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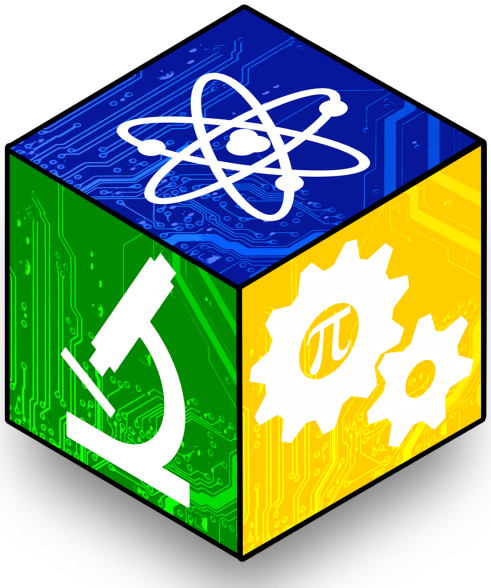

74th Annual Fair
March 7-19, 2022

Student Abstracts

Fair Categories

	Life Sciences	Physical Sciences
7th & 8th Grade Team	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)

Special Categories

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

Special Category 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	Fair Category	Project Number
248	LS	3001

Title: Longitudinal Changes in Linguistic Complexity Among Professional Mixed Martial Artists.

Student Name(s): E. Cole

Abstract:

Typically, as one ages, their sophistication of speech increases due to an expansion in vocabulary depth. Various neurological disorders have the ability to impact one's linguistic complexity. The objective of this study is to analyze the trends in linguistic complexity in Mixed Martial Artists (MMA) who are at risk of developing the neurological disorder, Chronic Traumatic Encephalopathy (CTE). This disorder is thought to be caused by repetitve traumatic brain injury, therefore the risk of developing this disorder is increased in MMA fighters due to excessive exposure to blunt head trauma. Changes in Lexical Density over a 10 -15 year period were measured by transcribed interviews of the MMA fighters and compared to transcribed interviews of the control. Subjects were placed into groups based on knockouts experienced throughout their career, 0, 1-3, 4-6, 7-9, and 10+, respectively. An analysis of variance (ANOVA) was performed to compare the slopes of data over a ten year span.. There was no statistically significant difference between the groups with knockouts below ten. The ANOVA reveals that those who have had ten or more recorded knockouts experienced an overall decline in Lexical Density compared to those who have had 0 recorded knockouts. This trend persists even after controlling age and years participating in the sport as a potential confound. The results demonstrate that long term damage for fighters can impact their linguistic sophistication, which could be an indicator of CTE, therefore, steps should be taken to minimize the number of knockouts experienced over a career.

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

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	Fair Category	Project Number
248	LS	3002

Title: Quantifying the Interspecific Impacts of the Asian Shore Crab on the Atlantic Blue Crab and the American Lobster in the Long Island Sound

Student Name(s): S. Davis

Abstract:

The Asian Shore Crab (ASC) is an invasive species in Long Island Sound which originates from the Pacific Ocean. This project will quantify the specific ways that the ASC impacts the interspecific relationships of the Atlantic Blue Crab and the American Lobster. The introduction of the ASC is a possible catalyst to the biodiversity depletion of many key species in the Sound. The loss of native biodiversity would cause the ecosystems to lose their instrumental functionality due to the interspecific relationship disruptions. The lack of data surrounding the impacts of ASC inhibits researchers developing mitigation plans and native species restoration efforts. This proposal is split into two areas, conflict related impacts, and spatial related impacts. For conflict testing there were three tanks set up, 24,273mL^3, 172,980mL^3, and a control. Each tank had a 10 ASC to one native species ratio. The different volumes tell whether the space given impacts how they interact. In the blue crab portion of this test respective results showed 100% conflict related mortality of ASC, followed with 20% mortality. With limited space, the blue crab consumed each ASC. For spatial testing, the tank had the same ratio of crustaceans. The average distance between blue crabs and ASC decreased from 118cm to 31.8cm. The lobster test didn't show a trendline. Therefore, the ASC doesn't impact the lobster spatially, but will invade the blue crab's territory. This research will be used to develop a non-toxic, low impact behavior based mitigation strategy for ASC.

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

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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	Fair Category	Project Number
94	LS	3003

Title: An Investigation on the Multi-Generational Effect of Acidic Soil on the Growth of Brassica rapa

Student Name(s): C. Campellone

Abstract:

Acid rain has been an known problem and side effect of pollution and climate change for decades, and the effect it has on trees and vegetation is imminent and visible. The purpose of this experiment is to answer the questions of: How does acid rain affect the epigenetics and development of Brassica rapa? How will soil of various different pHs affect long term epigenetics, leaf color, height, and flower count? AnswerIng these questions will help answer more general questions about the effects of acid rain on plants and detail how to deal with them.

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

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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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CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
233	LS	3004

Title: Using NYC Parks Department "Report a Sighting" Data to Investigate the Relationship Between Human-Wildlife Interaction and Borough and Uncover Instances of Environmental Racism in New York City

Student Name(s): A. O'Connor

Abstract:

The "Report a Sightings" reports are used to track and collect public sighting reports of healthy wildlife throughout NYC. Although New York City is abundant with parks, research such as a recent report from the Hispanic Access Foundation and the Center for American Progress shows that "communities of color are almost three times more likely than white communities to live in 'nature deprived' areas." Redlining, or the practice of delegating housing based on race and economic status that ended in 1968 has unfortunately left behind a legacy of placing vulnerable communities in areas with significantly less green space. The purpose of this study is to determine the association between negative human-wildlife interaction recorded in "report a sightings" data, access to parks (measured as ratio of park area to total borough area), and the ratio of the number of neighborhoods designated as "declining" to total neighborhoods per borough in the 1930's . Results show that the borough of Queens has the highest ratio of negative responses, the highest ratio of declining neighborhoods that have been redlined, in addition to the lowest park area to total borough area ratio. There is a positive correlation between the ratio of redlined neighborhoods and negative response ratio and a negative correlation between park access and negative response ratio. These results suggest that environmental racism prevents exposure and positive interactions with wildlife in areas that have been redlined.

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

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3. This project was conducted at a Registered Research Institution. ☐ Yes ☒ No
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CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
254	LS	3005

Title: The Effects of Green Tea on β-Amyloid Induced Alzheimer's Disease in neritina reclivata

Student Name(s): A. Woodworth

Abstract:

Alzheimer's disease is a common condition that affects millions of people around the world each year. There is currently no cure for Alzheimer's disease, and the medications available are not effective in treating the disease's symptoms as the medication's effects do not last long, causing inconsistent symptom relief. During the experiment, snails are subjected to KCl after sucrose exposure to reduce feeding behavior. After training sessions, the snails are exposed to either caffeinated or decaffeinated green tea, and certain snails are injected with β-amyloid, except the control group, which creates the neurodegeneration exhibited in Alzheimer's disease. After injection, a memory test is conducted to determine whether caffeinated or decaffeinated green tea is the most effective in mitigating the effects of Alzheimer's disease. The pond snails' response to caffeinated or decaffeinated green tea reducing the effects of beta-amyloid induced Alzheimer's disease is quantified by the number of times the pond snail opens its mouth to exhibit a feeding response when given sucrose. The Caffeinated Green Tea group had a reduced feeding response: 11 bites during the pretest to 1 bite during memory test. Caffeinated green tea will have the greatest effect on suppressing the effects of beta-amyloid induced Alzheimer's disease. Snails exposed to caffeinated green tea and beta-amyloid will be expected to have a reduced feeding response after injection compared to those exposed to decaffeinated green tea. The findings of this research highlights the importance of green tea in mitigating the effects of Alzheimer's the suffering one experiences can be reduced.

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

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☐ vertebrate animals ☐ controlled substances

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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
254	LS	3006

Title: The Use of Secondary Plant Metabolites to Reduce Pseudogymnoascus destructans Transmission Among North American Bats

Student Name(s): G. Hilton

Abstract:

White-Nose Syndrome is a disease that affects hibernating bats and causes them to wake up more frequently, resulting in a decline of fat reserves and eventually, starvation. This disease was first recorded in the United States in 2006, and it has killed millions of bats. The causative agent behind White-Nose Syndrome is Pseudogymnoascus destructans, a fungus. P. destructans is a psychrophilic fungus that especially prospers in caves and bat roosts and can be transmitted either directly between bats or from bat to bat via surface contamination. The proposed way to mitigate the effects of the fungus is through the use of secondary plant metabolites. These plant metabolites hold antifungal properties and include compounds such as flavonoids, alkaloids, and tannins. Through a process containing mixtures of methanol, tert-butyl methyl ether, and water, these metabolites can be extracted from plants. The metabolites were applied to Saccharomyces bayanus which models the behavior of P. destructans, and the yeast cell growth is calculated to determine the efficacy of the metabolites. The data collected directly indicates that secondary metabolites from ashwagandha root aid in reducing the cell growth in yeast cultures. Using the UV-Vis spectrophotometer, a positive linear relationship was established between absorbance and cell density, y=13,803,131.76x + 141,371.40, with y representing cell density and x representing absorbance. The cell density of the yeast with ashwagandha metabolites reduced by 711.11%. Future research is recommended to integrate metabolites into a non-reactive liquid, allowing the metabolites to be easily applied to bat cave and roost surfaces.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
249	LS	3007

