajan

Abstract:

The 2023 Connecticut Invasive Plant Working Group (CIPWG) report highlighted efforts against invasive plants, with 5,345 volunteers and 4,670 online participants dedicating over 30,765 hours (CIPWG 2023). To enhance these efforts, CNN models (ResNet50, Inception V2, No Foundation Sequential, VGG16, VGG19) (Keras Library) and the GPT Vision 4 Model were tested using photos of Connecticut's 10 most prevalent invasive species from Invasive.org and iNaturalist. It was hypothesized that a pre-trained model could identify invasive plants with at least 75% accuracy. The independent variables were the machine learning model type, data augmentation, dataset size, and image source. The dependent variables included plant identification accuracy and validation loss. Two datasets were prepared: a small set of 350 images and a larger 10,000-image dataset from iNaturalist, split 80% for training and 20% for validation. The GPT Vision 4 Model outperformed the VGG19 model, achieving 55.8% accuracy, despite VGG19's validation accuracy improvement with data augmentation. However, Autumn Olive was classified as Japanese Knotweed 100% of the time. The model's highest accuracies were for Multiflora Rose (86%), Garlic Mustard (85%), and Common Reed (81%). Challenges arose from data augmentation issues and the GPT Vision 4 Model's training limitations due to its inability to utilize data augmentation, impacting its generalization. This shows the potential of new machine-learning models in environmental conservation in identifying specific plants but the limitations it has in identifying invasive plants overall.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM CBIO AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

235

2024

Fair Category

LS

Project Number

3060

Title: Determining Trail Making Test B Accuracy in Predicting Driving Preparedness in Pre-Driving Age Adolescents

Student Name(s): M. Mejnartowicz

Abstract:

Adolescent new drivers have the highest crash rates in the United States, largely due to underdeveloped cognitive and executive functioning skills. Adolescents' under-developed attention-switching(AS) and scanning skills make learning how to drive challenging. The purpose of this project was to determine Trail Making Test B (TMT-B) accuracy in predicting driver preparedness in pre-driving-age adolescents. It was hypothesized that the TMT-B would be an accurate predictor of adolescent driving preparedness. Participants reviewed a hazard list, completed one focused simulator (FS) and one distracted simulator (DS) on an online driving test website, and completed the TMT-B. Changes in simulator scores were calculated by subtracting DS accuracy scores from FS accuracy scores. An R2-test was used to determine the correlation between change in simulator scores and TMT-B speed and accuracy scores. The data shows a non-significant correlation ($R^2= 0.150$), and the hypothesis is not supported. AS skills only correlate with 11% of decreases in hazard identification accuracy when distracted, meaning that people with low TMTB scores were not more likely to have lower scores on the DS than people with high TMTB scores. The data does not support the hypothesis of the TMT-B as an accurate predictor of adolescent driving preparedness. This study demonstrates the need for tests that accurately measure adolescent AS skills to aid them in the crucial decision of when to begin driving.

**Technical Disciplines Selected by the Student
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BE

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

216

2024

Fair Category

LS

Project Number

3061

Title: The Effect of Deforestation at Sleeping Giant Park on Soil Erosion

Student Name(s): K. Fiore

Abstract:

Soil erosion has affected the lives of ecosystems and organisms all around the world. In this experiment it was tested if soil erosion was happening at Sleeping Giant State Park, an humongous ecosystem which was victim to a tornado in 2018. This tornado was specifically interesting because it knocked many trees down and removed their roots creating major deforestation, which is a main cause of soil erosion. To test if soil erosion was occurring Water Works Nitrogen Testing Strips were used on soil near downed trees throughout the park. This was done to see how much nitrate and nitrite were in the soil because a testable indicator for soil erosion is nitrogen levels that tell if the soil is fertile or not. Through analyzing the results of these strips it was found that nitrogen levels were far below the sufficient amount for soil of 10 ppm(parts per million). Although on wet days the nitrate levels were apparent at every spot and were higher, this is most likely due to the excess nitrogen in surface water from the rain that was added to the soil. After analyzing results from the nitrate and nitrite strips, it was concluded that soil erosion was evident at every location throughout the park because of deforestation and the uprooting of trees.

Technical Disciplines Selected by the Student
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EA PS EV

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

199

2024

Fair Category

LS

Project Number

3063

Title: Clean the waters

Student Name(s): E. Gebretinsae

Abstract:

After learning about the phytoremediation technique (a process of decontaminating soil or water by using plants and trees to absorb pollutants) last year, I started to wonder which plants can absorb which metals or contaminants in water? Which is what my project is on. After some research, I made a hypothesis that Duckweed would absorb more types of metals at higher quantities than the other plants that I will be testing. For my experiment, I tested water plants such as Duckweed, Water Spangles, and Red Root Floater. I put each plant in small containers in a solution of Lead, Iron, and Nickel. I tested the concentration of those metals every 3 days for a period of 9 days using a 16 in 1 Drinking Water Test Strips. It turned out that Water Spangles was able to absorb the most amount of Lead and Iron in a shorter amount of time than the rest of the plants. And Duckweed was able absorb the most amount of Nickel in a short amount of time than the other plants. So, unlike my hypothesis, Water Spangles was actually the plant that absorbed more types of metals at higher quantities than the other plants.

Technical Disciplines Selected by the Student
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EV PS

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

257

2024

Fair Category

LS

Project Number

3064

Title: The Effect of Exogenously Added Diacetyl on Long-term Thermotolerance of Thermally Acclimated *Breviolum minutum*

Student Name(s): K. Cheng

Abstract:

Insufficient algal thermotolerance is a primary initiator for coral bleaching (Douglas2003). Heat acclimation treatments have stimulated short-term thermotolerance of the coral-symbiont system, but not long-term (Gibbin2018). Administering heat treatments during inhibited algal growth from exogenous diacetyl may epigenetically modify algae to long-term heat tolerance by downregulating gibberellin through the DELLA pathway (Achard2009, Colebrook2014, Wu2022). No published data have demonstrated diacetyl's effect on coral symbionts such as *Breviolum minutum*. Exogenous diacetyl at concentrations of 0.3 μ M, 1 μ M, 3 μ M, 10 μ M, and 30 μ M was supplemented in 10mL L1 media with 2x10⁵cells/mL for three days. Daily cell counts showed 7.13% and 22.5% increase for 3 μ M and 10 μ M diacetyl, respectively, compared to 75% increase for control, demonstrating delayed growth. Subsequently, *B. minutum* treated in duplicate \pm 3 μ M or 10 μ M diacetyl was exposed to heat treatment at 29°C for 11 days, followed by recovery treatment at 25°C for 2 days (Gibbin2018). All samples then underwent lethal temperature simulation at 34°C for 2 days (Gibbin2018). Under lethal conditions, preliminary data suggest 10 μ M diacetyl-treated algae were more thermotolerant as shown with +87.2% increase compared to 0.301% change for the no diacetyl group. This is the first time a coral symbiont has been treated with diacetyl to slow growth. Preliminary data suggest this increases thermotolerance, possibly indicating phenotypic plasticity (Scoville&Pfrender2010). Future studies will better quantify long-term phenotypic plasticity and evaluate biochemical mediators like reactive oxygen species in this new model system. This could lead to increased long-term algal and thus coral-symbiont thermotolerance and survivability.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

PS EM

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

240

2024

Fair Category

LS

Project
Number

3065

Title: The Influence of Natural and Man-Made Substrata on Intertidal Community Structure

Student Name(s): N. Raman

Abstract:

Human expansion, construction, and water pollution necessitate the protection of coastal ecosystems, vital for maintaining biodiversity. Several species, both sessile and motile, depend on rocky surfaces and man-made jetties for habitat. This study examines the impact of artificial substrata on Connecticut's coastline, assessing changes in benthic communities due to human activities. Utilizing the transect sampling method and a 10 by 10 inch PVC quadrat, I systematically sampled numerous rocky structures across six coastal sites while capturing photographs of the quadrats and their contents. With the data collected, I started an analysis with a two-factor ANOVA on the number of species and the percentage of algae. These two factors did not produce significant differences between the sites since they yielded p-values greater than 0.05. Then, I continued my analysis with the same two factors but against two different sites varying in wave exposure by using the Student's T-test. The analysis produced a p-value of 0.021, falling below the threshold of 0.05. Thus, this test presented a significant difference in favor of the natural substratum with an average mean increase of 0.48. While the abundance of most algae species remained similar, the analysis showed a higher average number of species in the natural substratum. These findings prove that, in comparison to man-made substratum, natural substratum bolsters intertidal community structure. In the future, I hope to expand my study to more coasts and various non-natural substrata.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EV AS PS

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

251

2024

Fair Category

LS

Project Number

3066

Title: Proteomic Analysis of Autism-Associated Human ASPM Protein

Student Name(s): P. Vijaykumar

Abstract:

Autism spectrum disorder (ASD) affects 1 in every 36 children in the U.S. Children with ASD show abnormal social interaction and repetitive behaviors. The neurodevelopmental gene human assembly factor for spindle microtubules (ASPM) is involved in embryonic neurogenesis. Recently, it was shown that single amino acid change mutations in ASPM gene cause enlarged brains in some ASD patients but the molecular mechanisms are unknown. To identify proteins that interact with wild-type human ASPM protein, I am using a proteomics approach in human immortalized embryonic kidney (HEK293T) cells. To accomplish this, I attempted to clone ASPM gene along with its intron one tagged with enhanced green fluorescent protein (EGFP) under the control of a EF1 α promoter which overexpresses ASPM protein. My attempts to clone ASPM gene using HiFi and Gateway cloning methods were unsuccessful because intron one was getting deleted. I was able to successfully clone ASPM gene into a plasmid vector using restriction digestion and ligation method, combine into an expression vector, transfect into HEK293T cells and purify total protein. ASPM interacting proteins were immunoprecipitated using GFP-trapped magnetic agarose beads and analyzed by protein gel electrophoresis. Observation of multiple protein bands in ASPM overexpression cell line compared to wild-type cell line indicates successful cloning and immunoprecipitation. ASPM interacting proteins will be identified by mass spectrometry technique. Completion of this project will enable us to understand how mutations in ASPM gene alter brain development in ASD patients and potentially will help us to develop tests and therapies for ASD.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CB BI ME

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

254

2024

Fair Category

LS

Project Number

3067

Title: Developing a Numerical and Image based Neural Network to Analyze and Determine the Effectiveness of the Genes that Initiate Thymic Involution.

Student Name(s): S. Desiraju, N. N/A, N. N/A

Abstract:

Thymic Involution is when the Thymus, an immune organ deteriorates in size leading to the decrease in effectiveness of production of T-cells and other immune cells to fight off foreign diseases and viruses. My goal is to identify the genes which cause this natural deterioration and then identify the most effective gene. To do this, I created two neural networks, one numeric-based and the other, image-based. Using many of the different attributes and functions of the machine learning libraries Keras, Tensorflow, Matplotlib, Pandas, and NumPy to aid the code throughout the process. Using these libraries significantly improved my code and simply made the writing process easier. I used Google Colab for the Image-Based Neural Network and for the Numeric Neural Network. When I was done with the code, my image neural network was at 100% accuracy and my numerical neural network was at 0% accuracy. I found 1 common gene which was CDE 3. So, this shows that one gene has a great effect towards involution of the Thymus. While it isn't nearly accurate, such research can truly revolutionize the medical field and scientists' work and help push for the goal of immortality. What's so amazing about this project is that it can be applied to animals as well with the right data. However, do get that data, scientists must focus more on this as the data collection was my biggest struggle throughout this project. Hence, this is the base and body of my project and what it truly accomplishes.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO CB ME

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

179

2024

Fair Category

LS

Project
Number

3069

Title: Shoots vs. Roots: The Effect of Hormone Treated Media on Lettuce Growth

Student Name(s): N. Rosen

Abstract:

With a growing population, access to agricultural products is under more threat than ever. There are several methods that humans can utilize during the plant growth process to increase growth in both plant shoots and roots. Through extensive research, it was determined that hormones like auxin promote faster and longer shoot growth while cytokinin promotes root growth. In this experiment auxin and cytokinin, hormones that plants naturally produce were used in different concentrations to elicit different reactions during the growing process. After germination, growth was monitored and used to determine what substance produced the plants with the most relative fitness. While there were some minor inconsistencies during the course of the two trials, it was determined that reduced auxin had the most consistent shoot and root growth, with plants reaching an average total height of 6.1 cm over 17 days. Further research should be done on a larger scale, with more careful control over outside sources of error. This data could then be extrapolated to determine how this can be utilized on a greater scale in the agricultural sector.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

PS EA BI

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

254

2024

Fair Category

LS

Project Number

3070

Title: Determining The Effect of ASD-Associated Gene GBX2 Deficiency on Thalamic Differentiation in Human Organoid Models

Student Name(s): Y. Lee

Abstract:

Dysfunction of the thalamus –a forebrain region that relays sensory information– is associated with a common neurodevelopmental disorder known as Autism Spectrum Disorder (ASD). The gene gastrulation brain homeobox 2 (GBX2), is associated with ASD as it is crucial for the early formation of the thalamus. The purpose of this study was to examine the potential cause of ASD during thalamic differentiation using gene alteration in human organoid models. It was hypothesized that if GBX2 is knocked down (K/D) in human brain organoids, then thalamus development will be suppressed and abnormally differentiated because GBX2 is essential for thalamus formation. The independent variable was the deficiency of ASD-associated gene GBX2, while the dependent variable was thalamic differentiation measured by size, protein, and mRNA levels of the thalamus, telencephalon, diencephalon, habenula, and neuronal markers. The positive control was the brain organoid grown with doxycycline, while the negative control was grown without doxycycline. Using lentivirus and CRISPR interference, a K/D of GBX2 was created. The brain organoids were grown for 42 days with doxycycline from day 2. Immunohistochemistry and RT-qPCR were performed to analyze protein and mRNA levels of forebrain markers. The student performed BSL-1 experiments while the mentor conducted BSL-2 experiments. The results show that a deficiency of GBX2 may cause ASD during neurodevelopment due to suppressed thalamic growth and abnormal differentiation ($p < 0.001$). This study identifies a new genetic factor of ASD by demonstrating GBX2's crucial roles in human brain development and its impacts on Autism Spectrum Disorder.

Technical Disciplines Selected by the Student
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CB BI MI

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

275

2024

Fair Category

LS

Project Number

3071

Title: Fabrication of a Europium-based Magnetic Nanosensor for the Detection of D-serine in Early-onset Alzheimer's

Student Name(s): A. Jackson

Abstract:

Nearly 6.7 million Americans age 65+ are currently affected by Alzheimer's disease (AD). Preliminary diagnosis of AD is a difficult and time-consuming process that often leads to false results, however accurate testing is painful and invasive. Both drug/non-drug interventions are exponentially more effective for patients diagnosed in the early stages of AD, as these treatments can slow the decline of memory and other cognitive skills. An effective, sensitive, and rapid diagnostic for early-AD is imperative, to provide the most meaningful therapeutic result. Recent literature by Piubell has outlined D-serine as a biomarker for Alzheimer's, as D-serine levels are positively correlated with disease progression. Additionally, D-serine is detected in the blood serum, making it less invasive than current methods. Thus, a europium-based nanosensor for rapid detection of D-serine in serum was created as the focus of this research. A magnetic, luminescent sensor was fabricated, based first on the synthesis of Fe₃O₄, which was encapsulated with CePO₄, Tb, and EDTA-Eu ligands, to produce a multicolor nanoprobe exhibiting, 480nm, 536nm, 582nm, and 610nm luminescence, using 260nm excitation. This nanoprobe is responsive to the addition of dipicolinic acid (DPA), and subsequently D-serine, where red luminescence wavelengths are enhanced, producing a green-to-red color change. With fixed addition of 30μM-DPA to the Fe₃O₄-CePO₄-Tb-EDTA-Eu nanoprobe, the color-response of the resulting Fe₃O₄-CePO₄-Tb-EDTA-Eu-DPA nanoprobe was linear with D-serine concentrations added, producing an ideal visual sensor for the early onset AD. Work is ongoing to transfer the nanoprobe to a paper sensor, to create a point-of-care, early-AD diagnostic.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ME EN AT

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

261

2024

Fair Category

LS

Project Number

3073

Title: How Do Phloem-Feeding Herbivores Suppress the Parasitism of Caterpillars on Quercus alba?

Student Name(s): A. Hilary

Abstract:

When phloem-feeding insects and caterpillars are both present on Quercus Alba, parasitism of caterpillars is completely suppressed. Phloem-feeder presence is hypothesized to mute plant volatile cues that are normally induced by caterpillars and also used by parasitoids to find their caterpillar hosts. To test this hypothesis, we measured the number of caterpillar-parasitizing tachinids from the experimental branches. Using insects collected from our treatment groups (phloem-feeders removed/replaced), we prepared them for DNA barcoding. A pipette was used to squirt 100% ethanol into each well. Then, a leg from 39 specimens was removed and placed into these wells, which were sent to the Canadian Center for DNA Barcoding for further identification. Each species was analyzed for significance to the project. Significance was determined by the species host, specifically caterpillar hosts. We then sorted all the significant species into remove/replace phloem-feeder groups, and analyzed the data.