Title: Using Pyrethrum Extract From Chrysanthemum cinerariifolium As A Natural Insecticide

Student Name(s): A. Capodanno

Abstract:

Pesticides on industrial and consumer levels pose a physical and chemical environmental risk to vegetation and terrestrial life. Current forms of alternative pesticides are both extremely inefficient and expensive. Pyrethrum extract from Chrysanthemum cinerariifolium serves as a potential candidate as a safe and inexpensive alternative to commercial and alternative pesticides, while not compromising effectiveness in pest eradication. Pyrethrins were extracted by removing the flowers of chrysanthemum plants, crushing, and soaking the flowers in a 70% isopropyl alcohol solution. The product was then mixed into water and applied via foliar spray. This project utilized crickets as a model pest for testing purposes, however other studies have shown the pyrethrins have a similar effectiveness on different garden pets and small invertebrates, such as beetles. The first pyrethrin trial had a mortality rate of 50%. Switching to a higher spray position, to allow for greater area coverage, resulted in a mortality rate of 100% over all trials. Three control trials were conducted to test the mortality of the crickets with no pyrethrin application, resulting in a 0% mortality rate. The trials used varying concentrations of alcohol, 0%, 16%, and 25% respectively. All trials had uniform crickets sizes, with average weights ranging from .39-.46 grams. The pesticide proved its ability to maintain the effectiveness in relation to chemical pesticides. This pesticide can be made cheaply, with 800 ML costing $14 less then home depot brand pyrethrin spray. Future research includes determining an alternative extraction method to eliminate alcohol from the process entirely.

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

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	Fair Category	Project Number
227	LS	3008

Title: The Effect of Azospirillum lipoferum Inoculation on Microbial Abundance and Diversity of the Corn Soil Microbial Population after a Moderate-Intensity Fire

Student Name(s): A. Hamza

Abstract:

High-intensity forest fires can negatively affect the soil rhizosphere by decreasing microbial populations and limiting ecological processes. After a high-intensity fire, the soil microbiome can take months or years to completely recover and resemble pre-fire conditions. However, both plant growth and an increase in microbial diversity can aid in the recovery process over time. Inoculation of the soil rhizosphere has induced positive effects in the soil microbiome in some studies with unburned soil. Studies have demonstrated that Azospirillum lipoferum inoculation significantly increases corn soil nitrogen and osmotic potential of corn plants in water-stressed environments. However, whether Azospirillum lipoferum also has a positive effect on the soil rhizosphere during fire recovery has not yet been studied. The goal of this study is to explore the possibilities of Azospirillum lipoferum inoculation in aiding corn growth and soil microbial recovery after a moderate-intensity fire. Soil taken from the roots of corn plants was burned for six hours at temperatures above 800°C. After burning, both the unburned and burned soil were cultured. The burned soil had no culturable bacteria on any of the 10-4 dilution plates immediately post-fire. The post-burn greenhouse study found that soil inoculation with A. lipoferum led to an increase in plant growth when compared to unburned soil. Increased plant biomass may positively affect the soil microbial population over time.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
248	LS	3009

Title: Implementing Nontoxic Modified Biochar Enhanced Filtration for the Efficient Removal of Emerging Contaminants in an Aqueous Solution

Student Name(s): S. Mohanraj

Abstract:

Many water sources contain emerging contaminants that currently lack sufficient regulation but lead to debilitating health and environmental effects, yet current standard water treatment processes cannot remove most such contaminants from water. This project researches the usage of doped biochar enhanced by the addition of metal oxide nanoparticles for removing specific emerging contaminants, namely pharmaceuticals, pesticides, microplastics, and oil, from water. Biomass content derived from either coconut shell or rice husk, both of which are abundant natural scrap materials, was individually pyrolyzed into biochar. Further, each biochar sample was separately tested with the enhancement of synthesized Fe3O4 and MnO2 nanoparticles. With biochar's advantageous absorption properties further enhanced by the increased surface area available for sequestration of contaminants through the addition of metal oxide nanoparticles, it was expected that an efficient contaminant removal method would be devised. Pharmaceutical and pesticide removals were measured using liquid chromatography mass spectrometry (LC-MS), microplastic removal was measured using digital WiFi light microscopy, and oil removal was measured using light spectrometry. Coconut shell biochar enhanced by the addition of Fe3O4 nanoparticles was the most effective design tested, removing 65.69% of acetaminophen and 50.09% of ibuprofen (pharmaceuticals), 61.05% of glyphosate (pesticide), 56.26 % of PETE microplastics, and approximately 71.83% of gasoline oil. This demonstrates considerably efficient removal through this inexpensive, environmentally-friendly, easily-implementable, and sustainable method. A prototype of a standard filter with compartments for sand and biochar filtration was developed using 3D modeling software and will be further refined for real-world implementation.

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

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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	Fair Category	Project Number
242	LS	3010

Title: The Comparative Effects of Fuhc Immunosuppressants and Allotransplanted Blood Plasma Transfusion on Allotransplant Acceptance in Botryllus Schlosseri

Student Name(s): S. Crombie

Abstract:

When a patient requires any type of transplant, many factors determine whether the patient's body accepts the new tissue. Individuals requiring transplants are often immunocompromised and often lose partial function of vital organ systems, making the speed and completeness of the acceptance of new tissues vital to the patient's health.

This study established two separate colonies of B. Schlosseri, with peripheral ampullae testing done to determine fuhc allele variety. The growth count, oxygen respiration, and peripheral ampullae behavior of each colony was observed. The two colonies were divided and trypsinized, creating four groups which either received immunosuppressants, a blood plasma transfusion from the other colony, tissues from the other colony, or tissues from the same colony. Extent of acceptance was observed based on the visual occurrence of dark regions, implying sites of rejection.

Each colony of B. Schlosseri except the xenogeneic sample had similar growth counts, oxygen respiration trends, and peripheral ampullae behavior but had different fuhc alleles as determined through PCR testing. Excluding the autologous group, the group given a blood plasma transfusion had the highest acceptance rate and the fastest growth count compared to the immunosuppressed group. The allogeneic group had the lowest rejection rate and highest growth count overall.

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

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☐ vertebrate animals ☐ controlled substances

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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
239	LS	3011

Title: Selection of High-Affinity scFvs for HPRT by Yeast Surface Display

Student Name(s): S. Meier

Abstract:

Cancer is the second leading cause of death in the world. Common treatments against cancer include chemotherapy and radiation, which are highly invasive and have many negative side effects. Previous studies have shown the effectiveness of immunotherapy, an up-and-coming, non-invasive cancer treatment, to reduce tumor size, kill cancer cells, and limit side effects. In addition, studies identify HPRT, an antigen expressed only on cancerous cells, as a potential target for an scFv antibody immunotherapy treatment which is easier to genetically engineer and travel through the bloodstream than a monoclonal antibody treatment. The purpose of the completed experiment was to select scFvs with a high-binding affinity for HPRT in order to create an HPRT antibody-mediated immunotherapy treatment to incite an immune response against cancer. Yeast surface display was used to select the high-affinity scFv by treating a yeast library expressing a multitude of scFvs with HPRT and using MAC and FAC sorting. The yeast cells expressing scFvs with high-binding affinity to HPRT were selected and analyzed with clonal selection. After selection, an affinity binding curve was measured for each unique clone to identify an scFv with the highest affinity. Two clones were selected with scFvs that had a high binding affinity thus supporting the hypothesis. The experiment will continue to identify other clones with high binding affinity in order to isolate the scFvs and use them to create a CAR-T cell treatment.

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

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

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
268	LS	3012

Title: Synthesis of Polysaccharide-Encapsulated Hydroxyapatite Nano-composites to Stimulate Plant Growth and Promote Phosphorus Absorption

Student Name(s): I. Gega

Abstract:

In modern-day agriculture, excessive use of fertilizers exacerbates many environmental issues and decreases the productivity of phosphorus (P) intake. By 2050, global phosphorus use in fertilizers will reach 26,000 Gg/year, however low plant absorption rates will lead to increased runoff, causing accumulation of P on surface water. This accumulation can lead to increased growth of algae and large aquatic plants - contributing to eutrophication. In this research, biodegradable polymers nano-composites with differing polysaccharides (amylopectin and starch) were fabricated to encapsulate hydroxyapatite (Ca3(PO4)2) nano-structures. The timely release of hydroxyapatite nano-structures from within the polysaccharide biodegradable nano-composites (~2-3 hours for full release) enhances plant growth, plant phosphorus uptake, and has the potential to reduce the negative environmental impacts that ensue. Following their application to soybean-seeded soil, an ~8.3% increase in plant biomass was observed for hydroxyapatite NPs, along with a 22.9% increase for starch nano-composites, and a 25% increase while for amylopectin nano-composites, following 2-weeks of growth. Additionally, soybeans that were treated with nano-composites grew x3 higher than their nanoparticle and untreated counterparts. To measure phosphorus uptake, an EDS analysis was conducted for each soybean treatment, and the phosphorus to (constant) carbon ratio determined. While untreated control soybeans displayed a 0.13 P/C ratio, the hydroxyapatite soil treatment displayed a 0.21 P/C ratio, while the amylopectin and starch nano-composite treatments produced P/C ratios of 0.26 and 0.36, respectively. These respective 2x and 2.8x improvements in phosphorus-uptake further support observed, increased plant growth, and demonstrate the polysaccharide nano-composite's potential positive impact on the environment.