Compared to the removal treatment group (average tachinid count of .27), the replacement treatment group's average tachinid count was greater (average tachinid count of .76). Using a T-test, we found that our data was significant ($p < .05$). This study showed that when phloem-feeders are present, the average tachinid amount is almost 3 times greater than the phloem-feeder absence average tachinid amount, suggesting that another mechanism, other than HIPVs, might be the cause of the suppressed caterpillar parasitism when phloem-feeders are present. Further exploring this interaction would allow for more knowledge on caterpillar-parasitoid-phloem feeder interactions and also lead to advancements in the agricultural pest control field.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EV PS

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

LS

Project Number

3077

Title: Utilizing Fucus distichus Alginates To Develop an Enhanced Aerosol Treatment For Cystic Fibrosis

Student Name(s): M. Nierenberg

Abstract:

The sodium alginate derived from Fucus distichus will be utilized to develop an enhanced aerosol treatment for Cystic Fibrosis. The alginate solutions will be used to test if they can stop Pseudomonas putida, the bacteria associated with Cystic Fibrosis, from growing. One of the several therapies for Cystic Fibrosis is aerosol inhalation, which can deliver a variety of medications directly to the lungs and maintain hydration of the fluid lining the epithelium. Aerosol is not dispersed equally as obstruction grows, and some locations with inadequate ventilation might not receive any medication at all. This research aims to develop an enhanced aerosol treatment using alginates to present as a more natural alternative treatment, that is more eco-friendly, and can be used as a vehicle of dispersion to deliver a known antibiotic that is used for Cystic Fibrosis. Droplet size testing was conducted to determine the normal distribution of droplet sizes of the solution in comparison to the droplet size of a human cough trigger. Droplet frequency distribution presented a bi modal distribution with an average droplet size of 289.56 μ m. Dynamic viscosity testing was conducted on the distilled water and sodium alginate solution with an inclined plane (41.68 $^{\circ}$). Data demonstrates an average viscosity of ~13.39 mPa-s, when coupling viscosity with droplet size, the alginate matrix is capable of being dispersed unlike the current aerosol treatment via an aerosol nebulizer for direct inhalation by the patient. This statement of validation is proven through the microbial zone of inhibition when cultured with Pseudomonas putida.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN ME BI

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LS

Project Number

3078

Title: Investigating the Relationship Between the Size of Blood Clots, Blood Flow Rate, and Anticoagulants in the Cardiovascular System for the Implementation in Ischemic Stroke Patients

Student Name(s): T. Adeniran

Abstract:

Strokes are one of the leading causes of death in the United States. While many treatments are available for the dissolution of thrombi, some treatments must be used under restrictions, such as the protein Tissue Plasminogen Activator (tPA). This project aims to analyze the relationship between blood clot size, blood flow rate, and the dissolution of blood clots, in order to reach a conclusion about the effects of blood clots on potentially experiencing and recovering from a stroke. A physical model of the cardiovascular system was created to simulate blood flow rate as blood clot sizes varied. Different amounts of Sodium Citrate and Vitamin E were used to study the dissolution of Calcium Alginate blood clots. It was evident that a blood clot of diameter $\frac{1}{2}$ inches produced the slowest blood flow rate of 1.81 mL/sec on average, compared to the blood flow rate of 25.79 mL/sec on average of the blood clot of diameter $\frac{1}{8}$ inches. Additionally, as the mass of each anticoagulant in their solutions increased, a decrease in the mass of the modeled Calcium Alginate blood clots persisted. Conclusions drawn from experimentation include evidence of blood flow rate decrease as blood clot sizes increase. Additionally, the study showed the potential of Sodium Citrate to be an effective anticoagulant in the cardiovascular system. Further applications of the study include exploring the composition of tPA, and the criteria that constrain its usage, in order to produce a stable and accessible treatment to ischemic stroke patients.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ME CBIO BI

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LS

Project Number

3079

Title: Effect of calcifying microorganisms with carbonized rice hulls on removing ultra fine dust.

Student Name(s): S. Chin

Abstract:

Particulate matter (PM) and volatile organic compounds are common air pollutants with significant health risks to the human body. This study aims to explore the potential use of *Sporosarcina pasteurii* (*S.pasteurii*) activated carbonized rice husk (CRH) blocks (SPaCKs) for PM removal and assess their suitability as materials in biowalls. An experimental setup was devised in which smog is collected in one container, passed through the tested materials, including CRH and *S. pasteurii*-induced gauze, and then collected in another container where the dust density change is measured. A prototype of the biowall substrate was developed by combining CRH, agar, and coconut fibers with SPaCKs created by *S. pasteurii* into the prototype. The effectiveness of CRH in PM removal increased with higher quantities, and the highest experimental removal efficiency was 44% with 5g of CRH. *S.pasteurii* demonstrated its highest effectiveness when treated with calcium broth at a 3:2 ratio, resulting in a removal efficiency of 40%. A block comprised of 0.75g agar, 2.5g nongrinded CRH, and 1g coconut fiber, along with the addition of 50 ml distilled water, had a removal efficiency of 47% and was selected for SPaCK creation. CaCO₃ was identified in the SPaCK through microscope images. In SPaCKs, 66% of seeds successfully germinated, and tensile stress of 20.8 kPa was observed when dry. SPaCKs show a significant PM removal efficiency in indoor air, presenting a sustainable approach utilizing waste materials. Large-scale, real-world testing within the entirety of the biofilter is necessary for practical applications.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN MI PS

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

245

2024

Fair Category

LS

Project Number

3080

Title: Inherently Aggressive Fish and the Ability to Learn a New Skill

Student Name(s): G. Schober

Abstract:

Fish are common household pets, and providing enrichment, such as learning a new skill, can improve the overall quality of life for the fish. The present study experimentally investigated the correlation between aggression in fish and the ability to train. A zebrafish, goldfish, and betta fish were assigned individual aquariums. Over the course of 2 months and 3 times a week, a small plastic hoop was placed in each aquarium. Each fish was rewarded with a small amount of fish food every time it swam through the hoop. A recent study done by National Center for Biotechnology Information discovered that there was a positive correlation between aggression, which was measured by readiness to gill display in that study, and exploratory tendency, measured by readiness to approach a new shelter (Chang, C., Li, C. Y., Earley, R. L., & Hsu, Y. (2012) Aggression and related behavioral traits: the impact of winning and losing and the role of hormones). I used zebrafish, goldfish, and betta fish because they are common fish breeds used as pets. The most aggressive of the fish, the betta fish, held true to Chang's study by being the most explorative. This exploratory tendency made it easier for the betta fish to initially swim through the hoop. The goldfish, assumed to be the most amiable, displayed no interest in the hoop. Consequently, the goldfish never swam through the hoop. My study concluded that the genetically more aggressive fish was quicker to perform a new skill.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AS

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

251

2024

Fair Category

LS

Project
Number

3081

Title: Antioxidative Effects of Sargassum horneri on Alleviating Neurodegeneration Induced by Sustained Alcohol Exposure on Caenorhabditis elegans Model

Student Name(s): R. Lee

Abstract:

Sargassum, a brown macroalgae rising as a global economic and ecological threat, contains antioxidants among many bioactive compounds. Chronic alcohol exposure is reported to induce neurodegeneration through causing oxidative stress. This study investigated whether antioxidative extracts from Sargassum horneri could be used to alleviate neurodegeneration induced by sustained alcohol exposure using Caenorhabditis elegans as a model animal. Two S. horneri extracts, Distilled Water Extract and Ethanol Extract, were made with solvents distilled water and 80% ethanol, respectively. Polyphenol, Flavonoid, DPPH radical scavenging assay, and reducing power assay were conducted to confirm the extracts' antioxidative potential. Neurodegeneration was induced in wild type C. elegans N2 through sustained ethanol exposure at 300 mM and was attempted to be alleviated with treatment of S. horneri extracts. Worm behaviors over 7 days were recorded and analyzed on Wormlab software against five movement criteria to track the progression of neurodegeneration. In result, worms in the group 'Ethanol Exposure + S. horneri Ethanol Extract' displayed patterns in movement criteria—Wavelength, Mean and Maximum Amplitude, and Smoothed Speed—that were indicative of a slower rate of neurodegeneration. Therefore, this study concluded that S. horneri Ethanol Extract effectively alleviated neurodegeneration in C. elegans induced by sustained alcohol exposure. Further study should explore how different dosages and duration of alcohol exposure as well as concentration and preparation method of S. horneri extracts impacts the extracts' anti-neurodegenerative performance. This study demonstrates the potential for S. horneri, an overlooked and problematic marine resource, to be repurposed for application in medicine and pharmaceuticals.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

BI ME CB

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

234

2024

Fair Category

LS

Project Number

3083

Title: Using Sunscreen as a way to distribute Beneficial Microorganisms for Corals (BMCs)

Student Name(s): L. Cox

Abstract:

Using Sunscreen as a way to distribute Beneficial Microorganisms for Corals (BMCs). This project is trying to create a BMCs enriched sunscreen that will be used to distribute the BMCs to a natural reef environment. The Beneficial Microorganisms that will be used help strengthen corals against the effects of coral bleaching. When corals are exposed to long periods of heat stress or other stressful conditions it disrupts the relationship between the coral host and its endosymbiotic zooxanthellae. This then leads to the loss of a coral's coloration and the coral becomes weaker, this can also eventually lead to death. To test the concept of a BMC enriched sunscreen, serial dilution was done with e coli. Different variables were introduced into the growth environment of the e coli including Zinc-oxide and glycerol. To see how well how the bacteria distributes through the water column, e coli was placed in a fish tank in water that was not moving then again in water that was. After looking at the growth of the bacteria it was found that the e coli grew well with glycerol. The results from the Zinc-oxide and e coli plates showed indecent, there was bacteria but it was uncountable. As of now the data being collected is unsupportive of the hypothesis that BMC enriched sunscreen will be effective at mitigating the effects of coral bleaching; but data is still being collected.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EA MI

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

242

2024

Fair Category

LS

Project Number

3085

Title: Chlorophyll's reflection of Near-Infrared and Red Light as a Method to Determine Overall Health of Medicago Sativa, Phaseolus vulgaris, and Solanum lycopersicum

Student Name(s): M. Lanson

Abstract:

The aim of this project was to develop device that can, with reasonable accuracy, determine the health of a plant from a distance by taking a photo of it and analyzing the near-infrared and red bands of light it reflects. The device, which consists of a Raspberry Pi and Raspberry Pi High-Quality camera with an infrared filter removed and a red filter added, assesses the health of a plant by capturing a photo and converting it to NDVI using the bands of light mentioned above. The resulting NDVI photo consists of a grayscale photo in which healthy plants with more chlorophyll will have lighter pixels. As a result, the average luminosity of the pixels of a plant can be calculated to determine its overall health. Being able to accurately and quickly assess the health of a plant is incredibly useful to anyone from casual gardeners to full-scale farmers because it allows them to give more focus to unhealthy plants, increasing their efficiency in terms of resources and maximizing their success in growing crops or plants. In testing the device, the results showed that it was capable of assessing the health of a plant with astonishingly excellent accuracy, proving its usefulness in the agricultural world. In the future, by simply making minor adaptability upgrades to the device, it can easily be implemented and used in real-world applications, especially when combined with drones to get aerial shots of crops below.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EV PS BI

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

262

2024

Fair Category

LS

Project
Number

3086

Title: Prediction of Non-B DNA Structure Using PacBio Sequencing Interpulse Durations

Student Name(s): N. Jain

Abstract:

It is widely believed that DNA solely takes the form of a double-helical structure (B-DNA); however it is less commonly known that a non-canonical structure of DNA (non-B DNA) exists as well. However, these deviations are highly unstable and may hinder replication, leading to mutations in the genome. While essential for DNA metabolic processes, non-B DNA may lead to numerous issues including neurological and autoimmune diseases, as well as oncogenesis, mutagenesis, and cancerous growth in the body. Very little research has been done in the field, thus we construct a classifier that can predict non-B DNA structure using a sequencing technique called PacBio and one of its features, Interpulse Durations (IPD). Due to its instability, non-B DNA takes a longer time to replicate, which is measured through IPDs and is a distinguishing feature of the aforementioned classifier. To be able to analyze and find correlations in the data, we implement the K-Means clustering technique as well as a one class SVM to find anomalies in the IPD data from both non-B and B-DNA. With these models, we found it is possible to create a model with accurate performance to accomplish the task of predicting non-B structure through a Logistic Regression classifier. As previous models that aimed to predict non-B structure may have been unrepresentative or based on differing features, this classifier uses IPD values as a distinguishing feature, and can be advanced to expand future work to understand non-B DNA structure and thus, our genome, to a greater extent.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO CS EN

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

182

2024

Fair Category

LS

Project
Number

3087

Title: The Effect of Pesticides on Diplotaxis tenuifolia Growth

Student Name(s): A. Campolo

Abstract:

Pesticides are a worldwide way to limit insects' damage on plants, on both a commercial and domestic scale. Little is known on the effects of pesticides on plant growth. This research aims to establish pesticides as a growth inhibitor of *Diplotaxis tenuifolia*, a species of arugula. Three different types of pesticides were applied to see if there was a difference in the final percent of growth average. Plants were exposed to three different types of pesticides. A fourth group was used as a control. The plants were then measured before and after the application of the pesticides, around halfway through the experiment. As a result, when spraying the pesticides, the growth was affected. The control group had the highest percent growth at 20.5% while Sevin had the lowest percent growth at 9.4%. An analysis of variance (ANOVA) test was conducted. The data reflected p-scores of 0.017847, 0.053419, and 0.051285 for Sevin, Neem oil and Earth's Ally respectively. While Neem oil and Earth's Ally stunted plant growth, their differences were not significant. The differences are statistically significant between the control and Sevine.

Technical Disciplines Selected by the Student
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PS EA CH

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

238

2024

Fair Category

LS

Project Number

3088

Title: GENESIS: An Optimization Framework for iPSC Differentiation Using a Stochastic Gene Regulatory Network Approach

Student Name(s): D. Girish Kumar

Abstract:

The differentiation of induced pluripotent stem cells (iPSCs) into specific cell types is pivotal for advances in regenerative medicine, disease modeling, and drug discovery. However, their potential is currently limited by challenges such as inefficient differentiation processes, leading to heterogeneous cell populations and insufficient yields of desired cell types. To tackle this issue, I developed GENESIS (Gene Expression and Network Exploration for Stem-Cell Induction Simulation), a framework leveraging a stochastic gene regulatory networks (GRN) to computationally simulate and optimize the differentiation of iPSCs across seven different cell types. By integrating data from the TF-Marker database, incorporating 1,316 transcription factors (TFs), their interactions with 1,092 target markers, I constructed a GRN-based machine learning model that predict the optimal combinations of instructive factors (IFs) for the efficient differentiation of iPSCs into target cell types. The framework predicts the efficacy of IF combinations by simulating differentiation processes under various conditions, then benchmarks these predictions with actual cell type expression profiles from the same dataset through a 70:30 split for training and testing. The overall gene expression profiles predicted by GENESIS for each differentiated cell type were compared with those obtained from experimental observations, with the model achieving an Pearson average correlation coefficient of 0.81 across all differentiation scenarios. By leveraging this approach, GENESIS provides researchers with optimal IFs for differentiation, enabling more control over cell differentiation outcomes and advancing developments in precision medicine, disease modeling, and drug discovery.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO EN ME

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

256

2024

Fair Category

LS

Project Number

3089

Title: Addressing the PFAS Water Crisis: The Efficacy of a Packed-Bed White Rot Fungi Bioreactor

Student Name(s): C. Meyer

Abstract:

This study presents an innovative bioremediation approach for PFAS (Per- and Polyfluoroalkyl Substances) contamination in water systems. PFAS, known for their resistance to natural degradation due to strong carbon-fluorine bonds, pose significant health risks and are not effectively removed by current wastewater treatment technologies. This research focuses on the efficacy of a packed-bed bioreactor employing white rot fungi, known for their enzymatic potential to degrade complex organic pollutants, as a sustainable treatment method. The proposed bioreactor design incorporates biodegradable cellulose-based sponges as a growth substrate for the fungi, ensuring an environment conducive to mycelial expansion and subsequent PFAS degradation. The study outlines a methodical approach, including autoclaving sponges to prevent microbial contamination, inoculating with liquid white rot fungi culture, and incubating in a dark, humid environment to promote optimal fungal growth. PFAS-contaminated water is then treated in a continuous flow system through the bioreactor, packed with nutrient-rich substrate to enhance fungal activity and PFAS degradation. Anticipated results include a measurable decrease in PFAS concentrations, consistent fungal growth indicating effective colonization, and continuous flow system efficacy for fungal exposure to PFAS. The study also expects to document the time efficiency of the bioreactor, setting a benchmark for practical applications. The broader implications of this research suggest significant environmental health benefits by reducing the ecological footprint of PFAS and offering an economically viable treatment option. The successful application could influence policy and regulation regarding PFAS discharge, potentially leading to the widespread adoption of this eco-friendly technology in industrial-scale water treatment plants.

Technical Disciplines Selected by the Student
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BI MI EM

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

LS

Project Number

3090

Title: Enhanced Therapeutic Recovery Gloves Designed for Spondylosis Rehabilitation

Student Name(s): G. Shen

Abstract:

Clumsy finger movement is a common clinical manifestation of myelopathy patients. Evaluating the impaired hand function can provide a strong basis for assessing the severity of myelopathy. Currently, no objective and effective evaluation method is widely accepted in clinical practice. Also, there is no specific rehabilitation tool for myelopathy hand dysfunction. We developed a myelopathy-hand functional evaluation and rehabilitation system (MFERS), which mainly consists of a soft finger exoskeleton glove and a computer with software. For hand function evaluation, 30 consecutive participants who signed informed consent were asked to wear the soft-robotic gloves and then perform a 10-second G-R test. The movements of each finger were recorded by gloves and converted into waveforms. Relevant waveform parameters were measured and analyzed. The Japanese Orthopedics Association (JOA) scores of each patient were marked. For hand function rehabilitation part, the MFERS were tested by research team members due to safety concerns for real patients. In aspect of hand function evaluation, the MFERS could measure the changes of the angles of the hand joints in real-time and convert the hand movements into waveforms. Myelopathy patients had a lower number of G-R cycles and a longer time per cycle than healthy participants. For hand function rehabilitation, the MFERS could perform glove-assisted passive movement of hand grip and release. This newly developed soft finger exoskeleton is an objective and quantitative assessment tool for patients with cervical myelopathy and demonstrates a potential role in the rehabilitation of myelopathy hand.

Technical Disciplines Selected by the Student
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EN

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

247

2024

Fair Category

LS

Project Number

3091

Title: Identifying Crucial Genetic Determinants of Hepatocellular Carcinoma through Bioinformatics Analysis

Student Name(s): R. Lanka

Abstract:

Liver cancer is one of the most common cancers in the world, with almost 1 million cases annually. Hepatocellular carcinoma (HCC) accounts for up to 90% of all primary liver cancers worldwide. Currently, there remains little to no effective biomarkers for surveillance and early HCC diagnosis, due to its clinical heterogeneity. Increasing evidence shows that specific molecular mechanisms and the genetic profile involved in the regulation and development of HCC can potentially identify treatment options. Thus, we aim to analyze HCC patients' genomic data to validate and identify novel molecular pathways and significant genes associated with HCC. First, gene expression data of 183 HCC patients was downloaded from the Gene Expression Omnibus public database. Using the GEO2R tool, data was compared to control samples and significantly differentially expressed genes (DEGs) were identified. Using the STRING database and CytoHubba plugin of Cytoscape, a protein-protein interaction (PPI) network was created using the previously identified DEGs. The top 10 connected genes were identified. These genes were significantly upregulated in HCC patients, and upon validation in HCC patients, overexpression of these genes were associated with decreased survival rates of >2.5 years. This clinical validation was conducted using GEPIA, and hundreds of samples from TCGA and GTEx. Upon further analysis, these proteins were involved in the cell cycle, and significantly enriched in cell division and CDK complexes. Overall, our comprehensive bioinformatics analysis of publicly available data revealed key molecular players involved in HCC that have the possibility to be prognostic biomarkers.

**Technical Disciplines Selected by the Student
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ME CBIO

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

LS

Project Number

3092

Title: Optimizing Establishment and Germination of Glycine Max Seedlings Using Biochar and Bacillus Megaterium Seed Coating

Student Name(s): J. Habshey

Abstract:

Existing research on seed coating treatments is diverse, however the application of combinations of different seed coating types, particularly bacteria treatments is limited. This study tested the effectiveness of biochar and bacillus megaterium on improving the germination and growth of Glycine max (soybean). Seeds were coated with biochar, bacteria, both or no treatment, and planted in sterilized soil. They grew for 12 days, the number of germinations counted daily. Once plants had produced mature leaves, they were dried. Germination of the plants was analyzed, with the biochar & bacteria treatment group having a more rapid germination rate than the control. The biochar-only and bacteria-only groups germination rate was less rapid than the control. An ANOVA conducted to compare the difference in the dry mass of the control and 3 treatments found no statistically significant difference in root mass. For the shoots, the bacteria & biochar and biochar-only groups, there was a statistically significant difference ($p < 0.05$) when compared to the control- the average mass of the treatment groups are lower (0.13g) than the average of the control (0.15g), indicating that the treatments negatively impacted shoot growth. For the root:shoot ratio, there was a statistically significant difference ($p < 0.05$) for the bacteria-only treatment vs. the control, the treatment had an increased average (0.26g) than the control (0.2g), indicating uneven growth. It was determined to optimize germination rate, bacteria & biochar coatings are most effective. The treatments negatively impacted shoot growth or root:shoot ratio, therefore shouldn't be used.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

PS EA EM

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

257

2024

Fair Category

LS

Project Number

3094

Title: The efficacy of Vitamin D on prevention and treatment of COVID 19

Student Name(s): C. Weng

Abstract:

For the last 4 years, COVID-19 has developed into a worldwide pandemic, infecting more than 700 million people and killing nearly 7 million people. Global research progress demonstrates that the susceptibility, severity and prognosis of COVID-19 are closely related to vitamin D level of the population.

My research starts with the effect of vitamin D on the immune system and how it helps maintain proper cardiovascular and respiratory function within our bodies, and continues to analyze recent epidemiological research and clinical evidence on the relationship between vitamin D level in human body and the likelihood and severity of COVID-19 infection. Epidemiological evidence points to the fact that COVID-19 emerged and spread in the Northern Hemisphere in the winter of 2019, when human vitamin D levels are at their lowest. This suggests that indirectly produced vitamin D in the human body may play certain protective roles against COVID-19. In 2020, a research team led by Professor Backman of Northwestern University studied global data and discovered a strong correlation between severe vitamin D deficiency and COVID-19 mortality. Rigorous large-scale, multicenter, randomized controlled clinical trials have also been conducted on severe patients worldwide to further explore the role of vitamin D in alleviating clinical symptoms of COVID-19 and improving prognosis.

Given known benefits of vitamin D and its suggested role in preventing and treating COVID-19, my research concludes in proposing to establish regular screenings of vitamin D levels in key populations including adolescents, the elderly, and those with underlying medical conditions.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BI CB

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LS

Project Number

3096

Title: Edhelper: The Application of Artificial Intelligence in the Aid of Learning for Neurodivergent Children

Student Name(s): A. Balas

Abstract:

Neurodivergence, an umbrella term, describes the diverse ways in which human brains process information and function. Two prevalent neurodivergent conditions are Autism and ADHD. Autism Spectrum Disorder (ASD), with an estimated prevalence of 1 in every 36 children, is characterized by persistent deficits in social communication and interactions, and repetitive behavioral patterns. Attention Deficit Hyperactivity Disorder (ADHD) is characterized by persistent patterns of inattention, hyperactivity, and impulsivity. Neurodivergent students often face specific learning limitations and have unique needs. Understanding and predicting students' learning styles, defined as "as an individual mode of gaining knowledge", is crucial for educators in order to tailor educational experiences to accommodate diverse learners. The current study created Edhelper, an AI model capable of predicting three distinct learning styles: kinesthetic, auditory, and visual. Edhelper uses a Natural Language Processing (NLP) algorithm to analyze user responses and to detect verbal patterns associated with specific learning styles. A group of 42 students, ages 3 to 21, were asked three questions selected from the VARK (Visual, Auditory, Reading, Kinesthetic) Inventory. Students' responses were then interpreted by our AI model. Of the 42 students, 6 students had been previously diagnosed with autism and 13 had been diagnosed with ADHD. 100% of the autistic individuals were predicted to be visual learners, and 54% of the ADHD students were auditory learners. This data suggests that a variety of different learning tools should be used to accommodate different types of learning styles, and that AI algorithms can help customize student's learning experiences.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BE CS CBIO

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

223

2024

Fair Category

LS

Project Number

3097

Title: Heterogenous Association Between Mortality and Environmental Factors

Student Name(s): A. Ju

Abstract:

The global environment has changed rapidly since the Industrial Revolution. Human emissions of heat-trapping greenhouse gases have warmed our earth, leading to more climate extremes. Human activities have also caused air pollution and, thus, worse air quality. Warmer climates and polluted air pose severe risks to human health. This paper focuses on temperature and air pollution as the primary environmental factors and studies their relationship with mortality across different ethnicity and age groups in the U.S. from 2001 to 2021. The main research methods employed in this paper are correlation analysis and least-square regressions. This paper finds that, on average, environmental factors are moderately and positively related to total deaths at a statistically significant level. Such a positive relationship still holds when I further investigate how the environment is associated with mortality by each individual cause. Moreover, heterogeneity in the relationship is identified among different races. In particular, temperature seems to have a larger impact on the Native Hawaiian/Pacific Islander and Black populations. At the same time, air pollution is observed to have a very strong association with the mortality of the Asian population, Pacific Islanders, and Hawaiian Natives. Finally, age disparities are not that significant. One finding worth pointing out is that children and teenagers (Age 1-14) appear to be more susceptible to air pollution than other age groups.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO ME BE

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

266

2024

Fair Category

LS

Project Number

3098

Title: The Effect of Diet Composition on Lifespan and Colorectal Cancer Progression in the *Drosophila* Midgut

Student Name(s): W. Boberski

Abstract:

Colorectal cancer (CRC) is the third most frequently diagnosed cancer, and the second leading cause of cancer mortality (Sung et al., 2021). Diet and the microbiome may impact the disease, but the effect of dietary fiber or fat on cancer progression is not fully understood (Ren et al., 2021). A transgenic Apc-Ras cancer model in *Drosophila melanogaster* (gifted from Dr. Andreu Casali) allows the comparison of standard, high-fat, and high-fiber diets on cancer progression (Martorell et al., 2014) (Bangi et al., 2016). Experimental diets were prepared with the Bloomington standard cornmeal medium supplemented with $\pm 10\%$ coconut oil for high-fat, or $\pm 10\%$ psyllium husk for high-fiber (Liao, 2020) (Lambeau, 2017). Tumor progression was indirectly measured by lifespan, and every other week by fecal depositions and fluorescence microscopy of GFP-labeled Apc-Ras clone cells. It was anticipated that high-fat diets would be correlated with a shorter lifespan, more tumors and fewer fecal depositions compared to high-fiber diets (Cheng et al., 2020) (Martorell et al., 2014). Preliminary data suggests that flies on high-fat diets may have shorter lifespans and more fecal depositions. Fluorescence microscopy of midguts suggests that flies on high-fat diets present differently, and may have more tumors; for example, a high-fat fly had approximately 18 tumors, while a high-fiber fly had approximately 4 (n=1 for each). This preliminary data is promising and supports additional study; evidence for the beneficial impact of a high-fiber diet, or the deleterious impact of a high-fat diet, would support dietary interventions to ameliorate CRC progression.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AS ME CB

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

LS

Project Number

3099

Title: Simple and Rapid Removal of Onychomycosis Using Electromagnetic Microwave

Student Name(s): S. Bier

Abstract:

Previously, onychomycosis, caused by the dermatophyte *Trichophyton rubrum*, has been treated through the utilization of active pharmaceutical ingredients (APIs). These methods of treatment have proven to be very unreliable with their varying treatment success rates as well as harmful side effects. This research ultimately serves to identify the effectiveness of a nonionizing electromagnetic microwave device named “Swift” on onychomycosis. According to literature, non-ionizing electromagnetic waves have an inactivating effect on fungi as well as the production of mycotoxins by the fungi. In this model, the Swift system was utilized to reduce the production of xanthomegnin, the mycotoxin in *Trichophyton rubrum* that promotes filamentous and virulence growth in the host cells. To test this hypothesis, the Swift system was carefully applied to both a culture of *Trichophyton rubrum*, as well as a synthetic nail, that followed an 8W/2S/5x regimen. The synthetic nail was fabricated through a keratin extraction process involving a solution of anhydrous ethyl alcohol, deionized water, as well as hydrochloric acid. ATR-FTIR and SEM analyses were used to confirmed the successful extraction of keratin. Following confirmation, the keratin solution was poured into plastic wells with Sabouraud medium, and inoculated with *Trichophyton rubrum* to promote fungal growth. After mature growth of *Trichophyton rubrum* on the simulated toenail, the Swift system was topically applied. Utilizing SEM analysis for both pre-and post-analysis, the simulated, synthetic nail and culture both showed clear signs of fungal regression and rendering. These results ultimately confirmed the initial hypothesis proposed by this research.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

ME EN AT

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LS

Project Number

3100

Title: Optimizing the LSTM Deep Learning Model for Arctic Sea Ice Melting Prediction

Student Name(s): V. Pegkou Christofi

Abstract:

The National Oceanic and Atmospheric Administration reports a 95% decline in the oldest Arctic ice over the last 33 years, while NASA states that summer Arctic Sea Ice Extent (SIE) is shrinking by 12.2% per decade since 1979 due to warmer temperatures. Given the rapidly changing Arctic conditions, accurate prediction models are crucial. Deep learning models developed for Arctic forecasts primarily focus on exploring convolutional neural networks (CNN) and convolutional Long Short-Term Memory (LSTM) networks, while the exploration of the power of LSTM networks is limited. In this research, we focus on enhancing the performance of an LSTM network for predicting monthly Arctic SIE. We leverage five climate and atmospheric variables, validated for their correlation with SIE in prior studies (Chen 2023). We utilize the Spearman's rank correlation and ExtraTrees regressor to enhance our understanding of the importance of the five variables in predicting SIE. We further enhance our predictor variables with seasonal information, lagged time steps, and a linear regression simulated SIE that accounts for the influence of past SIE on current SIE. Statistical methods guide our selection of data scalers and best evaluation metrics for our model. By experimenting with hyperparameter optimization and advanced deep learning training techniques, such as batch sizes, number of neurons, early stopping, and model checkpoint, our model achieved a Mean Absolute Error (MAE) of 0.191 and R^2 of 0.996, underscoring its ability to account for nearly all the variance in our data and holds great promise for the prediction of SIE.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM MA EA

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LS

Project
Number

3101

Title: The Effects of Resveratrol on ALS Positive Fruit Flies

Student Name(s): L. Hogan, L. Hogan, L. Hogan

Abstract:

Amyotrophic Lateral Sclerosis (ALS) better known as Lou Gehrig's disease is a debilitating nervous system disease that causes muscle dysfunction, and causes pain throughout the entire body. It has age related onset meaning that it does not strike till later in life. One proposed source of this pain is mitochondrial issues caused by the SOD1 mutation, which is the most common cause of familial ALS. Mitochondrial dysfunction results in the decrease of ATP formation, causing muscular dystrophy. Resveratrol is a natural supplement that has been used to help with mitochondrial issues. Flies will be used with an overexpression of the mutant SOD1 gene which will model symptoms of ALS in humans. One group of ALS SOD1 positive flies will start taking Resveratrol at ten days, while another group of positive flies will start taking Resveratrol at thirty days. Loss of motor function will be measured using a climbing assay. The flies will be tested each week and their results will be compared to ALS positive and negative control groups. ATP levels will be measured using an ATP determination kit. A small group of each of the four groups will be killed at forty days and their leg muscles will be used to look at ATP levels. Flies who started taking Resveratrol at 10 days and 30 days showed major improvements in the motor function specifically in the climbing assay. ALS Positive flies are still living as long as ALS negative flies proving that this mutation causes an age related reaction.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME AS BE

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

237

2024

Fair Category

LS

Project Number

3102

Title: Novel Soybean-oil Based Garment Dye Alternative to Toxic Acid Based Dyes

Student Name(s): A. Reyes

Abstract:

The photo oxidation of soybean oil, UVB light and Riboflavin will be used to form an original soybean oil-based clothing dye. The chemical process of Photo Oxidization will be utilized to denature the fatty acid into a resin base/pigment for dyeing clothes. Acid-based dyes are widely used clothing dyes, despite the environmental and humanitarian issues that arise from their toxic chemical products. This research aims to develop a soybean-oil based non-toxic clothing dye, presenting a natural alternative that can have little to no toxic chemical products and have a consistent color retention under UV light exposure. A Weathering Protocol was conducted to test the dye's color fastness in relation to Acid Dyes, where a reduction in saturation in the Acid dye under weathering conditions indicated less pigmentation. The Photo Oxidized dye saturation pigment stabilization demonstrated an increase of 13 saturation, proving it more resistant to weathering than the Acid Dye. An LD50 was conducted to identify the Lethal Dose, or concentration of dye it would take to reduce the mortality of a population of Artemia Shrimp by 50%. It was identified that, at an equal dye concentration of 70%, the Photo Oxidized Dye and Acid Dye resulted in 9.5% and 56% shrimp mortality over a 2-hour exposure, respectively. Results prove the Photo Oxidized Dye maintains color fastness and is a significantly less toxic alternative to Acid Dyes in the textile industry.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN EM AT

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

259

2024

Fair Category

LS

Project Number

3103

Title: Assessing the Impact of Artificial Sweeteners on E.coli

Effects on Growth and Biofilm Formation

Student Name(s): A. Olasewere

Abstract:

Potential side-effects of artificial sweeteners on the gut microbiome remain relatively unknown, particularly with increasing prevalence of use in American diets. This study compared the effects of artificial and natural sweeteners on Escherichia coli, a key microbe in the human gut (Sharma, 2016). Despite some studies indicating that sweeteners can alter E. coli growth, none have systematically evaluated their impact, compared to natural or no sugars, at comparable concentrations (Chichger, 2021; Li, 2022). Furthermore, evidence supports biofilm's role in reduced stress tolerance, antibiotic susceptibility, and immune function (Beloin, 2010). Effects of sweeteners on E. coli growth and biofilm formation were examined. E. coli were cultured in 10mL 2% Luria-Bertani(LB) broth with a cell density of 8×10^8 cells/ml, supplemented with ± 1 mM sweeteners (saccharin, sucralose, aspartame, acesulfame potassium), or natural alternatives (glucose, stevia). E. coli growth over 4 days was assessed via OD600 analysis. Separately, after 24 hours, 1.2×10^6 cells/well were transferred in quadruplicate to a 96-well plate and grown for an additional 24hrs; biofilm formation was measured using fluorescent SYTO 9 stain (excitation/emission wavelength 479/520nm). Sweeteners did not statistically impact bacterial growth compared to LB broth control, but significantly increased mean biofilm formation compared to LB broth and glucose-treated E. coli. This increase suggests that artificial sweeteners have the potential to negatively alter E. coli communities. Differences in biofilm formation from artificial sweeteners compared to natural or no extra sugars signify the need for cautious consumption. Understanding their impact on E. coli is crucial for informed consumer choices regarding sweeteners.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