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

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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	Fair Category	Project Number
237	LS	3013

Title: Data mining the LmrS protein on Staphylococcus aureus

Student Name(s): T. Saunders

Abstract:

MRSA, (Methicillin-resistant staphylococcus aureus) is a pathogenic bacteria that has caused considerable problems in the medical field because of its ability to become antibiotic-resistant quickly. LmrS is an efflux pump on MRSA that gives it resistance to many antibiotics. Because of this, the project found out how effective LmrS is at giving antibiotic resistance. The project averaged individual antibiotics in trials found in articles and found that the resistance that LmrS gives is significantly different. Some of the antibiotics such as Kanamycin, and Linezolid had lower resistance, while other antibiotics like Gatifloxacin, Erythromycin, and Oxytetracycline had higher antibiotic resistance than what was previously known.

The project also tried to find if LmrS gives resistance to certain classes more than others, the project found MICs (minimum inhibitory concentration) of each of the antibiotics through different articles in a class and looked at studies to see if those MICs were high enough to give resistance. Class resistance is found by finding if the majority of the antibiotics were resistant or not. We found that LmrS gave lots of resistance to beta-lactams but otherwise was not class-specific.

The third part of the study was to find out if there was any correlation between MRSA's high resistances and the resistances LmrS gave. The project found through other articles and comparing data that many of the antibiotics that LmrS gives resistance to MRSA were frequently resistant to them.

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

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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
221	LS	3014

Title: he Dark Side of Dancing: Are Ballet Dancers More at Risk for Eating Disorders and Negative Self Image?"

Student Name(s): E. Blair

Abstract:

Ballet has been an incredible force in art and entertainment since its creation, bringing joy to its audiences and dancers alike. The industry, however, has been infamous for its skinny dancers who look impossibly small and for the lack of dancers with diverse body shapes. While ballet dancing requires a certain strength and build inherently to succeed, many professionals such as Misty Copeland, have spoken up about how directors told her to lose weight to fit a company image. This problem brings up a question, are all ballet dancers more at risk than the average person for negative self-image and eating disorders? In this experiment a group of young ballerinas were given a survey. Their answers were compared with a group of young athletes of the same age and gender who were given the same survey. The results of this experiment showed a likely correlation between ballet and negative self-image. The averages of the experimental group were higher than the control group in every single question. This demonstrates a potential connection between the dancers and eating disorders that can be proven with a larger test group and further research. Once this has been identified as an issue, a solution can be developed, making more research on this topic necessary for the mental health of the next generation of ballerinas.

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	Fair Category	Project Number
229	LS	3015

Title: Using SiO2 to Reduce the Amount of Microplastics Dissolved into Oceans.

Student Name(s): L. Southam, L. M Southam

Abstract:

Microplastics are a form of small plastic particles that mostly come from the dissolution of large plastic objects. This can be anything from car parts to water bottles. Extended contact with water causes these materials to break down into smaller and more illusive particles, called microplastics. They are extremely hard to filter out of the water and can cause a wide array of health problems to aquatic animal populations. These problems often make their way up the food chain into humans through our extensive consumption of seafood, especially large predatory fish like tuna. The purpose of my project was to expand on my previous research of SiO2 coatings. The first experiment confirmed that the spray did work to slow the dissolution of microplastics into the oceans This experiment was designed to specifically simulate real world environments to test the effects of outside factors on the spray. I placed a total of 10 water bottles in a variety of situations to mimic: tides, heat and sunlight respectively, measuring the PPM of the water each week for a month. These tests have revealed positive results; the coating works well as the untreated water bottle consistently released more particles than each treated bottle. I plan to continue testing and refining the SiO2 spray in real world environments, hoping to create an applicable solution to the epidemic of microplastics currently filling our oceans.

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

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	Fair Category	Project Number
249	LS	3016

Title: Reprogramming senescent cells by inhibiting pro-inflammatory TNF/Edn1 pathway as a potential treatment of age-related diseases

Student Name(s): S. Cui

Abstract:

Biological aging, characterized by the loss of cellular stability and regenerative capacity, had been believed to be an irreversible process. However, emerging evidence suggests that epigenetic intervention of aging may be a prospective avenue for reversing multiple age-related diseases. For instance, transcription factors Oct4, Sox2, Klf4, and c-MYC (OSKM) were identified as critical reprogramming factors that generate induced pluripotent stem cells (iPSCs). Their overexpression can also partially reverse multiple age-related phenotypes and extend animal lifespan. However, using iPSC OSKM reprogramming factors to treat age-related diseases has a major caveat since OSKM were not discovered based on the gene expression profile comparison between senescent and young cells.

This project aims to identify candidate age reprogramming genes as alternatives to OSKM through directly comparing senescent and young cells (with gene expression data from human bone marrow-derived stromal cells, mouse retinal ganglion cells, and mouse fibroblasts). Surprisingly, no common age reprogramming gene was found, indicating that aging may occur through different mechanisms among varying cell types. Nevertheless, network enrichment of differentially expressed genes highlighted inflammation as a crucial factor in aging. Opposing conclusions from each analysis suggested that the intricate interactions between pro-inflammatory and anti-inflammatory genes in different cell types establish distinct cytokine profiles that affect aging differently. Edn1, a secreted pro-inflammatory protein, was identified from the network as a key pro-aging gene. The downregulation of Edn1 through receptor antagonists, chemical inhibitors, or epigenetic alterations may be potential approaches for improving age reprogramming.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CB CBIO 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	Fair Category	Project Number
197	LS	3017

Title: Could a Small Scale Hydroponics be the Solution to a Sustainable Food System for a High

Student Name(s): I. Brahmst

Abstract:

Abstract

By 2050, the food industry will need to increase production by 70% to meet the demands of an increasing human population and associated rises in meat and dairy consumption and biofuel use. Food security has already decreased with 870 million malnourished people globally (Global Agriculture Towards 2050, 2009). This trend highlights that with current methods, our earth can not generate the yield of food that is required now or projected for the future. It is therefore necessary to develop new solutions to assist the agricultural system in creating yields of crops to feed the projected populations in a sustainable way. Hydroponics is one of the technological solutions that have been created in attempts to create a more sustainable food system for our world. Due to its potential in solutions for the climate crisis, scientists have researched and examined how to make hydroponics the next type of lucrative farming (Junge et al., 2017). This project will continue this research on a smaller scale in a high school science lab, comparing agriculturally and hydroponically grown plants to examine whether hydroponics can be a potential solution for the high schools' need for a more sustainable and larger crop yield.

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

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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	Fair Category	Project Number
226	LS	3018

Title: Modeling Predator-Prey Relationships of Brine Shrimp and Invasive Waterboatmen to Optimize Ecological Stability

Student Name(s): S. Cho

Abstract:

Recent studies have indicated the practicality of creating artificial habitats to maintain the biological variability of aquatic life, increase the population of endangered species, and simulate wild environments to develop optimal habitats for biodiversity. Artificial habitats, despite the significant impact they may have on preserving aquatic biodiversity, are inefficient. The following experiment attempts to remedy such faults through the use of physical experimentation and a python algorithm to predict the levels of biodiversity in a particular environment. The virtual environment visualizes the optimal conditions required to maintain a stable predator-prey relationship, helping researchers to understand the basis for all ecological problems and the leading component of extinction. The results from lab experimentation and the predictions made by the virtual environment conclude that a Corixidae-Artemia system in 40 ppt was optimal for maintaining a stable predator-prey relationship. Environments with a salinity of 30 ppt expedite the predation rates of Corixidae but do not allow for the consistent growth of Artemia, causing the brine shrimp population to crash. On the other hand, environments with a salinity of 50 ppt hindered capture rates while enhancing brine shrimp reproduction, causing an Artemia overpopulation. Such values were graphically analyzed to specify an optimal salinity condition in which the simple predator-prey system was optimized, showing that modeling aquatic ecological systems using a virtual environment is plausible and promising.

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

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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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
241	LS	3019

Title: The Probability of a Shark Attack Across the East Coast and the Effect of the Moon Phases on Shark Attacks

Student Name(s): R. Riebling

Abstract:

This study focuses on where a shark attack is most probable to occur on the east coast, and then how the different phases of the moon could impact that probability. It was hypothesized that a shark attack was more likely to happen in a larger state with a warmer year-round climate and that an attack was more probable under a moon phase with higher illumination. Focusing on the east coast of the US, the number of usable beach days and amount of coastline per state were recorded, as well as the number of shark attacks and pings off each state using the databases Ocearch and the International Shark Attack File. Data was converted into comparable units and the results showed that the states that had more usable beach days and had more miles of coastline were more likely to have a shark attack occur in the waters off their coast, the most being off Florida. The attack probability from Florida was then compared to the specific phase of the moon that occurred on each date of an attack using a moon phase and illumination tracker and the already calculated probability. However, the results yielded no pattern, not showing enough correlation between the attacks and the moon phase. This is important information to know because the human population makes a very large impact on the environment and it is essential to know where people are most likely to interact with organisms.