CB ME MI

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

208

2024

Fair Category

LS

Project
Number

3105

Title: Testing Prevalence of Bacteria Resistant to Tetracycline, Sulfamethoxazole, and Chloramphenicol Antibiotics in Hotspot Connecticut Environments

Student Name(s): S. Pidvysotski

Abstract:

Emerging resistance to antibiotics is one of the defining medical crises of our time. The prevalence and diversity of antibiotic-resistant bacteria in the environment, and the risks they pose to humans, are not well understood, in part because there has been limited standardized surveillance. Evidence suggests that environmental surveillance of antibiotic-resistant bacteria is an important first step in targeting efforts to prevent spread and transmission of antibiotic-resistant microbes to humans. This project serves to document hotspot locations of tetracycline, sulfamethoxazole, and chloramphenicol resistant microbes in the Connecticut area, particularly in a wheat field, near a hospital, and in a water treatment plant. By using eDNA, PCR, electrophoresis, and zone of inhibition techniques, the following was discovered: the wheat field had the most bacteria resistant to tetracycline, all environments had medium to high concentrations of bacteria resistant to sulfamethoxazole, and no environments were found to have significant resistance to chloramphenicol. Further research is being conducted by Tuft's PARE Project, which these results will contribute to, in order to further understand this topic. For future research, other types of environments across a variety of states or countries may be tested in order to have a better scope of the antibiotic resistance that is present in the environment.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

MI

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

168

2024

Fair Category

LS

Project
Number

3108

Title: The Economic Efficacy of Various Algae Strains for Biofuel Production

Student Name(s): S. Olvany

Abstract:

Producing fuel products from algae could provide a solution to the draining of fossil fuel reserves and help reduce the detrimental effects of fossil fuel extraction on the environment. This study determined what strain of algae is the most economical for biofuel production. The experiment compared the economic efficacy of 3 different types of algae: Chlorella, Spirulina, and Scenedesmus. For all algae types, data for the elemental compositions was gathered from various literature and databases. After compiling this data, the values were entered into the NREL Algae farm model. This model produced an estimated cost per ton of biomass for each lipid. From this, the percent lipid compositions, which are also gathered from literature and databases, can be used to determine the estimated cost per ton of lipids from each algae strain. This result serves as an indicator of which algae strain is the most cost-effective for biofuel production. Through this research, Scenedesmus was determined to be the most economically efficient algae strain of the three tested.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

ET PS EM

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

LS

Project Number

3109

Title: Using Defibrinated Sheep's Blood To Predict Endometrial Cancer

Student Name(s): S. Rutkowski

Abstract:

In scientific literature there exists a significant gap in menstrual health research, leading to increased risk due to improper assessment of changes in menstruation. By quantifying menstrual blood volumes, doctors can track changes in menstruation over time, serving as an objective early diagnostics-tool for endometrial cancer. The purpose of this study was to determine the volume capacity, in milliliters, for the five different sizes of Tampax tampons. It was predicted that the volume capacity would increase in fractional value for each tampon size when the volume of blood added to the given tampon increased. Twenty trials measuring blood density, in grams, were conducted. Fitting the tampons into glass vials, volumes of defibrinated sheep's blood were added to induce the tampon to $1/6$, $1/3$, $1/2$, $2/3$, $5/6$, and maximum capacity of its blood holding volume. Pictures were taken after each trial to design six images for each tampon size, portraying the visual pattern when a given volume of blood was added. Results show that absorbed blood per tampon exceeded the advertised weight by Tampax. The experiment also determined that visual patterns prior to maximum capacity fill the entirety of the tampon; in other words, even if the tampon is completely red, it is still probable that it can absorb more blood. By quantifying menstrual blood absorbed in tampons by mass (g) instead of visual patterns, doctors can objectively identify heavy menstrual bleeding, a primary symptom of endometrial cancer that could be unknowingly overlooked if solely pictorial blood-loss assessment charts are used.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME CBIO EN

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

253

2024

Fair Category

LS

Project Number

3110

Title: An Analysis of the Efficacy of Chamomile Flavonoids as a Preemptive Measure for Basal and Squamous Cell Carcinomas

Student Name(s): E. Howard

Abstract:

Flavonoids are secondary metabolites that are found in fruits, vegetables, and plants. It is proposed that their ability to protect plants against UV rays can be applied to humans to prevent basal and squamous cell carcinomas. To prove this, gene-altered TP-12 *C. elegans* was used as a model organism to test quercetin (a flavonoid found in chamomile) in its ability to prevent photoaging and prolong the nematode's lifespan under lethal UV conditions. TP-12 *C. elegans* produce green fluorescent protein (GFP) containing collagen through their dermal layer, causing them to fluoresce when exposed to UV light. When their dermal layer undergoes photoaging (the human precursor to skin cancer), their ability to produce collagen is inhibited, negatively affecting their ability to fluoresce. The *C. elegans* were treated with a quercetin flavonoid solution and validated for systemic uptake. Then, they were subjected to varying durations of lethal UV exposure. When compared to the non-flavonoid-treated *C. elegans*, the treated groups demonstrated a ~2X increase in lifespan after 2, 4, and 6 hours of UV exposure. The treated group scored, on average, 200% higher on the fluorescence scale compared to the untreated group. Flavonoid treated groups had an average of 192% longer lifespan after 2 hours, 450% longer after 4 hours, and 187% longer after 6 hours of UV exposure. Based on this data, quercetin flavonoid supplements have the ability to prevent basal and squamous cell carcinomas in humans. Further research will be needed to determine the optimum treatment needed for human application.

**Technical Disciplines Selected by the Student
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EN BI ME

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- Yes No

CSEF Official Abstract and Certification

Word Count

198

2024

Fair Category

LS

Project
Number

3111

Title: The Use of CRISPR-Cas9 in Different Lepidoptera Species Reveals the Major Genes that Control Wing Patterning and Coloration

Student Name(s): K. Shen

Abstract:

Many factors influence the colors and patterns on a butterfly's wing, including lamina thickness, which controls the appearance of structural colors; focal cells that determine the origin of certain patterns; and genes, some from biosynthetic pathways, that code for the presence or absence of a pattern. To validate this claim, experiments with CRISPR have been, and continue to be, conducted, proving each factors' role in the overall appearance of a wing. Different genes deleted from a single butterfly species reveal if those genes work in tandem with one another to produce a pattern or if they are independent of one another. In contrast, the same gene deleted from several different species reveals if the function of that gene varies from species to species or if it remains the same. Altogether these findings show the importance CRISPR technology has played in advancing scientific studies of Lepidopteras and its apparent role in modern studies. Understanding evolution has been a long term interest in the science world, and these butterfly knockout mutants display phenotypes that contribute to new speculations and solid conclusions. The way wing patterns give butterflies an ecological advantage, camouflage, is applied to the inconspicuous tools we humans use.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

AS CB

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

253

2024

Fair Category

LS

Project Number

3113

Title: Implementation of a Multi-Objective Genetic Algorithm to Optimize Resource Allocation in Disease Prevention.

Student Name(s): I. Bell

Abstract:

The Covid-19 pandemic displayed the necessity of proper response protocols to pandemics. While Covid has stagnated, studies suggest the threat presented by pandemics is still present and even growing more prominent. Despite the obvious importance of pandemic response, decision making regarding how financial resources are allocated during an outbreak is still traditionally done through estimation. This research explores development and implementation of a multi-objective genetic algorithm(GA) to optimize pandemic response and financial resource management through a combination of machine learning and mass simulation intended for government use. The program follows the standard GA model but deviates from traditional structure by evaluating each solution via a simulative approach during which the solution being evaluated is deployed to a simulated population amidst an outbreak. Input parameters, including behavioral data, affecting modeled people's movement, and virus data, affecting illness attributes, influence simulation function allowing the simulation process to be customized to accurately model the area/people which they preside over and the virus to be suppressed. By accepting additional input parameters specifying disease prevention budget as well as prevention measures to consider, their costs, and their effects, the program becomes scalable to any population, budget, and prevention measure in pursuit of applicability to future pandemics. The program was tested through deployment to two studied areas during the COVID-19 pandemic. Returned financial allocations were simulated and results were compared to actual cases/deaths from the time. The program outperformed actual disease response in both tests with significant reductions in both cases and deaths.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ME CS EN

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

263

2024

Fair Category

LS

Project Number

3114

Title: Comparison of intrabody-mediated degradation of mHtt through ubiquitin independent vs. dependent pathways

Student Name(s): J. Fan

Abstract:

Huntington's disease (HD) is caused by a mutation in Huntingtin gene (HTT) coding for the mutant Huntington (mHtt) protein. The mHtt protein causes neural cell death, leading to symptoms in HD patients. Degrons are degradation signals located in some proteins that direct misfolded or aggregated proteins to Ubiquitin-Proteasome System (UPS) for degradation. Intrabody is a small recombinant antibody that targets antigens intracellularly. Anti-mHtt intrabodies were found to be able to promote mHtt degradation and degrons can enhance the intrabody-mediated mHtt degradation. By involving various degrons, intrabodies can work through either ubiquitin-dependent or ubiquitin-independent pathway to degrade mutant proteins.

To investigate which of the above pathways is more efficient in intrabody-mediated mHtt degradation in developing a potential treatment for HD, we created HD cell model using HEK293 cells, and compared the intrabody-mediated degradation pathways with CL1 vs. PEST degrons fused to the intrabody. Live-cell fluorescence microscopy imaging and western blot were performed to evaluate mHtt degradation and the cellular mHtt protein level, respectively.

Results from the study showed that diffuse mHtt instead of aggregated mHtt was observed in cells transfected with C4-CL1 or C4-PEST, with the overall mHtt level being reduced for both transfected cell groups compared to control group, indicating that intrabody C4 facilitates mHtt degradation. Additionally, the ubiquitin-dependent proteasome pathway involving CL1 degron was found to be more efficient in mHtt degradation than the ubiquitin-independent proteasome pathway involving PEST. These results provide the scientific foundation of developing a potential intrabody-mediated treatment for HD disease via the ubiquitin-dependent pathway.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CB

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LS

Project Number

3115

Title: Analyzing mutations of the Spike protein of COVID omicron subvariants XBB and EG from their origin in order to identify correlations with their prevalence in the United States

Student Name(s): J. Zafar

Abstract:

COVID-19 is a CoronaVirus disease prone to genetic evolution that has caused the formation of many different variants. One of the main structural proteins in COVID is the Spike (S) glycoprotein which is responsible for attaching to receptors in several cell types in the human body and starting infection. The latest subvariants of Omicron have over 40 mutations which changes virus transmission rate and pathogenicity. The purpose of this project was to analyze mutations of the gene encoding the spike protein of COVID omicron subvariants XBB and EG from their origin in order to identify correlations with their prevalence in the United States. The hypothesis was that Omicron subvariants which have more mutations in the spike protein, specifically the Receptor Binding Domain and N-Terminal Domain or include critical mutations will have a higher prevalence. Newly identified genome sequences of different SARS-CoV-2 variants were collected from GenBank. For each subvariant a sequence was collected and analyzed from each week since the origin of the subvariant. They were then aligned with a reference sequence using the alignment program SnapGene which was used to find mutations. The mentor provided guidance and access to SnapGene and the student gathered and analyzed data. Each subvariant was compared to prevalence statistics from the National Center for Biotechnology Information. The results thus far partially support the hypothesis. The results of this project help identify the most critical mutations in COVID which can help future research on the virus and vaccine development.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

C BIO CB MI

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

LS

Project Number

3116

Title: The Effect of Disinfecting UV-C Light Exposure on Bacteria Content, Transparency and Flexibility of Soft Contact Lens.

Student Name(s): Z. Demo

Abstract:

Recently products have circled the Internet that suggest ultraviolet-c light as a new method to disinfect contact lenses. UV-C light has germicidal properties, however, the short wavelengths can be damaging to some materials, ultimately challenging the benefits of this method. This experiment was designed to determine the effects of UV-C light on the bacteria content, flexibility, and transparency of contact lenses. One lens from each pair of collected daily contact lenses was kept as a control and the other was exposed to UV-C light for either 1 minute, 5 minutes, or 10 minutes. After treatment all contacts were sampled on agar plates, then put through tests to determine if the flexibility and transparency of the lens was affected by the light. An ANOVA test on the data of the quantity of bacteria colonies, proved there was no statistically significant correlation between the duration of exposure to UV-C light and the number of bacteria colonies. The flexibility data showed no correlation between the duration of exposure to UV-C light and the amount of deflection a 1g weight inflicted on the lens. The data for transparency was statistically significant ($p < 0.01$), highlighting the relationship that the longer the lenses were exposed to UV-C light the less transparent they were, indicating by the increased absorption of light. With these results it can be concluded that UV-C light is statistically unsuccessful as a disinfectant and impacts the contact lens performance as a visual aid implement.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

BI AT ME

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

122

2024

Fair Category

LS

Project Number

3117

Title: The Affect of Sound Pollution on Armadillidium Vulgare

Student Name(s): D. Lanche-Flores

Abstract:

This research investigates the influence of sound pollution on the behavior of Armadillidium Vulgare, commonly known as Pill bugs, which were chosen as model organisms due to their sensitivity to environmental stimuli. The study aims to elucidate the potential consequences of sound pollution on pill bug behavior and, by extension, on ecosystems. A choice chamber experiment was designed, exposing pill bugs to vibrations mimicking those generated by humans, via transportation, at different decibel levels. These results did not provide a strong or any correlation between direct vibration exposure and pill bug migration/ avoidance behavior. However, this experiment did not provide sufficient data to support the correlation between increasing strength of vibration exposure to the increased avoidance and stressed behavior of the organism.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AS BE EV

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LS

Project Number

3118

Title: Implementing the Usage of Nontoxic Sand and Bacterial Filtration in the Enhanced Degradation of Emerging Contaminants in Aqueous Solutions

Student Name(s): S. Aliminate

Abstract:

Many freshwater sources are being impaired by emerging contaminants in the environment, which bring lasting, lethal effects on human and animal health. Due to the lack of research and difficulties in implementing cost-effective solutions, current water treatment systems have yet to remove most of these contaminants successfully. This project researches the implementation of nontoxic sand and bacterial filtration systems in degrading these contaminants, specifically Pharmaceuticals, Microplastics, Pesticides, and Heavy Metals, through Bitumen extraction of Naphthenic Acids in an aqueous solution. With sand's advantageous porous structure, it was hypothesized that the sand biofilter would filter out microplastics the most efficiently through its structure. Additionally, introducing bacteria to the filter in order to mimic those naturally living in oil sands would increase the system's effectiveness at filtering out bitumen/naphthenic acids. To test this, a biofiltration system was built using sand and *Pseudomonas putida*. Pharmaceuticals and Pesticide concentrations were tested using Liquid Chromatography Mass Spectroscopy; Microplastics were tested using microscopy through a counting mechanism similar to a hemocytometer, and heavy metal contamination resulting from bitumen contamination was tested using the Varify Drinking Water test kit. It was shown that implementing these biofilters significantly decreased the contaminants in the water samples. More specifically, the microplastic count decreased by four particles/mL, there were significant reductions in the average amount of pharmaceutical and pesticide contamination, and there were reductions in concentrations of various heavy metals detected before filtration. This demonstrates an efficient and quick source that is affordable, environmentally friendly, and easily implementable.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EV MI EM

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

LS

Project
Number

3119

Title: Conserving By The Meter

Student Name(s): K. Keddo

Abstract:

My project was to determine if I could use a moisture meter to promote water conservation while maintaining a healthy plant. Freshwater is becoming a limited resource by wasting water and pollution in water. The target audience for my project is for agricultural purposes. The moisture meter contains three sections: red (1-2), green (3-7), and blue (8-9). A moisture meter measures just the right amount of water for each plant. When measuring a moisture meter, I focused on keeping the meter green. My hypothesis was If I water plants based on the reading of a moisture meter, then I would conserve more water therefore reducing our use of freshwater resources. To test my hypothesis, I brought four coffee plants and created four different watering schedules. My controlled variable was watered based on what is considered normal for a coffee plant; the second plant was monitored by a moisture meter, plant three was watered every couple days, and plant four was watered 3 – 4 days after the soil was dry. I measured the height and pH levels. Throughout the experiment, the pH stayed alkaline. My observations showed that iteration 4 and the controlled variable were the ones that experienced the highest soil dryness. Iteration 3 was thriving initially, but it started to dry up. Iteration 2 has the highest success. Two flourished but it also received the least amount of water while being green. I think perfecting moisture meters and other green technologies could be beneficial in promoting water conservation.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

213

2024

Fair Category

LS

Project Number

3120

Title: The Effect of Plant Based Protein (Soy) vs. Animal Based Protein (Beef) on Sleep Quantity

Student Name(s): E. Yee

Abstract:

Plant based proteins have been associated with increased sleep quantity and quality in

previous research. This research seeks to directly compare the effect of plant based protein (soy) with animal based protein (beef) on sleep quantity in drosophila. Plant based proteins typically contain more tryptophan, than animal based proteins making them more effective in increasing sleep quantity. Tryptophan is an essential amino acid that also serves as a building block for melatonin, a neurotransmitter responsible for sleep and regulating the sleep cycle. Previous research shows that plant based proteins, especially in combination of fiber, are successful in increasing sleep quantity and sleep quality. Drosophila has been proven to be an effective model organism to measure sleep in humans as they share the same circadian rhythm patterns. Sleep can be measured by analyzing video data by hand over the course of 24 hours (if there is no access to a Drosophila Activity Monitoring, DAM, system). This research analyzed video data of drosophila with their respective diets over a course of 24 hours (in each of the 3 trials). This research is important because the amount of people adopting vegetarian or vegan diets has increased significantly in the past 30 years, and there is limited research regarding plant based diets, especially its effects on sleep.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ME

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

234

2024

Fair Category

LS

Project Number

3121

Title: Identifying the Progression Patterns of Alzheimer's Disease Using Longitudinal Clinical and Neuroimaging Biomarkers

Student Name(s): A. Song

Abstract:

Alzheimer's Disease (AD) is one of the most common neurodegenerative disorders worldwide. Therapeutics to treat AD or prevent AD progression have not been successful due to the possible heterogeneity of progression and individual patient responses to treatments. The goal of this study was to determine whether there is a common pattern of AD progression that can be used to guide clinical trials and treatment. Longitudinal clinical and neuroimaging biomarkers data from the Open Access Series of Imaging Studies were analyzed using an approach based on Mixture of Gaussian Processes Model (MoGP) to identify clusters that have similar patterns of progression. The approach enables non-parametric analyses with no assumptions on linearity and number of clusters. It was demonstrated that normalizing the patient's onset value yields better accuracy in stratifying patients by progression rate because it removes the systematic variations and imbalance induced by environmental and genetic differences among patients. Clustering results showed that AD progression is nonlinear, suggesting that the initial progression rate should not be used to evaluate future progression trajectory. It was also demonstrated that AD progression is heterogeneous among patients with each biomarker and among biomarkers within each patient., indicating the importance of personalized treatment for individual patients. Further analyses incorporating more data to strengthen the clusters will provide neurologists with a powerful tool for estimating the progression trajectory of each patient. This capability opens the door to personalized treatment options.

**Technical Disciplines Selected by the Student
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CBIO ME AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

269

2024

Fair Category

LS

Project Number

3122

Title: Rapid Detection of Pulmonary Fibrosis via Eu(TTA)₃Phen and Rhodamine-110, Dual-Sensor

Student Name(s): L. Huang

Abstract:

Automobile use continues to grow, causing a multitude of issues. Not only do motor vehicles release carbon dioxide, but their repeated use also releases tire particles. While climate scientists rightfully focus on carbon emissions, tire particulates also play a large role in human health, where they have been linked to pulmonary fibrosis (PF). Unfortunately, the detection of PF is difficult, requiring intensive and costly medical equipment. For these reasons, the design and creation of an accessible and affordable PF-detector is vital. Para-cymene is a breath component that is common in everyone, at 0.02ppm, however, for those with pulmonary fibrosis, its concentration is reduced. As such, a rapid, visual PF-detector, based on the breath composition of p-cymene, was the engineering goal of this research. A dual-fluorescent dye system was created from equal (0.2mg/L) concentrations of Eu(TTA)₃Phen and Rhodamine-110 each dissolved in ethanol. Using a 400nm excitation, the addition of normal breath condensate (0.2ppm p-cymene in water) to the dye solution changed spectral emission from pink to light-green, with an increase in the Rhodamine-110 540nm emission and no increase in the Eu(TTA)₃Phen 620nm emission. For PF concentrations of p-cymene, the same solution remained orange with consistent Rhodamine-110 (540nm) and Eu(TTA)₃Phen (620nm) emissions. This dual-dye system was moved to a 2cm-diameter cotton sensor, where the visible differences were more distinct. Using 400nm portable flashlight illumination, normal breath p-cymene concentration turned an originally orange sensor to white, while for the PF breath p-cymene concentration, the orange sensor color remained the same.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME EN AT

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

220

2024

Fair Category

LS

Project Number

3123

Title: Development of a Unique Carrageenan Based Matrix to Mitigate Hemorrhagic Trauma

Student Name(s): C. Borjas

Abstract:

Carrageenan is a polysaccharide that is a gelling and thickening agent which can be extracted from *Clathria prolifera* and *Chondrus crispus*. Hemorrhagic trauma leads to excessive bleeding, with current bandage technology it's unable to prevent product saturation and reduce pressure which inhibits a timely clotting cascade. Each year 60,000 people die of hemorrhages in the U.S. Overall goal is to save lives efficiently with an immediate reactive Carrageenan powdered substance accompanied with other substances to make a first-aid bandage. This project's goal is to determine a way to use *Clathria prolifera* and *Chondrus crispus* sourced carrageenan to form an instantaneous congealing bandage which will prevent bandage saturation and provide maximum clotting pressure. The carrageenan was extracted from locally harvested seaweed/sponge and lyophilized to form a pure carrageenan product. Dynamic viscosity testing was conducted on the H₂O/carrageenan matrix with an inclined plane (41.68°). Based on industry data, a bandage saturation of 0.1033ml/cm² inducing bleed through, it has been determined the target dynamic viscosity for maximum congealing properties is ~8 mPa-s. Through extensive repeated trials the target viscosity was achieved with a 53.09g/100ml ratio. This ratio translates into a practical bandage application of 0.04g/cm² carrageenan. To promote a rapid clotting factor, it is suggested to utilize an infused fibrin matrix coupled with the carrageenan matrix.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN ME BI

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LS

Project
Number

3125

Title: Inhibition of Prion Protein Propagation

Student Name(s): B. Cardamone

Abstract:

Transmissible Spongiform Encephalopathies (TSEs), or Prion Diseases, are rare neurodegenerative diseases with no known cure or treatments. Though understanding of their underlying processes is lacking, some information has been gathered. Firstly, no genetic information is responsible for TSEs. Instead, the 'prion only hypothesis' states that the prion protein, whose biological purpose is unclear, is the pathogen. In TSEs, the healthy prion protein, PrP^c, converts to a diseased isoform, PrP^{sc}. This isoform is known to be capable of conferring its malformity to the healthy variant. PrP^{sc} forms oligomers, fibrils, and amyloid plaques within the brain, the concentration of which is associated with symptom progression. Secondly, the removal of PrP from the brain via a monoclonal antibody has a stabilizing effect on the degeneration caused by Creutzfeldt-Jakob Disease -- a TSE -- in humans and mice. This paper proposes a novel technique for the treatment of TSEs wherein an interfering peptide (IP) is designed in silico which is capable of binding to PrP^{sc}, inhibiting its ability to convert more proteins, via interference in protein-protein interactions (PPI), slowing or halting disease progression. The IP will be designed utilizing a 3D model of the prion protein, its structure tailored to bind to 'hotspots', residues with higher binding energies and therefore a higher likelihood to interact with other molecules. The intention behind this is to provide succor to those, and their families, suffering, in the form of relief from the disease, further progress in their field, and hope that one day TSEs will be cured.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CB CBIO BI

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

253

2024

Fair Category

LS

Project
Number

3126

Title: Advanced Hybrid Water Treatment Systems: A Comparative Study of Membrane Filtration, Adsorption, and Photocatalysis for Comprehensive Contaminant Removal

Student Name(s): S. Aliminate

Abstract:

In the face of escalating concerns regarding water contamination and the pressing need for efficient treatment solutions, this study delves into advanced hybrid water treatment systems. Specifically, it explores the comparative effectiveness of three distinct treatment methods—membrane filtration, adsorption, and photocatalysis—in removing contaminants across diverse environmental contexts. I hypothesize that photocatalysis will emerge as the most effective method for removing and clumping particulate contaminants. The experiment integrates specific properties for each treatment method: membrane filtration employs varied pore sizes; adsorption utilizes activated carbon as the adsorbent for effective contaminant removal; photocatalysis incorporates titanium dioxide nanoparticles into water samples, subsequently exposed to UV light for contaminant filtration. Parameters such as turbidity, pH levels, light absorbance, particle concentration, and heavy metal concentration (iron concentration) were measured after each test. While all three methods induced aggregation of contaminants, the most notable efficacy was observed in the extreme conditions of photocatalysis and adsorption. These methods exhibit superior performance across all assessed parameters, including a nearly 200 NTU reduction in turbidity, pH neutralization, an average 100% increase in light absorbance, and a substantial decrease in heavy metal concentration. Photocatalysis and adsorption emerge as highly effective approaches for comprehensive water purification, encompassing diverse contaminants, while membrane filtration also offers notable efficacy. Initially designed for individual use, this system demonstrates promising scalability potential for industrial applications. Subsequent iterations will refine an integrated purification setup, providing environmentally sustainable and cost-effective solutions. The envisioned applications span from informing policy development to addressing the challenges of large-scale wastewater management.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EV EA CH

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

LS

Project Number

3127

Title: Determining the Location and Effects of Mutations in the DNA Sequence of Lung Cancer Tumors in Mice Model caused by Epigenetic Change

Student Name(s): D. Raissi

Abstract:

Epigenetics is a hereditary change in gene expression, the process of genetic sequence converted into instructions/function to create molecules caused by environmental factors. It was previously discovered that by removing a specific gene in mice, it removed methyl groups from histones that can activate/inactivate certain sections of DNA. The removal of the gene which interacts with epigenetic markers in mice led to an increase of lung cancer tumors in the second generation. The purpose of this project is to identify the location and predict the effect of genetic mutations in lung cancer tumors compared to regular lung tissue in mice. The independent variables are the various mutations in the tumor's DNA sequence. The dependent variable is the effect of the mutation on the protein. The control of the experiment is regular lung tissue. The first step is to organize a list of mutations in genes that control epigenetic change and organize it into a database, organizing based on location and domain mutations found in the protein's sequence. Next was to determine which protein, KMT2D, was the most activity in different mutations to further study in the lab. Then the immunofluorescence intensity of cultures of H3K4me1 and H3K27ac were compared between cultures with KDM6A knocked out and the control. No direct link between KDM6A and H3K4me1 and H3K27ac was discovered. This suggests that KDM6A does not affect the culture globally, but rather at a gene by gene basis. The implications of this project are identifying factors in how cancer spreads in humans.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

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- Yes No

CSEF Official Abstract and Certification

Word Count

254

2024

Fair Category

LS

Project Number

3128

Title: The Effect of Activating ATR-Kinase on Mitotic Timing and Blastocyst Survival In Mice Zygotes

Student Name(s): S. De Pinho

Abstract:

In early zygotes, replicating a mass amount of DNA causes stress leading to changes in daughter cells (Palmerola, 2022; Mihaljevic, 2022). It's a leading cause of IVF failure and chromosomal abnormalities (Yang, 2021). Slowing the initial replication down gives cells more time to replicate its DNA origins, potentially improving zygote survivability (Rainey, 2020). This study investigated whether activating Ataxia telangiectasia-Rad3-related (ATR) protein slows mitosis down (Rainey, 2020) and impacts blastocyst development in mice. mRNA encoding ETAA1's ATR Activating Domain (AAD) was created through gibson cloning, bacterial transformation into 5 Alpha E.Coli, and plasmid creation. ETAA1-AAD mRNA and mouse sperm were injected into oocytes (n=25). Zygote time in mitosis and blastocyst survival were compared to three groups: no electroporation (n=15)(control 1), electroporation no mRNA (n=11)(control 2), and Green Fluorescent Protein mRNA (eGFP mRNA)(n=18). Oocytes electroporated with ETAA1-AAD mRNA had 96% blastocyst survival rate compared to control 1 (86%, p=0.501), control 2 (100%, p=0.278), and eGFP mRNA (94.4%, p=0.811). Average mitotic entry for ETAA1-AAD treated-oocytes was 16.28hrs, compared to 15.93, 16.27, and 16.08hrs for control 1 (p=0.331), control 2 (p=>0.999), eGFP mRNA (p=0.789), respectively. With no significant differences between groups for blastocyst survival and mitotic entry, there is no toxicity to this approach. Future studies that challenge the blastocyst with replication stressors are required. Future studies will test if this approach improves success of IVF and decreases mortality rate in early stage zygotes under stressed conditions.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CB MI ME

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

255

2024

Fair Category

LS

Project Number

3129

Title: The Application of Amygdalin as an Early Stage Medicinal Cancer Therapy to act as an Accessible Option on a National Scale

Student Name(s): E. Alexy

Abstract:

Amygdalin, otherwise known as the vitamin B17 is a naturally occurring compound found in a variety of fruit kernels. This compound has been a subject of controversy in recent years due to lack of research surrounding the use of amygdalin as a cancer therapy though it has been proven in many cases to diminish cancer levels due to hydrogen cyanide presence within the compound. Despite the lack of consensus within the scientific community over the therapies efficacy and safety, over 70,000 cancer patients use amygdalin as a primary cancer therapy or in addition to their current treatment. During experimentation the efficacy of amygdalin in lowering cancer levels was conducted on gene mutated ZebraFish with non-mutated Zebrafish as the control. Amygdalin was isolated from ApricotAmygdalin solution was applied in a concentration gradient of 1.0×10^{-3} , 1.0×10^{-4} , 1.0×10^{-5} and 1.0×10^{-6} . Observations of activity and physical appearance were conducted to determine the therapies efficacy. Mutated Zebrafish who were given higher concentrations of the solution showed improvement and an increase in development, vibrancy and activity. In the non-mutated Zebrafish that were administered high concentrations showed a decrease in these functions, as predicted. It was hypothesized that if sequestered amygdalin is applied to both mutated Zebrafish, cancer levels will diminish due to the hydrogen cyanide compound within amygdalin proving to be an alternative, economically viable, therapy. The results support this hypothesis as there was significant resolution in the prior effects the cancer had on the mutated Zebrafish.

**Technical Disciplines Selected by the Student
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ME PS BI

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

256

2024

Fair Category

LS

Project Number

3130

Title: Coagulation Cascade Suppression and Enhanced Bioavailability via Biodegradable Polymeric Quercetin Nanoparticles

Student Name(s): F. Skibo

Abstract:

In America alone, over 100,000 people die from blood clots each year (CDC). There are existing anticoagulants, but quercetin is a natural alternative which may prevent clotting, but also holds significant health benefits including anti-inflammatory, anti-carcinogenic, and anti-bacterial properties. In this research, polymeric quercetin/PLG nanoparticles were fabricated to enhance the solubility, bioavailability, and anticoagulative properties of quercetin. The nanoparticles were prepared by the solvent evaporation method adapted from Avnesh, et al., where poly(D,L-lactide-co-glycolide), quercetin, and dichloromethane were sonicated, followed by the addition of PVA. Their efficacy as a delivery system was confirmed via a dissolution study which measured the timed release of quercetin from the PLG encapsulant. Full degradation of PLG was observed at 65 minutes with quercetin following close behind at 70 minutes. Subsequently, a coagulation study was performed to determine the ability of quercetin to inhibit the coagulation cascade. The study found that blood with 0.02 mg/mL quercetin clotted over 3.5x slower than normal blood, providing direct evidence that quercetin possesses anticoagulant properties. The engineered quercetin/PLG nanoparticles prolonged the blood clotting time 5.5x that of regular blood. Ultimately, the quercetin/PLG nanoparticles extended blood clotting time by more than 1.5x, relative to a free-quercetin solution. These results suggest two advantages for PLG encapsulation of quercetin; (i) the integrity of the nanoparticle for 65-70 minutes provides ample time for effective delivery of quercetin, and (ii) the bioavailability of quercetin is significantly increased by the PLG, leading to 1.5x increase in the anticoagulant properties.

Technical Disciplines Selected by the Student
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ME EN AT

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- Yes No

CSEF Official Abstract and Certification

Word Count

146

2024

Fair Category

LS

Project Number

3131

Title: PlanetProtect

Student Name(s): D. St-Louis

Abstract:

Members of my high school are surprisingly unphased by how their daily habits degrade the environment (53% hold a neutral stance on their carbon emissions according to my survey). This is an issue of lack of awareness and initiative. My ultimate goal is to help my peers and teachers lessen their carbon footprints, specifically regarding driving/commuting. To do this, I am building a web app called PlanetProtect that tracks individual driving data. Once it is complete, peers will volunteer to use the app for a period of two weeks. Both before and after releasing my app, I will distribute a questionnaire that assesses self-reported carbon footprint awareness. By using data collected from the app and answers from survey respondents, I will be able to determine if the use of PlanetProtect did indeed aid members of my school on their journey to lower carbon footprints.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AT ET BE

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

213

2024

Fair Category

LS

Project
Number

3132

Title: The Impact of pH on the Rate at which Organic Matter Decomposes in Compost

Student Name(s): A. Deras

Abstract:

Composting is becoming an increasingly popular sustainable waste management practice. However, soil microbes within this decomposition process may break down organic material slowly, leading to composting being somewhat inefficient. Consequently, this experiment investigates methods of expediting the composting process, specifically by altering pH.

Three compost piles, uniform in their organic material, were treated with different compounds to lower or increase pH. Aluminum sulfate was added to one pile to make it acidic, limestone was added to another pile to make it basic, and the final pile contained untreated soil. Once the piles were set up, they were weighed weekly and watered or turned if necessary. By measuring the weight of each pile, a property proportional to the mass of the pile, the data was able to convey which compost pile decomposes faster since they were all given the same amount of time to biodegrade.