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

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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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
230	LS	3020

Title: Machine Learning Analysis of EEG Signals to Predict Working Memory Performance in Healthy and Schizophrenic Adults

Student Name(s): N. Kalangi

Abstract:

Schizophrenia is a serious mental illness that affects 1% of the population worldwide. Our aim is to use convolutional neural networks (CNNs), classification methods, to predict whether or not an individual is diagnosed with schizophrenia. To accomplish this, we used an EEG dataset previously used to classify working memory performance on the Sternberg Working Memory Task (SWM). EEG is used to measure voltage changes in the brain, and the SWM is a well-known behavioral experiment that studies the 4 phases of the working memory: baseline, encoding, retention, and retrieval. Trials of anywhere from 4-8 letters are presented to the participant, in series, after which they are asked to respond whether or not a probed letter was contained in that trial set. We generated single-trial time-frequency spectrograms from the frontal and occipital channels of the EEG recording. We then created a CNN with convolution and max pooling layers followed by dense activation layers for classification. This model was trained and tested using the spectrograms from the baseline phase of the SWM. CNNs are useful in this context because they take into account spatiotemporal information of the images. The model was able to predict schizophrenia with at least 73% accuracy based on the images generated from the baseline interval alone. This shows that CNNs, when used on EEG time-frequency data, have the potential to reliably classify clinical status.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CBIO CS 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	Fair Category	Project Number
251	LS	3021

Title: Creating and Testing a Frequency-Emitting Program to Bolster the Efficacy of Mosquito Traps and Enhance Mosquito Surveillance and Control Efforts

Student Name(s): D. Liu

Abstract:

Mosquitoes are some of the deadliest animals in the world, acting as the primary vectors for diseases such as malaria or the West Nile virus. While it is known that mosquitoes are attracted to specific frequencies for mating purposes, existing traps are often hundreds of dollars, rely on attractants such as carbon dioxide, and lack acoustic features. Therefore, the purpose of this project was to help counteract the spread of mosquito-borne diseases by improving existing methods of mosquito surveillance by developing a passive, cheap mosquito trap that utilizes mosquito mating frequencies. First, a Java program was created to play sound at a certain frequency. Next, a funnel trap containing a speaker was placed into a cubic feet container. After the speaker began playing at 400 Hz, female and male Aedes aegypti mosquitoes were released into the container. 30 minutes afterward, the mosquitoes were immobilized in the fridge before the number of captured mosquitoes was recorded. This was repeated at 500 Hz and 600 Hz before additional trials were conducted at 425 Hz, 450 Hz, 475 Hz, 485 Hz, and 700 Hz with virgin males or females to find the optimal frequency. Overall, the passive trap successfully captured mosquitoes; however, male mosquitoes were far more attracted to frequencies than females, with 475 Hz being the most effective. The $22 passive trap can provide an affordable alternative to inaccessible standard traps in rural areas plagued by mosquito-borne diseases. Extensions of this project may include testing the trap with other mosquito species.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project): EM AS CS

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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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
249	LS	3022

Title: Developing and Testing a Novel Acne Reducing Spray for Face Masks and Accessories

Student Name(s): F. Cavallaro

Abstract:

Acne vulgaris is a skin condition characterized by lesions of differing types and distributions across the face, chest, and shoulders. It impacts a patient's quality of life, including self-esteem and psychological development. Acne is a disorder of follicular occlusion, mechanical stress, and microbiome dysbiosis, all of which are affected by mask wear. The purpose of this research was to reduce the acne caused by face masks (maskne). A proposed acne treatment for masks in the form of spray was created using lemongrass oil (2% concentration), salicylic acid (0.0006% concentration), and water. The commercial product SkinSmart Antimicrobial was also tested, and the control was an untreated mask. Each mixture was applied equally to mask pieces. The first testing method focused on the antimicrobial ability of the mixture. Cutibacterium acnes was collected from the experimenter's face and grown in agar dishes. Masks were applied, and after three days, images were taken of the dishes. Proper safety equipment was used. The next testing method viewed the ability to prevent follicular occlusion. Stomata of a houseplant were viewed under a microscope. Each experimental group was applied to the leaf, and after days of application the stomata were viewed for difference in size. This test was used to hypothesize the effects of the treatment on skin pores. Many people wear face masks, hats, or goggles that can cause skin irritation on the face such as acne, and research into preventing this condition should continue. This development could reduce facial acne for people worldwide.

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

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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
74	LS	3023

Title: Research on Eye Movement Recognition of Early Childhood Autism Spectrum Disorder Based on Hybrid Timing Neural Network

Student Name(s): L. Dong

Abstract:

This essay presents a new method of Autism Spectrum Disorder(ASD) testing with two advantages. It is designed to solve two problems that clinical diagnose currently have: subjectivity and time-consuming. The results were never based on observation and answering questions, instead statistical data will be collected to analyse. Moreover, after collecting datas, the results can be yielded within a few seconds, which is way less than the traditional ways that might take years.

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

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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	Fair Category	Project Number
71	LS	3024

Title: Pathoid - Immune System Game

Student Name(s): E. Yang

Abstract:

Pathoid is an educational game that allows the player to learn about the human immune system through the eyes of a pathogen. This lens provides a non-traditional look at how the parts of the immune system function. Covering a wide variety of immune system parts, from the skin to B cells. Designed for classroom usage, this game is ideal for education in a biology class on the human immune system.

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

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

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
286	LS	3025

Title: Rapid, Visual Detection of Benadryl Cocktails via Competitive, Amine-Responsive Fluorophores

Student Name(s): A. Fogarty

Abstract:

Diphenhydramine (DPH) is the newest narcotic used in drug-facilitated sexual assault. The amine is easily accessible in OTC cold-treatments, and now used to create a "Benadryl-cocktail," simply by slipping ~250µg/ml DPH into a beverage. There is a clear need for a simple, rapid, real-time diagnostic to detect a DPH-cocktail in typical lounge setting. This research has created a DPH-in-beverage detection card, based on DPH-initiated competition within a dual-fluorescent dye system. To begin, a 1:1 (m/m) Fluorescein-isothiocyanate [FITC]:Cellulose acetate-protoporphyrin-IX [CA-PPIX] was created in ethanol (0.7g each in 10ml), and characterized for each dye's emission maxima (540nm-green and 630nm-red, respectively). 25µl of this 1:1 dye solution is deposited onto a cellulose filter paper, with plastic-card backing, where it dries to the red CA-PPIX color. As the newly-formed DPH-Sensor, when ~2 drops of untainted beverage is added, paper-friendly CA-PPIX remains adhered to the filter paper, while free FITC liquifies, and fluoresces brightly under 405nm excitation, producing an overall green, SAFE indicator. Conversely, when 2-drops of DPH-tainted beverage is added, the primary amine conjugates to FITC in solution, quenching its green fluorescence, so that CA-PPIX luminescence dominates. The DPH-Sensor appears as red, or NON-SAFE. Using methyl-red indicator and 0.02M NaOH (included test kit reagents), beverages must first be adjusted to pH-6.9 (yellow), so that the sensor produces accurate measure of DPH, absent of all beverage-related interferences. Including a sensor-card, and related reagents, the newly-devised test kit can detect 250ppm-DPH in all beverages, in seconds, using a smartphone camera image for result interpretation, at ~$1/test.

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

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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
246	LS	3026

Title: A DSM III, IV, and V Dissection of the Accuracy of Autism in Film Overtime

Student Name(s): E. Futch

Abstract:

Mental illness has become an increasingly prevalent issue in today's society. As movies have progressed in complexity, mental health has been explored as a common motif, but also has been misrepresented in ways that affect the perception of a particular mental disorder. In this study, a total of 18 movies with autistic characters were chosen for evaluation. Six were selected from each time period of the Diagnostic and Statistical Manual of Mental Disorders (I, II, III) and analyzed using a code sheet modified from Nordahl-Hansen et al (2018). The code sheet was designed to analyze the accuracy of each movie to the corresponding DSM definition of autism at the time the film was made. The code sheet also tracks the exacerbation of 5 common myths of autism: difficulty keeping eye contact, verbally communicating, responding to affection, responding to social cues, and smiling. A contingency analysis was run in JMP for each characteristic on the code sheet. When measuring social emotional reciprocities' occurrence over DSM 4-5 , a significant difference was found. A significant trend was shown of less social emotional reciprocity occurring in the DSM 5 movies. This trend was evident in other analyses, but it was not statistically significant.The results of this study identify not only a trend of more developed characters starring in films, but also highlight trends in the media representation of autism, reveal the complexity of stereotypes films, and provide further insight into the study of Autism in film for future research.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) BE 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	Fair Category	Project Number
239	LS	3027

Title: Development of resting state electroencephalographic (EEG) oscillations in children with developmental dyslexia over the course of a five-week reading intervention

Student Name(s): R. Homma

Abstract:

Developmental dyslexia (henceforth described as dyslexia) is a neurological disorder associated with reading difficulties and is one of the most common learning disorders. Recent research has shown that rhythmic activities in the brain, specifically, decreased alpha power (8 -12 Hz) and increased theta power (4-8 Hz), are related to the prevalence of dyslexia in children. However, it is unclear whether these neural patterns can be improved as a result of reading remediations. To address this, the present study examined the development of alpha and theta powers over the course of a reading intervention. During a five-week summer program, children with dyslexia received either reading or math (control) interventions, and EEG data was collected at four time points from each participant. At each time point, the participant watched a five-minute silent and relaxing video while their EEGs were recorded. The exploratory analysis included the data from 16 children, and the changes of alpha and theta activities were characterized by the slope, which was the change of absolute power relative to the time course of intervention. T-tests indicate that the reading and the math intervention groups did not differ significantly in alpha or theta powers. These results suggest that alpha and theta powers are relatively stable, and they may not be influenced by reading interventions. However, further studies with larger samples and typical readers are needed to examine how these neural activities fundamentally differentiate with respect to reading abilities.