This study suggests that soil microbes in the pile with a basic pH broke down organic material slightly faster than the other two piles, but more research must be done to confirm these results. The scale used within this research was not precise enough to measure small changes in weight involved in this experiment, and recording observations over a longer period of time would likewise point to clearer results.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM PS MI

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LS

Project
Number

3133

Title: Determining the Effects of Moisture Content in Artificial Diet on the Survival, Growth, Development, and Pupation of *Anoplophora glabripennis*

Student Name(s): S. Osowiecki

Abstract:

Asian longhorned beetles (*Anoplophora glabripennis*, or ALB) are an invasive insect species native to China and the Korean peninsula. A highly destructive invasive pest, they target a variety of trees, primarily hardwoods, and develop by feeding mostly within the host tree, damaging its structural integrity. It is not yet known whether the implicit disparities in moisture content caused by host health and wood quality affect ALB. The purpose of this study was to determine effects of moisture content in artificial diet on *Anoplophora glabripennis* survival, growth, development, and pupation. The hypothesis was larvae reared on artificial diet with 40% moisture would survive longer, gain more weight over time, develop at a faster rate, and have a higher percentage of pupation. The independent variable was artificial diet moisture content. The dependent variables were the survival, growth, development, and pupation of the larvae. Two treatments of 60 larvae each were used (a control treatment of ~70% moisture and an experimental treatment of ~40%). Larvae were weighed, placed into treatments, and kept at the ideal rearing temperature of 25° C for the study's duration to simulate their preferred environment. Larvae were checked for growth, deaths, and pupation at 4, 8, and 12 weeks. In the dry diet group, more individuals survived, pupated, and reached adulthood, but control group individuals grew faster on average. This study could provide an understanding of the impacts of different diet moisture contents on the potential for future spread and establishment of this species, which is an urgent issue.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EV EM AS

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

242

2024

Fair Category

LS

Project Number

3134

Title: Acoustic Noise Pollution Affecting the Behavior and Development of Artemia Salina

Student Name(s): A. Taylor

Abstract:

This experiment investigates the impact of noise pollution on the behavior, health, and development of brine shrimp (*Artemia salina*). The study is conducted in the shrimp's natural environment, replicating the temperature and habitat found in saline waters. To carry out the experiment, two 10-gallon tanks are used. Both tanks contain an equal number of brine shrimp. However, in one tank, the shrimp are kept undisturbed in their natural environment, while the other tank is subjected to noise pollution to observe its effects on the shrimp. Two speakers are placed next to one of the tanks and a 700 Hz test tone is played, which is the same frequency that is emitted from a wind turbine underwater. To document the frequency of the acoustics being transmitted underwater, a hydrophone is used. To monitor the shrimp's shell deposition, their average weights are recorded each day after taking a small sample of them, drying them, and counting how many shrimp are in the petri dish. It's been observed that the experimental group is experiencing an increase in their shell deposition a day after hatching, but then decreasing afterwards. In regards to the behavior, the shrimp being subjected to the noise are completely non-moving or are struggling to move. It's also been observed that the shrimp are swimming quickly in circles and are swimming close together. This data is essential for understanding intense acoustic in the water and its potential effects on the shrimp.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

AS EV AT

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

201

2024

Fair Category

LS

Project
Number

3135

Title: Stimulus for the PSI Prion in *S. Cerevisiae* Under Exigent Circumstances.

Student Name(s): A. Yi

Abstract:

The Manuelidis Lab at Yale has posed the question of whether or not prions are truly randomly-folding or, instead, aggregate as a result of cascade activation by external stimuli. In order to investigate this, samples of HA12 *S. Cerevisiae* have been used to monitor the occurrence of PSI prions in various exigent circumstances involving naturally occurring bacteria competing for the same source of sugar and nutrients. Differences in prion propagation in different circumstances following a general trend would suggest a [PSI+] phenotype that makes yeast cells more evolutionary competitive. Ten plates of YPD were prepared with various naturally-occurring bacteria given differing amounts of time to grow on the media. HA12 *S. Cerevisiae* maintained on a media with adenine was then streaked onto the plates lacking adenine and allowed to incubate for four days. The rate of consumption of adenine was tracked by watching the change of color of [psi-] to red when producing its own adenine. [PSI+] cells remain white. Yeast grown in the presence of flat, filamentous bacteria were the slowest to use up their supply of adenine, indicating that external factors interact in some way with the adenine pathway in ways similar to those observed with prions.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

MI

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

LS

Project Number

3136

Title: Effect of Organic Fertilizers on Soil Carbon Levels, Soil Microbial Activity and Carbon Sequestration in Baby Lettuce

Student Name(s): T. Cassell

Abstract:

Soil is one of the largest carbon (C) holders in the world (Panettieri et al.,2022); therefore, agriculture possesses the potential to decrease C in the atmosphere. Enhanced soil nutrients boost plant biomass and C absorption. As plants intake C, it's deposited in the rhizosphere, soil around roots. Microorganisms absorb and convert it into biomass C, amplifying microbial activity with greater plant C inputs. (Adingo et al.,2021). Although no studies directly compared organic fertilizers' (OF) impact on soil microbial activity and C sequestration in lettuce, prior research showed OF enhance soil C more than synthetic. (Nakhro, 2010). After lettuce germination, lettuce was transferred to control soil and supplemented with one of four OFs--fish emulsion, cow manure, worm castings, bone meal-- and grown for 64 days. The microbial respiration(Slovita test kit), and percent C in soil/lettuce measured by vario macro analyzer (UCONN). Soil with bone meal had the highest C at 6.5%, fish emulsion and cow manure at 1.5% each, and worm castings matched control soil at 0.05%. Soil microbial respiration, lettuce tissue wet-to-dry weight ratio, and % C in lettuce were similar (anova: $p>0.05$). Despite soil C level differences, these variations didn't affect lettuce growth notably. Other studies found OFs increase C uptake and plant biomass compared to control soil, but this study didn't have similar findings. The lack of correlation in soil C, tissue, microbial respiration and plant growth suggest the impact of these fertilizers most likely need to be studied on a longer timeline.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EV EM EA

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LS

Project Number

3137

Title: Testing the Efficacy of an Applied Low-Voltage Current on Mosquito Blood-Feeding Prevention

Student Name(s): R. Liu

Abstract:

Electrical charges have been known to affect insect behavior, although this has only been correlated with avoidance thus far. The purpose of this project is to test the efficacy of an applied low voltage direct current (DC) on mosquito blood feeding prevention. By using a lower setting voltage, resistance effects can be gained while not ceding human safety. The independent variable is the voltage setting that is applied to the mosquito feeding apparatus. The dependent variable is the percentage of mosquitos that were prevented from blood-feeding. A permeable membrane will be constructed out of conductive knit strips, fiberglass weave. The conductive knit will have strips about an inch longer lengthwise to allow attachment to a power source. Defibrinated lamb blood will be heated to 37°C using the Hemotek artificial feeding system and then the blood will be placed in a small plastic vat/gasket. The gasket - membrane apparatus will be placed within the rearing cage with the wires leading out to the battery that is placed outside. A designated number of Aedes aegypti mosquitoes will be used for each trial (e.g. 30 or 50). After the period, mosquitos will be freezed and crushed onto white paper to see if feeding occurred (each red splotch counts as successful feeding). The implications of this project include further insight into how direct currents interact with mosquito feeding. Possible applications of a successful low-voltage prevention may lead to other applied uses in designing special charged fabrics and other apparatuses for insect prevention.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

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238

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Fair Category

LS

Project Number

3138

Title: Determining the predictiveness of Beech Leaf Disease symptom severity based on overwintering nematode abundance in *Fagus grandifolia* buds

Student Name(s): D. Watson

Abstract:

Beech leaf disease is a novel disease impacting *Fagus grandifolia* (American beech) in the Northeastern United States. It was first discovered in Ohio in 2012 and has since spread across the Northeast. It has been determined that beech leaf disease is caused by the infestation of plant parasitic nematode, *Litylenchus crenatae mccannii*, yet little is known about the causal agents of beech leaf disease. Symptoms include interveinal banding of the leaf, leaf crinkling, bud abortion, and eventual tree mortality. To determine how these symptoms occur, the population of overwintering *L. crenatae mccannii* nematodes was measured in buds from *F. grandifolia* trees flagged at MDC Reservoir #6 in West Hartford, CT. The symptom expression of leaves on the same branch and most immediately next to the bud that was sampled in February was assessed. Two leaves were selected for spring leaf-out assessment per single overwintering bud. Severity assessments were made using an ordinal scale developed specifically for beech leaf disease symptom expression. Statistical analysis comparing nematode count per 5mL and leaf symptom severity score revealed a moderate positive correlation between the two variables. These results indicate that the nematode abundance of overwintering *F. grandifolia* buds can determine the symptom expression of nearby leaves. In addition, confirming the relationship between the level of nematode infestation in overwintering *F. grandifolia* buds and symptom expression can serve as foundational knowledge in understanding the causal agents and vectors of beech leaf disease.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

PS

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

251

2024

Fair Category

LS

Project Number

3139

Title: Nano-Coatings for Tooth Remineralization and Tooth Protection.

Student Name(s): K. Keerthivasan

Abstract:

Tooth decay and staining pose significant challenges in dental health, often leading to discomfort, aesthetic concerns, and extensive treatments, leveraging advancements in materials science and experimentation methodologies. The primary objective was to evaluate the effectiveness of nano-hydroxyapatite in preventing tooth decay and mitigating staining caused by common dietary factors. Despite significant progress in dental care, tooth decay remains a prevalent concern globally, impacting individuals across diverse demographics. The study involved comprehensive procedures, including pH measurements of various beverages- soda, vinegar, citric acid, sports drink, water, tea/coffee, milk, fruit juice- and immersion of artificial teeth to simulate real-life exposure. Additionally, a nano-hydroxyapatite solution was developed and applied to teeth to assess its protective properties against staining and degradation. Concurrently, petri dishes coated with the solution were utilized to examine its potential in inhibiting bacterial growth with saliva, a key factor in tooth decay. Preliminary findings indicate promising outcomes, with reduced staining and softer texture observed on teeth treated with nano-hydroxyapatite. It was also noticed that the more acidic or colorful the beverage was, the more staining occurred. Moreover, coated petri dishes exhibited decreased bacterial proliferation compared to non-coated ones, suggesting the material's potential in preventive dental care. The study's broader implications extend to enhancing dental health practices and addressing disparities in access to oral care, particularly in underserved communities. Further research endeavors could refine the application of nano-hydroxyapatite and explore its integration into mainstream dental care practices, fostering a brighter future for dental health worldwide.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

217

2024

Fair Category

LS

Project Number

3140

Title: Caffeinated Energy Drinks Effects on Athletic Performance

Student Name(s): C. Hicks

Abstract:

With a large amount of young adult athletes consuming highly caffeinated beverages, further research into their ingredients is extremely necessary. Creating awareness and helping to educate the public and athletes of all levels about the possible effects consuming caffeinated energy drinks may have. As well as increasing our knowledge of how these energy drinks and the herbs they contain may boost athletic performance. Main ingredients such as guarana, ginseng, and taurine are highly concentrated in these popular drinks. In this experiment, I focus on the possible stimulant effects of guarana on fruit fly behaviors as similar indicators to human athletic performance. I hypothesized that if given an herbal stimulant of paullinia cupana then drosophila melanogaster will experience little to no increased movement behaviors over a period of time. By performing a serial dilution and administering different concentrations of a water and guarana solution, I was able to see if there were different effects based on dosages. I then recorded the flies that were administered the different concentrations, as well as a control group who was given only water. When reviewing my data, I focus on the behavioral and physical indicators shown by the flies such as flight and response times. Initially, my data shows little to no differences between concentrations and between control and guarana-dosed flies.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

152

2024

Fair Category

LS

Project
Number

3141

Title: Using Evolutionary Adaptation of Bacteria with Artificial Pressures from UV Radiation to Create Antibiotic Activity

Student Name(s): E. Smith

Abstract:

With UV radiation, Bacillus subtilis bacteria, and E. coli are plated in a test to see if there is any antibiotic activity due to the random mutation from the UV radiation with the B. subtilis so that a mutation that creates antibodies against E. coli. The UV radiation is administered at 254 nm at 4 watts onto the B. subtilis colony, covering the E. coli colony with tinfoil. Each generation will be pictured and recorded to have possible and no signs of antibiotic resistance, saving each generation in a fridge. The results are still ongoing with no signs of antibiotic resistance that have stayed for multiple generations as plating errors may have taken place to create false positives. A chemical extraction on the possible antibiotic is being currently done and the results are to be determined. Without any conclusive evidence it may take longer or even too long for results to appear.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

MI

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

260

2024

Fair Category

LS

Project Number

3142

Title: Development of Non-Invasive Diagnostic Tool for Lipedema Using Colorimetric Analysis of

Student Name(s): H. Dcruz

Abstract:

Lipedema is a chronic condition that affects the lymphatic system, causing a localized build-up of subcutaneous fatty tissue in the lower half of the body. This disease is recognized by its disproportionate distribution of body fat while the trunk remains slim, and is often misdiagnosed for weight disorders. Currently, clinical diagnosis for lipedema is unclear, and successful only in later stages, where treatment is difficult. As a result, patients must face extreme discomfort and negative impacts on their mental health and quality of life. This research focused on the design and creation of a non-invasive, effective diagnostic tool for lipedema, based on an image classification algorithm (using a Convolutional-Neural-Network), which will provide an accurate diagnosis for lipedema based on patient skin images. Close inspection of a patient's typical (torso) vs. bumpy-dented skin (often legs) highlights changes in reflected skin color, as the stages of lipedema progress. These findings served as a basis for an AI-model that was trained with ~300 anonymous images of lipedema and normal patients. The Lipedema-Predictive Model (LPM) predicts the condition, based on calculation of a \hat{y} value, where >0.5 is normal, while <0.5 indicates a positive diagnosis for lipedema. The LPM was validated with 20 patient images, diagnosing these patients with 90% accuracy. In use, those evaluated for lipedema will be tested using the LPM diagnostic, and also asked to complete the pre-noted lipedema questionnaire. The combined LPM-Questionnaire diagnostic will identify lipedema with $>95\%$ accuracy, allowing patients to receive proper medical treatment, which is currently elusive.

**Technical Disciplines Selected by the Student
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ME EN AT

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4. Is this project a continuation? Yes No

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Yes No

CSEF Official Abstract and Certification

Word Count

228

2024

Fair Category

LST

Project
Number

3501

Title: An Organic Solution for Microplastics: Investigating the ability of Comamonas Testosteroni to break down microplastic precursors in a liquid environment

Student Name(s): G. Trahanas, O. Velasco

Abstract:

The purpose of this experiment was to investigate the abilities of Comamonas Testosteroni soil bacteria to digest polyester plastic precursors, as well as dyed polyester fibers, in a liquid environment. It was hypothesized that *C. testosteroni* would exhibit proficiency in breaking down microplastic particles in a liquid environment, while oxygen availability and a constant temperature of 31°C are maintained, effectively offering an organic solution to a problem that cannot be solved by conventional chemical or mechanical engineering. The developmental stage of experimentation involved examining the behavior of both the *C. testosteroni* KF-1 strain and various precursors individually in order to determine parameters for advanced experimentation, including solubility tests for TPA and PTA powders, and multigenerational agar plate culturing of *C. testosteroni*. The experimental stage involved testing *C. testosteroni*'s ability to digest TPA, PTA, and polyester fibers in various liquid environments, including nutrient broth and distilled water, over periods of four days per trial. Quantitative data was collected via vacuum filtration and comparison of initial vs. final precursor powder mass. Qualitative data was collected in the form of initial and final photos of experimental trial flasks. Collected data was analyzed for significance and real-world implications, and it was concluded that *C. testosteroni* is effective in organically digesting polyester component microplastics in liquid environments, as evidenced by up to 75% digestion of PTA and TPA in experimental trials.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN MI EM

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

253

2024

Fair Category

LST

Project Number

3502

Title: NatureCare project

Student Name(s): Y. Mulualem, D. Gaudencio, C. Kumar

Abstract:

This project report presents a hospital designed to have minimum impact on the environment and, at the same time, medical treatment with maximum efficiency. Incorporating renewable energy technologies, smart waste management, and environment-friendly materials ensures that the carbon footprint from the hospital is reduced to the maximum extent, thereby meeting sustainability based on nature-healing principles.

Introduction: Among the several important domains, hospitals are considered prime contributors toward the degradation of the surroundings. This paper is written with the objective of catering to the need for sustainable infrastructure through new innovations about designing approaches.

Method: The design respects the environment at all stages of the building, with careful choices of locations and attachment to existing structures where possible. Our designs are highly economical in terms of energy usage, since solar panels and energy-efficient technologies will be employed to power technology. There will be minimal energy usage through water conservation methods, including rainwater harvesting and greywater recycling. Sustainable materials are selected and include recycled steel, reclaimed wood for construction, designed to lower environmental impacts. Further sustainability follows in waste management strategies involving reuse. Aside from reducing carbon emissions, NatureCare plans to add green space for the health of the patient. This will give an opportunity to be engaged within a community and have environmental stewardship.

Conclusion: Sustainable designing of a hospital is more than just taking care of the environment; it involves taking care of patients' health at the same time. Cleaner practices in hospitals will guide our future towards healthy sustainability.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ET ME EN

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LST

Project
Number

3504

Title: Reducing Plastic Waste A Little At A Time

Student Name(s): A. Omer, A. Rho

Abstract:

The project aimed to tackle escalating problem of plastic waste in oceans through comprehensive awareness campaign. Recognizing the urgent need to address this issue, the campaign utilized posters, social media outreach, and community involvement to increase awareness and prompt action. The hypothesis posited that a coordinated effort would result in heightened knowledge and engagement within the community. The campaign unfolded in multiple stages, strategically placing posters in locations while leveraging social media platforms to amplify the message. A dedicated website directed individuals to support the cause by contributing to Team Seas, an organization combating ocean pollution. Observations revealed staggering amounts of plastic waste, particularly evident in the Great Pacific Garbage Patch, where the ocean's plastic has increased significantly over the years.

Results demonstrated a direct correlation between the rise in plastic waste and environmental impacts, including rising sea levels, increased pollution, and detrimental effects on marine life due to oxygen depletion. Despite these challenges, the project's conclusions underscored effectiveness of the holistic awareness campaign. Active community participation was evidenced by heightened awareness levels and increased donations, highlighting the positive impact of the initiative.

The project's success suggests a promising approach for addressing environmental issues, serving as a blueprint for future initiatives. By integrating traditional methods like posters with modern platforms such as social media, communities can actively contribute to global causes and combat environmental degradation. However, the severity of plastic pollution underscores urgent need for continued action to prevent further harm to marine ecosystems and planet as a whole.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM EV EA

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

208

2024

Fair Category

LST

Project Number

3506

Title: Commercial vs. Edible Plastic Wrap: Determining the Superior Film for Food Storage

Student Name(s): K. Barney, C. Troiano

Abstract:

As society gets more environmentally conscious of what damage everyday items are doing to our planet, we run into the issue of what we will do or use to replace them. Plastic wrap, a common household element, is a large contributor to this negative effect on our environment and humanity. Our project proposes a sustainable, decomposable, and edible alternative to plastic wrap made of millets that is easy to make and has similar characteristics. By obtaining information from a variety of sources, we constructed and created a film whose qualities resembled its counterpart. Through a series of adjustments in ingredients and testing the film's durability, versatility, adherence, food preservation, and decomposition skills, we made a product similar, but not quite equivalent to commercial plastic wrap. In our research and experiments, we found that the addition of liquid glycerol improves the film's elasticity and strength, the inclusion of an alkali compound could potentially improve its resilience (excluding baking soda), and that our specific film was more flexible, more decomposable, and retained food quality the same as plastic wrap. Ultimately, we determined that if we were to continue this project, we would have to find a way to improve the film's durability, adherence, and consistency in its characteristics over time.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN CH

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LST

Project
Number

3507

Title: Using Mineral Packed Liposomes to Increase Plant Growth in Arid Environments

Student Name(s): T. Spiess, H. Johnson

Abstract:

The purpose of this study is to investigate whether the introduction of liposomes carrying essential nutrients such as magnesium would increase the growth rates of tomato plants without causing excess water usage. It was hypothesized that the application of manufactured liposomes would serve as a promising system of nutrient delivery. During sonication of the procedure, ethanol helps produce the liposomes by promoting the lipids' vesicle formation as the liposomes surround and package the intended nutrients. Then, the newly formed non-polar liposomes could pass through the polar stomata of the plant as the packaged polar magnesium goes undetected. In trial one, these liposomes were administered independently and with magnesium to 2 groups of 4 plants. Both groups of liposomes outperformed the negative control. Every group received the same amount of water, except the negative control did not receive any liposomes. This proved that the liposomes with magnesium had successfully delivered its nutrients to the plants while it was uncertain why the independent liposomes, which carried no nutrients, were most successful. In trial two, varying amounts of liposomes were administered to 4 different plants with one positive and negative control as well. In trial two, while the data could be easily misleading with so few data points, it was observed and hypothesized that the liposomes were clogging the plants stomata, potentially trapping the water in the plant from evaporating through the stomata. Therefore, basing only off trial ones' accurate data, the application of manufactured liposomes to dehydrated tomato plants was successful.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

PS CB EM

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LST

Project
Number

3508

Title: Defining the Significance of Inflammation in Atherosclerosis by Examining Cross-Cohort Transcriptomics Using R and Deep Learning Programs

Student Name(s): P. Liu, L. Zhang

Abstract:

Atherosclerosis is a leading cause of death with the accumulation of fatty plaques in arteries that affects 18.3 million (8%) of adults in America. Currently, the most popular treatment strategy for atherosclerosis aims to lower blood-lipid levels; however, this is not effective for every patient, suggesting additional factors should be considered. Although studies and some clinical trials have shown that inflammation could be a factor, many questions remain: how important is inflammation in atherosclerosis, and why some patients develop life-threatening conditions? Our project aims to understand if inflammation is crucial and what genes promote atherosclerotic inflammation. To find what genes were expressed differently in atherosclerotic patients compared to healthy people, we analyzed gene expression data from blood samples of 391 participants with different atherosclerosis severity (control, intermediate, or severe) using R programming. We calculated genes' expression fold change across groups, and performed pathway analysis to investigate what signaling programs are highly relevant to atherosclerosis. Meanwhile, we analyzed every sample using a cell function assessment program (inflammation, lipid handling) AtheroSpectrum, developed from machine learning methods. We found that genes in inflammatory pathways are expressed at significantly higher levels in patients with atherosclerosis than in controls. Interestingly, genes causing atherosclerosis are different in men from women, with higher inflammation observed in female patients. In the future, we will do cross-cohort analyses with other gene datasets and narrow down the gene list with feature selection machine learning programs. These discoveries could provide valuable information for improving atherosclerosis treatment or prevention.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

LST

Project Number

3509

Title: Renewable Fuel using Anaerobic Digestion

Student Name(s): J. Coulombe, T. Lambert

Abstract:

As of 2022, 36.6 billion tons of greenhouse gases were emitted into the atmosphere. Fossil fuels are the number one contributor to global climate change, including 90% of the CO₂ emissions. Many landowners have opted to use a better environmentally friendly method called a biodigester. This system utilizes organic waste like manure and compost to produce fertilizer and biogas. Biogas is mostly composed of methane, but its composition depends on the type of organic matter used and decomposition conditions. Methane gas is what gives biogas its fuel properties for use in industry. A biodigester in its operation is similar to the digestion system of an animal: organic matter enters, is digested by bacteria, and then gasses produce. This project shows a model proving that this method can be used for generating heat, and electricity, as well as fuel use. The biodigester most agriculture industries use is called continuous because the feeding of organic matter is constant. The retention time is much less because the influent is equal to the effluent as you feed. Biogas contains high concentrations of pollutants, but the large amounts of C₂O and H₄S reduce its calorific power. The unit was built by using 2 Erlenmeyer flasks, a sepatory funnel, and plastic tubing. By adding equal ratios of organic matter, manure, and water to the anaerobic system the process of hydrolysis starts. As this process starts microbes break down the food into simpler compounds making organic acid. The combination of CO₂ and CH₄ creates biogas.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN EA EM

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

262

2024

Fair Category

LST

Project Number

3510

Title: A novel approach to preventing the PrPSc induced neurotoxicity which characterizes Creutzfeldt-Jakob disease through the inhibition of Glypican-1.

Student Name(s): S. Rajan, S. Rajan

Abstract:

Creutzfeldt-Jakob (CJD) disease is a rapid and invariably fatal disease for which no cure currently exists. It is characterized by aggregation of misfolded proteinaceous infectious particles (prions). In CJD the healthy cellular protein PrPC undergoes conformational changes, going from an α -helix-rich secondary structure to containing more β -sheets. These changes cause the protein to gain mechanisms of aggregation and become less prone to lysis. These qualities make CJD an aggressive disorder with devastating impacts.

Our project focuses on a drug-based solution to the disease, exploring a novel approach of targeting Glypican-1, found in the cellular pathway where PrPC changes. We propose the inhibition of the scaffolding protein Glypican-1 through the ligand Monomethyl Auristatin F (MMAF) as a method of preventing the formation of infectious scrapie isoforms of the cellular prion protein (PrPSc). Competitive inhibition of Glypican-1 will prevent the PrPSc induced neurotoxicity which characterizes CJD.

We have used advanced computational techniques to simulate drug delivery of MMAF as a therapy for Creutzfeldt Jakob disease. Docking run on the software HADDOCK (High Ambiguity Driven protein-protein DOCKing) showed that MMAF had a HADDOCK score of 10.0 when docked to Glypican-1, while PrPc had a score of 32.9. This lower score indicates MMAF is a strong candidate for competitive inhibition of Glypican-1 in CJD patients. Along with this, we ran an advanced molecular dynamics simulation on SiBioLead that revealed that MMAF sustained hydrogen bonds with Glypican-1, indicating binding. Our experiments therefore suggest that the drug MMAF can effectively stop the flux of PrPSc aggregates.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME CBIO CB

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

235

2024

Fair Category

LST

Project
Number

3511

Title: Tanghulu: Sweet or Sticky? Crisp or Clumpy? ASMR Worthy?

Student Name(s): L. Jeong, L. Kim

Abstract:

The objective of this experiment was to identify the most effective ratio of solid sugar crystallization in tanghulu. Oftentimes, the inaccuracy of the ratio of ingredients results in a tacky consistency, which differs from the authentic solid crystallization over the fruit. With the growing popularity of tanghulu globally, we sought to try it and discovered that it was more difficult to make the candied fruit than imagined. During our first few attempts, we failed to create an accurate product even after following several examples and recipes that were most popular, instead creating a soft or slippery texture. Thus, we began experimenting with temperatures and ratios, and started to wonder about the science behind why results were inconsistent, working sometimes and not others. To conduct our investigation, we altered the ratios of sugar to water when making the tanghulu, as these are the two ingredients that alter the consistency of the crystallized sugar. Ultimately, we determined that a 2.125:1 ratio of sugar to water would be most effective in getting our desired results, a thin, crisp, and even texture of the syrup coating shell. Sugar crystallization and what causes it, although simple, also can be extended to various other chemical reactions. The process of experimenting with ratios is widely used in the scientific research field, and this opportunity created a chance for us to test out various variables within our homes and discover new ideas independently.

Technical Disciplines Selected by the Student
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ME

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

241

2024

Fair Category

LST

Project Number

3513

Title: The Impact of Ocean Acidification on Photosynthetic and Growth Rates of Rhodomonas salina, Amphidinium, and Auxenochlorella pyrenoidosa

Student Name(s): E. Lorenz, R. Ahn

Abstract:

As more CO₂ is emitted into the atmosphere each day, more CO₂ is being dissolved into the oceans, producing carbonic acid (H₂CO₃) which lowers the pH of the ocean. The purpose of this experiment is to investigate algal growth and photosynthetic rates in different pH levels in order to better understand what role algae will play in future oceanic ecosystems. Three different algal species were tested: Rhodomonas Salina, Amphidinium, and Auxenochlorella pyrenoidosa. These three species were tested in three pH solutions: 8.2, 7.5, and 6.8. It was hypothesized that if the photosynthetic and growth rates of algae are tested in the aforementioned pH values, then the species in the tank with a pH of 8.2 will have the highest rates of growth and photosynthesis because marine algae have biologically adapted to live in this same pH; that of the oceans. Moreover, the further from this pH, the lower the rates of growth and photosynthesis will be. Through thorough and careful testing, it was corroborated that algae in a pH of 8.2 consistently had a higher absorbance rate; however, the pH level of 6.8 was not as far behind as hypothesized. Regarding photosynthetic rates reflected through the concentration and production of dissolved oxygen, the pH level of 6.8 was the most beneficial for the algae, but a pH level of 8.2 was not very far behind. The pH level of 7.5 was consistently the least beneficial for algal growth and photosynthetic rates.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EV BI AS

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

232

2024

Fair Category

LST

Project
Number

3514

Title: The Mozart Effect

Student Name(s): N. Guzman, A. Cajilima

Abstract:

The topic of this project was the Mozart Effect. The Mozart Effect has many benefits, some being lowering of blood pressure, helping with spatial reasoning, and increasing one's IQ score. The main point tested for this experiment was that listening to Mozart's Sonata would help increase a participant's IQ. This experiment was chosen because many scientists were split between it working and it not working. The plan was to test 10-15 people of different ages and gender to see if age and gender may affect the results. After getting the participants, the group was split into two smaller ones. Each participant took the IQ test twice, but one group started by listening to music first, while the other group did the test without music first. It was expected that the group that listens to music second would get a lower score at first and then will get a higher score after they do the test again with the music. The difference between with and without music is not much, but once the participants were split by gender, there are many variations. Overall, the initial hypothesis was proven wrong. In future research it would be interesting to see why females and males have such variations in their results. For future research it is suggested to follow the same steps used with this experiment, the only difference might be the IQ test they use.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BE ME CBIO

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

148

2024

Fair Category

LST

Project Number

3515

Title: The Great Rooftop Garden Experiment

Student Name(s): J. Laguerre, M. Lackran, T. Atkins

Abstract:

This experiment was designed to test the effectiveness of implementing rooftop gardens in urban cities to increase drainage and reduce flooding. In order to conduct this experiment, two rooftop gardens were created. One herb was planted in the first rooftop garden, while two herbs were planted in the second rooftop garden. Every three days, heavy rainfall was simulated by pouring one cup of water on each garden.. After simulating days of heavy rainfall, excess water was collected, measured and recorded. The data collected from the two rooftop gardens was then compared to the control group, which was a garden with only soil. As anticipated, the two rooftop gardens produced less excess water than the control group and therefore supported the hypothesis that implementing rooftop gardens in urban cities could prove to be a beneficial solution in regards to increasing drainage and decreasing the amount of flooding that occurs.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM EV EA

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

246

2024

Fair Category

LST

Project Number

3517

Title: Saving the Scraps

Student Name(s): S. Holovatska, G. Zeng, A. Nair

Abstract:

Upon the significant CH₄ emissions produced globally, we aim to lower CH₄ emissions by reducing food and landfill waste in Connecticut. Additionally, we strive to raise awareness of the harmfulness of food waste within our school community. We conducted a survey asking students to what degree (if any) they throw away their fruits/vegetables, and whether they would participate in separately discarding their produce. We placed a bin in our schools cafeteria, solely for fruits and vegetable scraps that we collected, processed and transported to our local community garden everyday after school, for approximately 2 weeks. We extended our focus to implementing legislation PA23-170. In 2024, we will conduct a second survey and a food tally to quantify and categorize produce waste generated by students and what produce students would prefer to eat instead. In approximately 2 weeks, we collected 56.11 lbs. of food scraps that would have otherwise been sent to landfills. The first survey, with 214 responses, 68% of people stated they discard their fruits and vegetables to some degree. Additionally, 94% of students would be willing to use our cafeteria bin. In conclusion, we increased sustainable student practices and awareness surrounding the amount of produce being wasted, and created a student lead initiative, for composting fruits and vegetables. Over 2 weeks, we reduced, CH₄ emissions by 1.8 kg and landfill waste by 56.11 lbs. Overall, we offset landfill waste and in turn reduced the amount of pollutants entering our atmosphere, soil and water.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM PS BE

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

172

2024

Fair Category

LST

Project Number

3518

Title: How Does Golf Course Runoff Effect Rooster River in Fairfield, Connecticut?

Student Name(s): C. Gleason, E. Speicher

Abstract:

Algae blooms have harmful effects on aquatic ecosystems. We wanted to see if water with fertilizer runoff, in comparison to water without fertilizer, had any effect on the growth of the algae. We started by collecting river water samples from before a golf course and after the golf course, along with plain distilled water. We used these three water samples to grow our algae, each in a different bottle. We grew the algae under a growth lamp and took observations with a light meter every other day for two weeks. By seeing the difference in the algae growth we're able to see how the amount of fertilizer affects the amount of algae in the water. The results ended with the water after the golf course having the most lux. The river water before the golf course came in second and the distilled water came in last with the least amount of lux. This demonstrated that the more fertilizer in the water resulted in more algae, causing more harm to the aquatic ecosystems.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EA EV EM

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

208

2024

Fair Category

LST

Project Number

3519

Title: Selective Weed Extermination Utilizing a
Conductive Device

Student Name(s): N. Krause, H. Mayerfield

Abstract:

The purpose of this project was to devise an innovative, methodology for the targeted extermination of invasive plant species via electrical current while mitigating the negative effects on surrounding plant species and the microorganisms in the soil. Three instruments were evaluated for effectiveness: a piezoelectric grill igniter (18V), a DC Regulated Power Supply (20V), and a 5,000V charged prod. It was found that both the piezoelectric grill igniter and the DC Regulated Power Supply lacked the requisite strength to terminate the selected plant. Conversely, the 5,000V charged prod effectively neutralized the targeted plant, and confined electrical dispersion within the plant's biomass. Great White Northern Beans were used to simulate stand-alone invasive species and Alfalfa plants were used to simulate invasive species that 'root sprout'. The charge applied by the charged prod killed 43.7% of the entire 17x13cm tray and spread through the intertwined alfalfa roots and prevented further root sprouting. To conclude that the spreading of the charge was through the roots and not through the soil, four bean plants were planted in one pot, approximately 7cm apart, separating their roots. It was observed that only the charged plant was terminated, concluding that the charge of the 5,000 V charged prod did not spread through the soil.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM PS

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

121

2024

Fair Category

LST

Project
Number

3520

Title: Testing the Efficacy of Biochar Source Material in Filtering Heavy Metals From the Housatonic River in CT

Student Name(s): A. Tran, P. Uanino

Abstract:

Heavy metal pollution in Connecticut freshwater bodies pose an increasing threat to the environment. Recently, biochar filtration has emerged as one of the leading methods of treating these urban and industrial wastewaters. This experiment aimed to identify an optimal biochar source material for filtering heavy metal pollution and other contaminants from the Housatonic River in Connecticut. Out of the four types of biochar tested, the fruit peel and hay/straw biochar demonstrated to be most effective, reducing ammonia by 0.25 to 0 ppm, copper by 0.2 to 0 ppm, and iron by 0.3 to 0 ppm. These results offer valuable insights for wastewater treatment companies, promoting sustainable water filtration methods. Further research is suggested to validate and expand upon these results.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EV EM

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

228

2024

Fair Category

LST

Project
Number

3521

Title: Exploring Enzyme Inhibition Strategies for Food Preservation

Student Name(s): G. Tycz, A. Urbanowicz

Abstract:

The enzymatic browning reaction, catalyzed by polyphenol oxidase, poses significant challenges in the food industry due to its contribution to fruit and vegetable waste. In this study, the effectiveness of various inhibitors (beer, vinegar, pineapple juice, and pickle brine) in mitigating enzymatic browning was investigated across four food substrates: bread, ground beef, apple, and avocado. The experiment involved the addition of each inhibitor to the respective food samples containing 1 tablespoon from each of the inhibitors. Optimal conditions and varying substrate concentrations were explored to assess inhibitor efficacy. The findings revealed differential inhibition patterns among the tested inhibitors, with some demonstrating competitive inhibition (e.g., pineapple juice) while others exhibited noncompetitive inhibition (e.g., pickle brine). Our negative control (all food products without inhibitors) molded the fastest, compared to food products with inhibitors. While browning and mold still appeared on the bread, apple, avocado and ground beef with the pineapple juice, pickle brine and beer, it was preserved for a long period of time. Certain acids in the inhibitors were the reason for less molding and browning. The acids: ascorbic, benzoic and sulfur dioxide therefore are proven to be effective in lessening rotting. These results underscore the potential of utilizing inhibitors to reduce enzymatic browning and consequently minimize food waste. Further research is needed to identify accessible and effective inhibitors for practical applications in food preservation and waste reduction initiatives.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BI CB

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LST

Project Number

3522

Title: Flaviviruses Manipulate Host Skin Microbiota to Attract Mosquitoes and Promote Transmission by Disrupting Vitamin A Metabolism

Student Name(s): C. Zhou, D. Lu

Abstract:

Mosquitoes carry many human viruses, such as yellow fever, dengue, West Nile, Zika etc, which infect roughly ~400 million people worldwide. They transmit these viruses by sensing human cues like carbon dioxide, heat, and odors. However, it is still unknown if these mosquito-borne viruses can alter skin odors to influence mosquito behavior. Recently, we found that ZIKV and DENV infection leads to more skin Baccilus bacteria, which produce an odorant, acetophenon, to attract mosquitoes. This is because ZIKV and DENV suppress an antimicrobial peptide, RELMa (gene symbol Retlna). However, how viruses do this is unknown.