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
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☒ Yes ☐ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
251	LS	3028

Title: The Role of Social-Media Addiction on Perception of Real vs. the Imagined; Who Suffers the Most?

Student Name(s): C. O'Brien

Abstract:

Social media has dramatically evolved since the creation of MySpace in 2003, to the numerous advanced social media apps that are currently available. While many contend that young adults are more fluent in technology use and accessing social media, lately, seniors (65 +) have found an increasing reliance on new technology, and the accessibility that it provides. This research seeks to investigate these intersecting trends, looking closely at social media use by young adults and seniors. An Amazon MTurk survey was administered to ~200 participants, to highlight these groups' social media dependencies. Regarding social interactions, both age groups are highly dependent on social media for new friendships, where 78% of young adults and 83% of seniors prefer online, anonymous friendships vs. in-person meetings. While more than 70% of both groups admit to mindless scrolling through social media pages, 70-80% of both age groups admitted that they utilize social media to learn about news events, over traditional, reliable news sources. Phase-2 of this research looked closely at user's view and interpretation of social media "news-worthy" posts. Subjects were first asked to learn about a "factual" international news event via many traditional resources. Following, they were asked to evaluate a related, sensational social media posting. While 75% of respondents preferred illustration of news rather than traditional text, ~58% found truth in an otherwise nonsensical posting. This suggests that online users will seek those representations of fact that best fit their own beliefs, putting little weight on alternate descriptions of factual events.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) BE 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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
194	LS	3029

Title: The Effect of Computer Light on Caenorhabditis Elegans Development

Student Name(s): T. Yin

Abstract:

In a rising technological world, people use electronic devices on a daily basis and are constantly exposed to blue light emissions from the devices. Computers are one of the most commonly used electronic devices, and the high intensity blue light emissions from computer screens may have a negative effects on human development. C.elegans are microscopic nematodes that have a similar genome to humans and are popular subjects for scientific research. This experiment examines the difference in size between C.elegans exposed to computer light during the developmental stage and C.elegans remaining in the dark in the same stage. Subjects were placed in an incubator for 48 hours to be exposed (or unexposed) to computer light, before being taken out to be imaged. The images of 10 randomly selected C. elegans from each group were taken with a Keyence BZ-X800 microscope. After using the ImageJ software to measure the lengths of C.elegans, the average lengths of the two groups were compared, and it has been found that computer light exposure during the developmental stage causes a growth stunt in C.elegans. These results are concerning because a similar developmental restriction could be occurring in humans as well.

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):

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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	Fair Category	Project Number
262	LS	3030

Title: Design of a Novel, Dual-Functioning Tissue Plasminogen Activator and Anticoagulant Therapeutic for Rapid Ischemic Stroke Treatment

Student Name(s): A. Grover

Abstract:

Stroke is the second leading cause of death worldwide, with 15 million people suffering from its debilitating effects each year. 87% of strokes are ischemic, where an artery narrows or becomes wholly blocked due to a thrombus. Tissue Plasminogen Activator (tPA) is a protein that activates the conversion of plasminogen to plasmin, an enzyme responsible for the breakdown of clots. While tPA is the leading emergency treatment for ischemic stroke, it possesses several shortcomings, including a non-localized nature and increased risk of hemorrhage. Similarly, no existing therapeutic candidates have both dissolved the thrombus and simultaneously deterred the coagulation cascade, the process by which a thrombus is actively built. Herein, a rapid, clot-specific, and dual-functioning microbubble system, utilizing tPA and anticoagulant Dicumarol, was engineered to create a more effective emergency therapeutic. To begin, fabrication of the magnetic interior nanoparticles was completed by synthesizing Dicumarol-Carboxylic-acid coated Fe_3O_4 nanoparticles. Next, SiO2-tPA was fabricated, and added to complete the subsequent encapsulation layer of the nanoparticles. Finally, peptides CGSSSGRGDSPA and GRGD were conjugated to the nanoparticle's surface, to promote selectivity for platelets and fibrin, and ensure clot-specific adhesion and release. A vertical gel channel-system, composed of fibrinogen, thrombin, and agarose, was developed to validate clot dissolution function of the new therapeutic, which was 2x that of tPA alone. As a final verification component, in-vitro clots were created using ~100µl of whole-blood, in a 96-wellplate. Successful therapeutic-induced dissolution of thrombus was observed via increased absorbance throughout the visible spectral region, due to liquification of the clot.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) ME EN 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
- ☒ potentially hazardous biological agents
- ☒ 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	Fair Category	Project Number
252	LS	3031

Title: Impact of Cationic Lysine Residues on the Endosomal Escape Rate of Nucleic Acid Nanocapsules

Student Name(s): E. Szydlo

Abstract:

Nucleic Acid Nanocapsules (NANs) are surfactant micelles with nucleic acids attached to their surfaces that have the potential to treat medical conditions that cannot be effectively targeted by small molecule medications. NANs are taken into the cell via endocytosis and are engulfed in endosomes where they are cleaved by enzymes. The exposed surfactant tail permits the nucleic acids to reach the cytosol; however, endosomal escape is a significant hurdle in this process. Because nucleic acids such as DNA have a very negatively charged phosphate backbone and are macromolecules, it is very hard for them to cross the negatively charged lipid bilayer of the endosome. The study aimed to improve the endosomal escape efficiency of NANs through the addition of a cationic poly-lysine peptide crosslinker as such peptides have been found to improve the facilitation of endosomal escape for nanoparticles. Surface Crosslinked Micelles (SCMs) were synthesized through the addition of a poly-lysine peptide crosslinker to self-assembled micelles. NANs were then synthesized from the SCMs with the addition of thiolated DNA. The SCMs and NANs were purified using size exclusion chromatography and characterized through the use of dynamic light scattering, zeta potential, and transmission electron microscopy. An increase in size and a shift from a positive charge to a negative charge indicated that the NANs were successfully formed from the SCMs. Future studies using HeLa cell incubation are necessary to determine whether the NANs synthesized with the poly-lysine peptide crosslinker are capable of improving the endosomal escape efficiency of NANs.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
199	LS	3032

Title: DeTickt: An iOS App for Real-Time Tick Classification and Disease Risk Analysis

Student Name(s): A. Kolb

Abstract:

There is an alarming increase in the population of ticks and the tick-borne diseases (TBDs) they transmit, some of which are fatal. Due to limited training, healthcare providers cannot always accurately identify ticks and their associated illnesses, leading to delayed diagnoses and treatments. There is also little correlation between tick species and the particular TBDs they may carry, because the prevalence rates of different disease-causing pathogens vary based on geographic location within the USA. Using transfer learning, a convolutional neural network (CNN) was built for real-time tick species identification and embedded tick risk assessment using the Tick Lab of Pennsylvania's location-based tick surveillance statistics. With this, users can use DeTickt, an app developed in Swift that provides an accurate, conclusive analysis as to whether they are at risk of contracting a certain TBD. The app was able to accurately identify three tick species: Ixodes scapularis (Eastern blacklegged tick), Amblyomma americanum (Lone star tick), and Dermacentor variabilis (American dog tick) with an overall accuracy rate of approximately 80%. This iOS app will be useful nationwide in helping tick-bite victims identify the need to seek further medical assistance, particularly for those who have underlying health conditions.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project): CS CBIO 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	Fair Category	Project Number
186	LS	3033

Title: White-Nose Syndrome: A study of the impact of UV light delivered through a motion detector on propagation and growth rate of a close proxy for Pseudogymnoascus destructans.