We analyzed the viral RNA loads and the mRNA expression levels of Retlna and Rarb in the mouse skin, lung and liver treated with ZIKV/Vitamin A or metabolites. We noted that Zika virus(ZIKV) infection reduced the Retlna expression by more than 20 fold in the skin. Also, Retinoic Acid (RA) alone was able to upregulate around 6 fold in unaffected clean mouse skin. In infected mice however, the RA treatment only increased the Retlna expression by around 2.5 fold, not to the level in uninfected mice. In the liver, ZIKV virus infection was observed to have a similar trend. In contrast, Retinaldehyde (RDH) was unable to restore Retlna expression at all in the mouse skin and liver. Another mosquito borne virus, O'nyong nyong(ONNV) had no effect on the Retlna in the mouse skin.

In conclusion, ZIKV (not ONNV) primarily inhibits the conversion of RDH to RA, and moderately inhibits RA signaling.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

MI BI CB

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

251

2024

Fair Category

LST

Project Number

3524

Title: MushBox: In Situ Decomposition of Municipal Solid Waste through Mycoremediation via Mycelium and Cellulosic Waste Integration

Student Name(s): S. Basanth, T. Litt

Abstract:

Exponential buildup of Municipal Solid Waste (MSW) in landfills accounting for 60% of the 292.4 million tons, presents a major environmental challenge. This leads to ecological disruptions, groundwater contamination, wildlife harm from microplastics, and contributes to climate change. MushBox deploys mycoremediation to decompose MSW, leveraging the unique capabilities of mycelium. This avant-garde approach unfolds in situ within the complex MSW environment, facilitated by the MushBox—a modular brick acting as a transformative "seed" held together by reutilized cellulosic waste. Upon placement in landfills, the MushBox instigates mycelial growth, branching out and methodically breaking down waste until senescence. Various fungal strains were evaluated to optimize efficacy, including Pestalotiopsis, Aspergillus SP, Pleurotus Ostreatus, Mucor Hiemalis, Penicillium Funiculosum, and Phanerochaete Chrysosporium, by conducting tests on MSW samples obtained through data aggregation during landfill scoping. Separate testing concluded degradation of di-2-ethylhexyl phthalate, lignin, pharmaceutical waste, small metalloids, polyurethane plastic, and organic matter. Various types of cellulosic waste were also tested for ability to host mycelial colonization. An AI program was built to provide landfill specific MushBox production and integration. Combinations of test results were used to create variants. Refined 1x1x1 foot decomposed 1.19 tons of MSW in landfill testing in a span of a year. Self built computer modeling showcases exponential increase of MSW breakdown by MushBox volume. Project showcases that MushBox transcends traditional waste management, serving as a regenerative and recyclable scalability catalyst proven for arable land reclamation, leachate and microplastic removal, and combatant to climate change due to MSW breakdown.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM PS

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

LST

Project Number

3525

Title: Utilizing Beneficial Microorganisms to Prevent Coral Bleaching and Enhance Coral Recovery

Student Name(s): W. Nook, G. O'Hara, J. Sieg

Abstract:

The objective of this experiment was to evaluate how different Beneficial Microorganisms help the Montipora Capricornis, Oxypora, and Discosoma coral stop bleaching and begin to recover after a bleaching event has occurred. Four tanks were employed to test the effects of the different bacteria: a 40-gallon breeder tank, one 10-gallon bleaching tank, and two 10-gallon experimental tanks. The bleaching tank bleached the corals by increasing the temperature. The bleached corals were then used to test the effectiveness of six different strains of bacteria: Lactobacillus acidophilus, Lactococcus lactis, Bacillus megaterium, Clostridium sporogenes, Sarcina aurantiaca, and Micrococcus luteus. These bacteria were used alone and then all together to stop the bleaching process and accelerate the recovery of the coral fragments. The bleaching of the corals was quantified using Photoshop by using the threshold tool to differentiate bleached pixels from non-bleached pixels, and the percentage of bleached coral was then calculated. Once the corals were subject to the effects of bacteria, the Montipora and Oxypora that were exposed to Micrococcus luteus had a decrease in the bleaching percentage and an increase in mass. The effect of bleaching on the two types of coral was reversed, and growth was observed. The other bacteria utilized on the coral had little to no beneficial effects on the mass or percentage of bleaching. Overall, after the bleaching event had occurred, the coral's weight stabilized after an initial decrease. Across all coral species, the Micrococcus luteus bacteria was successful in preventing further bleaching.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

AS MI EM

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

232

2024

Fair Category

LST

Project Number

3526

Title: Cultivating Green Growth: Harnessing Electroculture for Sustainable Gardening Practices

Student Name(s): S. Caballero, A. Cardona

Abstract:

The practice of Electroculture Gardening has been used since around 1794 and has become an ancient technique. It was a way to have a large yield when gardening without the need for harmful pesticides. The purpose of this study is to test its effectiveness. The use of chemical pesticides is a major source of pollution, an important driver of biodiversity loss and a possible cause of negative health impacts for exposed users. Pesticides have been used to increase yield and quality of plants. The project started by creating two plant boxes that were tended to over the time of 1.5 months. Box one was kept as a control and box two was used as the experiment. Two wooden sticks were wrapped with copper wire then inserted into the soil. The copper wires' purpose is to pull ions from the air and atmosphere to reionize the soil, which helps the plant roots uptake the nutrients in the soil better. The sticks were connected with a strand of copper wire under the soil to connect the two copper wrapped poles. The growth and yield were measured approximately every 2-3 days. Once enough data was collected, an assay was run to determine the amount of chlorophyll from both an experimental and control plant. The results showed that the control plant had 0.53 mg/g of chlorophyll, while the experimental plant had 1.34 mg/g of chlorophyll.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

PS EA

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

207

2024

Fair Category

LST

Project
Number

3527

Title: The Effect of Varying Lengths of Ultraviolet Light Exposures on the Regeneration Rate of Planaria

Student Name(s): A. Sticca, F. Ramirez-Moreno

Abstract:

Objective/Goals:

If increasing the duration of exposure to UV rays has a negative effect on the average regeneration rate in millimeters of Platyhelminthes(planaria), then a control trial with no exposure will have a greater rate of regeneration in millimeters compared to experimental trials with 3 ½ minutes, 6 minutes, and 8 minutes.

Methods/Materials:

3 groups containing 8 planaria each, and a separate group of 4 planaria was used as a control which received no UV light. The three groups of 8 were exposed to Ultraviolet light once for low, medium, and high intervals of time. The UV light was placed in a box with kapton tape and UV goggles were worn during exposure to prevent any damage possible caused by UV rays to experimenters. Pictures were taken 4 times over the course of about three weeks to note any differences between the groups

Observation/Data/Results:

The hypothesis of this experiment was not supported. The control group's outcome was underwhelming compared to the other groups. The low group's trials appeared to regenerate faster, as well as mutate more. The medium group had mild mutations but regenerated much slower, and the high group was the smallest of them all, with a very slow regeneration rate.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AS

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LST

Project
Number

3528

Title: Human Recognition of ChatGPT's AI Generated Text

Student Name(s): S. Shi, J. Zhang

Abstract:

Artificial intelligence has permeated society in various ways, from social media algorithms to personalized chatbots. Thus, preserving originality and morality is crucial to ensure authentic and ethical innovations. Our study aimed to analyze the human ability to distinguish between natural and artificial text, revealing people's bias towards AI text and AI's efficacy in mimicking human writing. We sent a Google Form containing ten texts written by humans or ChatGPT to 58 participants with varying demographics. The participants first provided information about their educational background, age, familiarity with AI, and ChatGPT usage. Then, in a multiple-choice format, participants independently (without collaboration or external resources) determined whether a human or AI created each text. We then sorted results by demographic and text difficulty. Overall, education, age, and familiarity with AI had an inconceivable impact on accuracy. The most frequently incorrect questions included forged statistics or literature analysis. Since the median score was 5/10 across all demographics, the data supports our hypothesis that the human ability to detect AI writing is independent of background. AI-generated writing has developed to the extent of deceiving individuals with high educational backgrounds and extensive AI experience. Additionally, 60% of participants believed AI could not generate artificial scientific findings due to preconceived notions that all statistics are accurate and that only scientists can create scientific papers. However, we acknowledge that our survey may not ensure accurate results. Participants could have used the internet or asked their peers as responses were collected digitally, resulting in false data.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BE

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

251

2024

Fair Category

LST

Project
Number

3529

Title: Variation of classroom temperature settings in relation to an increase in student reaction time

Student Name(s): J. Liu, A. Shi

Abstract:

Numerous studies have previously looked at the correlation between temperature and academic performance, but little is known about the relationship between temperature and reaction time. Our research will address the effects of temperature on reaction time in high school students. By exposing student subjects to three different temperatures: hot (81 °F), control (75 °F), and cold (60 °F); we will look for how the changes influence reaction times in cognitive tasks and physical activities. We hypothesize that the control temperature will serve as the ideal temperature for students, with the lowest reaction times. For the experiment, we had participants do an online reaction time test and a ruler drop test in three different rooms with varying temperatures. We collected data from 17 student volunteers and results show that there was a moderate correlation between the hot temperature and an increase in student reaction time. There are weak to no correlations between the control and cold temperatures with reaction time. We also conducted an additional t-test and found there were no significant statistical differences between the results for the different temperatures. While we are unable to conclude anything significant regarding the ideal temperature for students, we have found that hotter temperatures hinder a faster reaction time, and therefore have implications for cognitive tasks and activities in the classroom. We believe that temperatures of 75 °F will enhance learning experiences for students. For further experiments, it would be beneficial to study a larger sample size and increase the extremity of temperature conditions.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

BE

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

161

2024

Fair Category

LST

Project
Number

3530

Title: Pickering Emulsion and it's Applications

Student Name(s): A. Lee

Abstract:

Here we presented for revision discusses the significance of Pickering emulsions in the realms of food production and pharmaceuticals, spotlighting their composition from two immiscible liquids (typically water and oil) stabilized by solid particles, which may be either organic or inorganic. The unique ability of Pickering emulsions to form liquid marbles underscores their potential for pioneering research and applications. The exploration of pollen as a biocompatible, sustainable, and renewable stabilizing agent for such emulsions presents a novel area of inquiry. This paper aims to delineate the foundational principles and methodologies associated with Pickering emulsions comprehensively, detailing their advantages and limitations. Further, it seeks to elucidate why Pickering emulsions have garnered extensive interest within the biochemical research community. The manuscript will proceed to detail the specific pollen types used in this study—sunflower, lycopodium, and camellia pollen—and will present empirical data and visual aids to encapsulate the findings, thereby enhancing the reader's comprehension of the optimal samples derived from this investigation.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN BI CB

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

154

2024

Fair Category

LST

Project
Number

3531

Title: Isolation and Recombination of Woodylide Compounds from the Sea Sponge Plakortis Simplex For Use as an Organic Antifungal Agent

Student Name(s): G. Kapp, N. Behringer

Abstract:

Sponges have evolved to survive in their habitats by having protective compounds that defend against other life forms that could potentially harm them. If harnessed, these compounds could be used to protect humans against similar threats. The purpose of this project was to investigate the antifungal potentials of compounds isolated from a sea sponge and combine the aforementioned compounds to form a possibly more potent solution. The sponge extract compounds were isolated by drying and grinding sponges, extracting organic matter, and then isolating the desired compounds via column chromatography. Once extracted, they were introduced to various fungi cultures. In addition, two of the extracted compounds were introduced to sulfuric acid to combine the antifungal agents via dehydration synthesis. When introduced to the fungi cultures, the inverse effect was noted as it expedited the growth rate of each type of fungi regardless of which sponge it came from and if it was a synthesized compound.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EN ME MI

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

217

2024

Fair Category

LST

Project Number

3532

Title: The Efficiency of Electrolytes in Athletic Performance

Student Name(s): K. Madhwani, A. Rodriguez

Abstract:

In a society increasingly prioritizing health and fitness, understanding how to optimize athletic performance and enhance the benefits of exercise has become critical. Electrolytes are essential minerals crucial for various physiological functions, and they have the potential to improve one's athletic endeavors. This study investigates the effect of varying electrolyte intake on heart rate after exercise, specifically focusing on a 15-year-old female engaged in cycling on an elliptical machine. Utilizing a commercially available electrolyte drink, we administered varying dosages to the participant and measured her heart rate immediately post-exercise which uncovered a consistent trend. This underscores the potential for electrolyte supplementation to influence cardiovascular responses and enhance exercise outcomes. Electrolytes, such as potassium and sodium, maintain cellular hydration, regulate pH levels, and facilitate neuromuscular transmission, ensuring efficient muscle contractions. Understanding these mechanisms is crucial for optimizing muscle performance and minimizing fatigue during exercise. This research holds significant implications for the ever-growing health-conscious society. By analyzing the relationship between electrolyte intake, exercise performance, and overall well-being, these findings offer practical insights for individuals seeking to maximize the benefits of their physical activity and their results. Moreover, this study lays the groundwork for future research endeavors aimed at refining strategies for enhancing athletic performance and promoting overall health in an increasingly active world.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BI ME CH

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

LST

Project Number

3534

Title: Elements of Ecology, the Institution for Innovation and Environmentally Beneficial Invasive Plant Removal Projects

Student Name(s): S. Karthik, N. Bhambure

Abstract:

Through Elements of Ecology, our purpose was to research about the raising effects of destructive invasive plant species, their effects on native plant growth, and largely their contribution to habitat fragmentation on the local environment. Invasive plants have caused the rapid increase of barriers between two segments of habitat for animals, and create detrimental conditions for the species to grow and thrive with isolation. Throughout the course of this project, an online website was created which consisted of 8 presentations, videos, quizzes to go along with each of these components, certificates and flyers. These videos and presentations were created with extensive research and interviews from professionals who were a part of the invasive management team from South Windsor and Farmington. We gained valuable information from the interviews as they shared some of the main invasive plants. Additionally, the conference from Farmington mainly focused on destroying invasive plants by the use of herbicides and discussed some of the large-scale precautions that the government carries out in order to prevent the growth of invasives. We also learnt that invasive plants have detrimental effects on the wildlife population mobility, and biodiversity through our investigation. In conclusion, our goal for Elements of Ecology is to increase the education support around the topics of invasive species and their detrimental effects in animal habitats, create awareness through the course, and help take action. Promotion of this topic in schools, community events, as well as to the general public will help create extension for our investigations.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

PS EM EV

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

89

2024

Fair Category

LST

Project Number

3535

Title: The Impact of Cutting vs. Bulking

Student Name(s): R. Nguyen, S. Rahman

Abstract:

We investigate the impact of bulking and cutting workout and diet regimens on body fat percentage and lean muscle mass, with a focus on determining which approach is more effective in promoting overall body health. Our hypothesis suggests that cutting will decrease body fat percentage while preserving lean muscle mass, while bulking will increase both body fat percentage and lean muscle mass. The experiment spans eight weeks who follow different diet and workout routines. To minimize bias, test subjects following the same regimen contribute to the data analysis process.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No