Student Name(s): C. Cline

Abstract:

The purpose of this study was to investigate the efficacy of Ultraviolet (UV) light in the treatment of disease caused by Pseudogymnoascus destructans (Pd) also known as White Nose Syndrome, in bats. White Nose Syndrome is a fatal disease that appears in hibernating bats and cannot be treated unless their wings are extended. Because Pd is particularly vulnerable to exposure to UV light, it was hypothesized that flashing UV light on infected bats could assist in eradicating the fungus in situ (Daley, 2018). Using an Arduino microprocessor and PIR motion sensor, a device was created and code used to flash a series of UV bulbs. A proxy fungus, Saccharomyces cerevisiae, grown on nutrient agar plates, was used to test the effects of UV light on growth as the plate was rapidly passed in front of the sensor and UV light housing. Preliminary trials indicate that, while the device successfully enables the firing of the UV light when triggered by the motion sensor, and that growth of the fungus is arrested, the growth is not significantly reduced, possibly due to the minimal time frame of UV exposure.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) AS AT 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	Fair Category	Project Number
255	LS	3034

Title: Shedding Light on an Obscure Disorder; Highlighting the Psychological and Psychosocial Effects of Hidradenitis Suppurativa

Student Name(s): M. Bayram

Abstract:

Hidradenitis Suppurativa (HS) is a chronic debilitating skin condition consisting of painful swollen lesions occurring in the armpit, groin, and breast regions. Currently, the exact cause of the condition is still unknown; however, researchers believe that smoking, obesity, genetics, and hormones affect the occurrence of abscesses. Currently, a reliably effective treatment does not exist, and the condition cannot be cured. Due to the severity and agonizing pain that individuals experience, HS has adverse effects on the mental health of many individuals. The drainage, pain, and disfigurement that it causes may contribute to the negative psychosocial impact of the disease. This research aims to highlight the psychological effects of HS on affected individuals. A detailed survey asking about social life, mental illnesses, effects on relationships, and more, was created, and distributed via newly-created social media support pages. Respondents were primarily post-puberty females, with onset HS at ages 10-15 years. This alone points strongly to hormonal imbalance as a leading cause of HS. Regarding psychological effects of HS, 92% of individuals reported worsening of their mental health, with 76% of those being diagnosed with anxiety or depression, post-HS diagnosis. Further, 70% reported that their intimate relationships had worsened, with little/no change in friend and family relations. Summarizing, these findings highlight the specific negative psychological, social, and physical impacts of life with HS, and bring necessary awareness to the difficulty of those living with the disease quietly face. Additionally, these findings act as resource for much-needed, further HS research on treatments and therapies.

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

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	Fair Category	Project Number
253	LS	3035

Title: Gastrointestinal In Vitro Test to Evaluate Survival of Probiotics Found in Commercial Supplement Products Versus Greek Yogurt

Student Name(s): J. Roth

Abstract:

As scientific research continues to show the beneficial effects of probiotics on human health, they are becoming increasingly more prominent within the food and medicine industry. Research on probiotics, however, is still limited, and FDA regulation on probiotic marketing is insufficient, resulting in the free-selling of unviable, or falsely marketed, products.

This research project aims to determine the viability, after digestion, of probiotics found in store-bought supplements compared to Greek yogurt, in order to verify marketing and determine if natural food sources provide adequate amounts of probiotics, as determined by other studies.

Through diluting samples of store-bought probiotic supplements and Greek yogurt and incubating the samples on MRS agar plates, the initial CFU (colony forming unit) counts of the bacteria Lactobacillus will become feasible to observe using optical microscopy. This initial CFU count of Lactobacillus will serve as the control factor. The samples will then undergo an in vitro gastrointestinal simulation, created in beakers with chemicals and enzymes, and the CFU count will be re-determined.

It is projected that the probiotic count determined after the in vitro gastrointestinal simulation on store-bought supplements will be lower than what is marketed. It is further projected that the probiotic count determined in Greek Yogurt will be sufficient to have beneficial health effects.

If the projected results are found true, this research will show that probiotic marketing could be more accurate and improved. Moreover, there will be an increased awareness of the positive health effects gained by eating naturally probiotic-rich foods.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) MI ME 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	Fair Category	Project Number
243	LS	3036

Title: The Anticoagulant Blood mixer and Anti-Stress Device for Patients Donating Blood

Student Name(s): A. Davis

Abstract:

Since the year 2020, over 1.8 million people are in need of blood transfusions, however only 5% of the eligible population is donating their blood. Some factors preventing people from donating are anxiety, stress, and fear of needles/blood. The purpose of this study is to investigate the main factors that are leading to less people donating blood, the impact this has on society, and develop and test an invention that will increase the number of blood donors.

After conducting research, I developed my first functioning prototype consisting of an LED stress ball connected to a rotating plate mounted on the ground. Volunteer participants answered a survey pertaining to donating blood and simulated donating blood while using the prototype.

During the prototype testing, the participants' results all had a resting heart rate between 75-95 bpm. None of the participants' heart rate got to 133 bpm, which is the average heart rate of a stressed individual. The majority also found LED light up cues to be helpful for combating their anxiety.

The outcome of testing the first Anticoagulant Blood Mixer and Anti-Stress Device prototypes has shown a decrease in stress levels for participants donating blood and could increase the percentage of blood donors. Based on the results from my prototype testing and research collected, it has led me to further the examination of this current study by designing a second prototype and investigating how the COVID-19 pandemic has affected blood drive volunteers.

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

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	Fair Category	Project Number
242	LS	3037

Title: Enhancing Microplastic Resistance of Honeybees through Transformation of Their Enterobacteria

Student Name(s): Y. Kim

Abstract:

Since intestinal bacteria are discovered to have an important factor in the survival of bees, many studies are underway to employ genetic engineering techniques on bee intestinal bacteria to lower bee's mortality. This study confirmed the possibility of developing bee intestinal bacteria resistant to microplastic toxicity by employing genetic engineering techniques to lower bee's mortality by the ingestion of water containing microplastic. Bee's lactic acid bacteria showing resistance or sensitivity to microplastic toxicity were respectively identified among the 20 isolated and cultured bacteria. As a result of transforming non-resistant bee's lactic acid bacteria with GFP or PETase genes or with plasmids of bee's lactic acid bacteria with resistance through genetic engineering, the bee's lactic acid bacteria expressed the transformed gene, and resistance to microplastic increased for bee's lactic acid bacteria transformed with PETase gene or bee's lactic acid bacteria plasmid. In particular, the non-resistant bee's lactic acid bacteria were identified as a Lactobacillus kunkeei species, which is a species essential for the bee's survival through, the 16s rRNA test. In conclusion, these results show that it is possible to make the bee's lactic acid bacteria essential for the survival of bees resistant to the toxicity of various environmental pollutants, including plastic, through genetic engineering techniques. Furthermore, the identification of various bee's lactic acid bacteria essential for the survival of bees and the development of high-efficiency plasmid DNA vectors for transformation will help to decrease bee mortality by environmental pollution.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) MI CB 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	Fair Category	Project Number
251	LS	3038

Title: The use of Prime Editing to Induce and Correct the CFTR-F508del mutation in iPSCs.

Student Name(s): B. Persily

Abstract:

According to the Cystic Fibrosis (CF) Foundation, over 70,000 people across the globe suffer from CF, and the life expectancy of patients with CF drops to about the age of 47. CF is an inherited condition that makes a patient's mucus thicker and stickier, which can lead to lung damage and infection. Approximately 70-90% of these cases are caused by a 3-bp deletion known as CFTR-F508del. Given the critical need for novel therapeutic interventions with greater efficacy, we aimed to model this mutation using prime editing and iPSCs to later differentiate and use these cells for studying CF. iPSCs serve as excellent models for disorders that affect different parts of the patient's body, due to their pluripotency. Prime editing serves as a powerful genetic editing alternative to the more traditional CRISPR/Cas9 method, as prime editing is safer and more reliable. Here, we report the successful reprogramming of fibroblasts into iPSCs and cloning of the pegRNAs required for prime editing. We then attempted to use prime editing to both induce and correct this mutation. The efficiency of the correction was higher than that of the induction; however, it was still very low. We are working to optimize the prime editing of the iPSCs via new and improved prime editing methods. Successful demonstration of prime editing in iPSCs holds great potential for not only studying CF in models, but for a wide range of genetic disorders in both research and clinical practice to help improve the lives of these patients.

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

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	Fair Category	Project Number
244	LS	3039

Title: Computational Study on Impact of Change in Granzyme A Secretion Rate in CAR T cells on Follicular Lymphoma Microenvironment

Student Name(s): T. Gorre

Abstract:

CAR T cell therapies are the newest innovation in leukemia cancer therapies in the last few decades. Follicular cancer, a type of cancer that is treated through CAR T cell therapy, is cancer that presents itself near blood vessels and tends to be aggressive in nature and therefore has seen lower remission rates[(Stenner & Renner, 2018)]. Using Compucell, a computational biology platform that can monitor extracellular interactions, we studied how modifying the secretion rate of Granzyme A, a factor that is pro-inflammatory and secreted by CAR T cells, affected not only the ratio of different cell types in the microenvironment but also remission in the span of 20.8 days. Compucell uses Monte Carlo steps as a measurement of time and in this simulation, we set each Monte Carlo step as 30 minutes in the real world meaning that the simulation lasted 1000 Monte Carlo steps. Then we changed the Granzyme A secretion rate from 0 to 0.2 on intervals of 0.05, with the normal secretion rate being 0.1, and were able to see the impacts of this change on the follicular lymphoma cell motility and cell ratio through Compucell's capabilities. These metrics were noted and used to determine which Granzyme A secretion rate is most effective which we found to a secretion rate of 0.2. This study can inform changes to CAR T cells secretion rates of Granzyme A through polyadenylation and entertain the idea of using polyadenylation in cell therapies to come.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
265	LS	3040

Title: A Novel Drug Delivery System of Gold-Nanoparticle—Chaperone complex to successfully mitigate Drug-induced Nephrotoxicity, an unwanted Side Effect in Organ Transplant Medications

Student Name(s): A. Galic

Abstract:

Drug-induced nephrotoxicity is not only life-threatening but also one of the most frequent causes of drug termination during clinical trials or withdrawal from the market. Cyclosporine A (CsA), an immunosuppressant highly effective and necessary for post-transplant survival, is known to cause nephrotoxicity by initiating endoplasmic reticulum (ER) stress in renal cells. Normally, cells upregulate chaperone proteins to counter ER stress. However, prolonged ER stress leaves the organelle functionally impaired, thus signaling apoptotic cell death and causing long-term harm to the kidney. This research sought to counter these effects via a novel drug complex (gold nanoparticles, AuNPs, bound to a chaperone) administered jointly with CsA, tested with GRP78 (chaperone protein) and 4-PBA (chemical chaperone). Carboxyl-functionalized AuNPs were used to promote the covalent binding to these large, complex chaperones, facilitating trans-membrane transport. Results were quantitatively analyzed via HRPTEpC cell density studies, average cell size, and ER stress (via the Thioflavin T fluorescence marker), and qualitatively via observed morphology. As anticipated, delivery of CsA alone promoted both significant reduction in cell size (4um) and ER stress. Introduction of Variation-I (AuNP-GRP78 with CsA) showed inconclusive results, with altered morphology in some treated wells. Introduction of CsA via Variation-II (AuNP—4-PBA with CsA), however, showed 20-22um cell size and cell density comparable to that of growth-medium alone (control), with no detectable ER stress within 48 hours post administration. As such, these findings have important implications for drug-delivery systems, with the conceptual use of AuNP-complexes to mitigate medications' harsh, ER stress inducing side effects on the kidney.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CB ME 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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
246	LS	3041

Title: Determining Position Preference of Different Species of Insect Galls in Relation to Each Other on the Solidago altissima

Student Name(s): S. Liu

Abstract:

Galls are abnormal growths created by plants and commonly induced by insects; they provide nutrients and shelter for insect larvae. Two common galls on the Solidago Altissima (goldenrod) are ball galls and bunch galls. However, little is known about the relationship of these two galling species at a field scale. The relationship between the two species could be categorized in three ways: positive association (the species prefer to gall near each other), negative association (the species prefer to gall away from each other), and neutral association (no preference). The purpose of this project is to determine how the positions of different species of goldenrod galls are associated. The hypothesis is that goldenrod galling insects are positively associated. The independent variable is the location of the galls, and the dependent variable is association. First, maps of actual gall locations (called actual maps) were created for two fields of goldenrod; to do this, sampling points were selected randomly; at each point, the number and identities of galls were recorded. Second, simulated neutral association maps were created by shuffling the labels/identities of each point. Third, the actual and simulated maps were compared to determine association in the actual maps. The results showed that the association (on the actual maps) was mostly neutral. Understanding the co-occurrence of galls can provide insight into the behavior and tendencies of galling insects, a step towards being able to use galls as biological control agents to limit the spread of invasive plants.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) AS 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	Fair Category	Project Number
256	LS	3042

Title: Did the Vaccination Quell COVID-19 Surge after Holidays: An Analysis of Real-World Data

Student Name(s): J. Li

Abstract:

Last year, I analyzed how holidays affected COVID-19 spread. This year, I wanted to further study the following: how vaccination impacted COVID-19; how the post-holiday spike differed from 2020; and how vaccination impacted the post-holiday surge.

Data was retrieved from CDC and Johns Hopkins databases. I studied Independence Day, Halloween, Thanksgiving, and 1/15-2/1/2022. Analysis was done using Excel pivot tables, linear regression, and Pearson correlation. I compared the post-holiday spike of 2021 to 2020 and examined correlation between vaccination rate and the spikes. I also correlated vaccination rate with cases/deaths when omicron was dominant. Next, I compared northeast and southeast states to see the impact of weather/temperature.

I found that in 2021, every additional 100 full vaccinations prevented 8 infections. Every 1% increase in full vaccinations prevented 35 deaths per million people. Partial vaccination was less effective.

In 2021, higher vaccination rates correlated with a greater surge after Halloween and Thanksgiving. Cold temperatures could have contributed to the greater surge in the Northeast than the Southeast during Halloween. There was a possibility that a false sense of security caused northeast states that had more vaccination to have a greater spike after Thanksgiving, which is suggested by a positive correlation between fold change and vaccination rate.

Results show that, overall, the vaccination is effective in decreasing infection and death but less effective for omicron. However, high vaccination correlated with greater surge after Halloween and Thanksgiving, which could be due to a difference in weather or a false sense of security.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project): ME MA BE

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	Fair Category	Project Number
215	LS	3043

Title: Identification of Druggable Sites and Lead Compounds to Target ORF8 in SARS-CoV-2

Student Name(s): S. Satheeshkumar

Abstract:

Current therapeutic strategies against SARS-CoV-2 are mainly focused on the traditional drug targets like spike proteins and viral enzymes. Other viral proteins with important roles in COVID-19 pathogenicity are not being targeted for drug discovery. For example, recent studies show that ORF8 protein may be responsible for the rapid spreading of SARS-CoV-2, compared to other coronaviruses. However, the knowledge of lead compounds and drug-docking sites for ORF8 is limited. The current study used the X-ray crystal structure of ORF8 to analyze potential drug-docking sites using Deepsite. A docking site composed of TYR58, TYR73, ILE74, ASP75, TYR79, PRO93, LYS94, and LEU95 was defined. Structure-based virtual screening was conducted against this site, using all FDA-approved small molecule compounds. “Dockthor” by GMMSB and “Cheminformatic Tools and Databases for Pharmacology” by Université Côte d'Azur open-source servers for virtual screening was used. The complementarity of each small molecule compound from the database was measured against the defined binding site. The virtual screening yielded a number of promising lead compounds including Paliperidone (Score: -119.990) and Glycerol phenylbutyrate (Score: -114.720). Top-ranked compounds can undergo further biochemical studies or lead compounds for drug repurposing against SARS-CoV-2. For the first time, this study provides potential lead compounds targeting ORF8 protein.

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

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	Fair Category	Project Number
204	LS	3044

Title: Statistical Methods on Incorporating Protein Structure Information with Rare Variant Association Studies

Student Name(s): S. Xu

Abstract:

Whole exome and whole genome sequencing association studies have long been used as a way to identify genes and variants that influence complex diseases and traits. However, despite their popularity, their statistical power is limited by a high background rate of neutral variants. In order to isolate rare variants more to improve the statistical power of analysis, many novel statistical methods have been developed. Three of these are POINT, PSCAN, and POKEMON, each of which use a unique method to identify the likelihood that a rare variant influences a trait or disease. With these three methods, I used a relatively well-studied set of genes to determine the statistical power of each of these three methods in identifying known disease-associated genes. Then, instead of using genes with experimentally mapped structures in the Protein Data Bank (PDB), I used AlphaFold2's revolutionary protein structure prediction algorithm, which allowed for more genes to have mapped structures, while sacrificing some accuracy. My project analyzed the impact that AlphaFold2 had on the statistical power and accuracy of the three methods' analyses, seeing if the impact of AlphaFold 2 on rare variant analysis is as significant as the impact it had on the biological community as a whole.

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

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	Fair Category	Project Number
251	LS	3045

Title: Development of Oil Spill Detection Technology using Video Image Processing by Deep Neural Network

Student Name(s): A. Oh

Abstract:

A single oil spill can cause fatal damage to the marine environment. As they spread so rapidly, early detection is crucial. The first step in doing so is to locate areas affected by the spill. This research aims to detect oil spills in regions where human supervision is difficult and to provide an alternative to human labor by developing a model optimizing Computer Vision. Based on a Google-developed model (Inception), the model incorporates hidden relu and output sigmoid activation function to prevent vanishing gradients. An Adam optimizer updates weight values in the model based on their contribution on the final output. Dropout layers were placed to prevent overfitting and unconscious bias in image data. Image data were collected by Crawling (ImagerGeek) and from a Kaggle dataset, then went through data augmentation to increase the accuracy of the model and prepare the model against unexpected cases of oil spills or unintended biases in data collected. Because it utilizes artificial intelligence, it can be used any time unlike human labor. Unlike pre-coded software, the model works real-time. When tested, the model had an accuracy near 90 % on image (testing oil spill) data, and on video data had a cumulative accuracy that neared 100 %- indicating that a majority of oil spills were able to be detected. The model without data augmentation functioned better (lower loss, higher accuracy) but had a less stable (reliable) growth in accuracy. By these results, it can be inferred that the model will be successful in practice.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
252	LS	3046

Title: Longitudinal viability of a mixed community of microbes in two methods of preservation

Student Name(s): A. Sharma

Abstract:

Research laboratories preserve microbial samples through freezing but often face the issue of avoiding intracellular ice formation. A practical solution is suspending the microbial culture in the presence of a cryoprotective agent (CPA) that permeates the cells, decreasing the freezing point of water and increasing its viscosity, thus reducing the probability of ice crystal formation. However, the impact of the duration of freezing on different microbial species is largely unknown. This preliminary study aims to understand the longitudinal viability of various microbial species in a metagenomic sample and the effects of glycerol in the viability period.

The chosen CPA for this study is a 10% glycerol solution. We prepare several aliquots of a known metagenomic sample in (Reasoner's 2A) broth with and without 10% glycerol and stored at -80°C. One aliquot, preserved with and without CPA, was thawed and serially diluted from 1:10 to 1:100K. The 1:1K, 1:10K, and 1:100K dilutions were plated and incubated at 37°C. Every week collected the data by counting colonies from 1:10K dilution plate and running a MALDI (Matrix-Assisted Laser Desorption/Ionization) scan on selected 48 colonies.

Our results showed that Staphylococcus species are more robust in their viability than Kocuria or Roseomonas under aerobic, anaerobic, with and without glycerol storage conditions. The data suggest that glycerol is an effective cryoprotectant for 4-5 weeks, after which it had a negative influence on the overall sample viability.

Scientists can use this information to establish laboratory procedures to store microbial samples and the timeline of experiments.

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	Fair Category	Project Number
242	LS	3048

Title: Dangerous and toxic lightening products used in the cosmetology field replaced with natural lighteners in order to provide a safe and effective lightening service without harmful chemicals.

Student Name(s): R. Pacheco

Abstract:

In the hairdressing industry many hairstylists use chemicals that are harmful towards them and even their clients. It can also be damaging for the hair causing it to become brittle and weak. The ingredients included in hair lighteners are bleach,ammonia, and phenylenediamine. What I intend to learn from this experiment is to try and find which natural lightener would be safe to use in order to assure that these products that are being used to lighten the hair are safer for cosmetologists and clients. In order to make a change like this we need to be able to replace the lightener used now with one that is not only less damaging and safer but also efficient. We will be testing four different natural lighteners in order to find one that will be ideal to be used in the salon. In this experiment we will examine how much the hair lightens in and an average time frame regular lightener would be used. Many of these natural lighteners tend to lighten at much slower rates and may need more sessions in order to get it the desired level so I will record how many levels the hair has lightened with each natural lightener. Using a regular lightener in hair, a client won't be able to go from dark to blonde in one session. It would require more sessions to accomplish the desired look, but it will be safer for the worker and client.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
229	LS	3049

Title: To shine or not to shine – How does a Zebrafish Pigment Cell Decide to Turn Black or Silver?

Student Name(s): S. Xu

Abstract:

What are the regulatory elements important for regulating iridophore gene expression? I have used bioinformatics to analyze functional epigenomic data with the goal of identifying regulatory elements essential for zebrafish pigment cell fate determination. One of the most important problems in biology is how the same genetic material all cells share gives rise to different cell types in development in a multi-cellular organism such as a human. The information orchestrating how each cell expresses different genes is encoded on top of the genetic information, thus defined as “epigenetics". How epigenetics determines cell fate thus holds the secret to one of the most fundamental questions of life.

Zebrafish pigment cell differentiation provides an attractive model to study cell fate progression. Here, a single neural crest progenitor engenders two morphologically distinct pigment types: black melanocytes and shiny iridophores. How the epigenetic factors contribute to pigment cell fate is poorly understood. Previously, Wanglab from WashU mapped the epigenetic profiles of melanocytes and iridophores, including DNA methylation, chromatin accessibility, and gene expression. I have used bioinformatics approaches to process and analyze these next-gen sequencing based large epigenomic datasets. I compared the epigenome and transcriptome landscape between melanocytes and iridophores, revealed differentially expressed genes and differentially epigenetically modified regions, and predicted regulatory elements important for iridophore gene expression. In the future, I plan to experimentally validate the most interesting candidate regulatory elements.

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

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	Fair Category	Project Number
249	LS	3050

Title: Effects of Lead on Gallus Gallus Embryonic Neurite Projections

Student Name(s): T. Tan

Abstract:

The Centers for Disease Control and Prevention (CDC) states that levels of lead under 5 ug/dL are considered safe. However, recent studies suggest that even lower levels of lead could lead to deficits in behavior, cognitive function, and brain development. Up to date, the mechanisms by which lead affects the nervous system are relatively unknown. In this study, I worked with a research team led by Professor Li at the University of Hartford to study Gallus gallus embryonic chicken dorsal root ganglions (DRGs), which are critical structures that give rise to the sensory nerves in the peripheral nervous system. Embryonic DRGs were cultured from E11 embryos and the effects of lead and neural growth factor (NGF) on neurite outgrowth were examined over the course of 5 days. Qualitative and quantitative analyses of neurite quantity and length of these DRG protrusions were performed. Lead-treated ganglions with NGF showed significantly larger ganglion size and shorter relative axonal growth versus control ganglions that were treated with NGF, or in culture media with no lead or NGF. Axons differentiated from lead-treated cultures with NGF had significantly shorter relative length as opposed to ganglions that were only treated with nerve growth factor ($p<0.05$). The overall data showed that lead concentrations well below safe limits were still detrimental to the nervous system for both its growth and development. More evidence underscoring the harmful effects of lead could lead to an increase in public awareness, harm reduction awareness, and further mechanistic understanding.

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

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	Fair Category	Project Number
260	LS	3051

Title: Computational identification of miRNAs associated with heart tumor and cardiovascular disease

Student Name(s): J. Gao

Abstract:

Sarcomas is a rare type of soft tissue cancer that is found in the blood vessels of the heart. Similarly, many cardiovascular diseases can invade various heart structures. A microRNA (miRNA), a small single-stranded non-coding RNA molecule, often regulates gene expression through targeting the 3' Untranslated region (UTR) of gene(s). The goal of my research was to investigate the connection between sarcoma and various cardiovascular diseases through examining the miRNA and gene target variant pairs that are associated with both diseases.

First, I used the published TCGA sarcoma study to select differentially expressed miRNAs associated with each sarcoma subtype. Then, I used the GWAS Catalog database to retrieve a comprehensive catalog of genes associated with coronary artery disease. Next, I searched TarBase for co-occurrence to both sarcoma and cardiovascular diseases. I then checked this list of common miRNA-gene pairs to compare against miRNAs reported to be differentially expressed in a study for rheumatic carditis patients. I identified one miRNA (hsa-miR-92a-3p) which overlapped in both studies. I then searched miRNet for this miRNA's targeting gene, GCLC. The mutation of GCLC is involved in myocardial infarction and also hemolytic anemia.

My research results imply that hsa-miR-92a-3p can affect GCLC gene expression and lead to more mutations that interfere with the cellular antioxidant processes in sarcoma patients, who might be at increased risk for myocardial infarction and hemolytic anemia. My research can be helpful in developing treatment strategies for sarcoma patients by assessing the risk level of being affected with other disorders.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
250	LS	3052

Title: Determining the Availability of Effective Online Triage Resources for Patients at Musculoskeletal Urgent Care Centers

Student Name(s): A. Bahel

Abstract:

Patients experience orthopedic injuries frequently and have previously relied on emergency departments (EDs) to receive care. Musculoskeletal Urgent Care Centers (MUCCs) have proved to be an alternative to provide more efficient and timely care. The purpose of this project was to determine the availability of effective online triage resources to ensure patients are directed to appropriate treatment facilities while also characterizing potential factors that would have an increased likelihood of triage resource availability. It was hypothesized that there aren't a sufficient amount of online triage resources on how to manage musculoskeletal injuries due to a proven increase in wait times, overcrowding, and insufficient patient care in EDs. The IV was the MUCCs along with their affiliation and location. The DV are the breakdown of both the specific and the number of triage resources that are available online. All MUCCs in the United States were compiled by using google maps search engine. Each MUCC website was searched for: presence of a ChatBot, wait time, ability to schedule appointments online, patient checklist, listed treated injuries, and affiliation. Results show that some offered chatbots to aid in triage and patient questions. Very few provided patients with resources to help with triage such as a checklist that informed patients when to go to the ED, and few provided a walk-in wait time estimate. This study could uniquely encourage MUCCs to educate patients regarding the appropriate facility to seek care, allowing EDs to continue providing care for more emergent conditions and true orthopedic emergencies.

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

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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	Fair Category	Project Number
262	LS	3053

Title: Do Left-Handed Students Experience Emotions Differently Than Right-Handed Students?

Student Name(s): M. Rossetti

Abstract:

This project's purpose was to discover if left-handed students respond and react to everyday high school experiences more emotionally than right-handed students. This topic was chosen because a study was done that found that in the study's population size, five percent more left-handed people had depression than right-handed people. This study helped form this project's hypothesis which was that left-handed people respond and react more emotionally to everyday high school experiences than right-handed students which is a reason why left-handed people are more prone to depression. A Google Form was sent to students in ninth, tenth, eleventh, and twelfth grade who all attend the same school. The survey consisted of a safety disclaimer and fifteen questions. The first question in the survey asked what the participant's dominant hand is. Then, seven questions asked how emotional the participants felt based on the situation mentioned. The other seven questions asked how emotionally the participants would react to the situation given. One-hundred-eleven students participated in the survey. Their results were compiled, percentages were calculated, and two double bar graphs and two box plots were created. In the double bar graphs, there were no significant discrepancies within the data. Also, the medians of the box plots were almost exactly the same. These graphs showed that left-handed and right-handed students' results were similar, and handedness did not contribute to the degree of emotions. Furthermore, the hypothesis of left-handed students responding and reacting more emotionally to high school experiences than right-handed students was not supported.

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

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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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
239	LS	3054

Title: Anti-Viral Properties of Ayurvedic Medicines (Ayush Kwath, Ashwagandha, Pippali

Student Name(s): M. Chhatre

Abstract:

Ayurveda has been used for centuries in Eastern part of the world to treat a variety of illnesses, including viral infection, and with the COVID-19 pandemic, treatment options for viral infections became increasingly essential to public health. Ayush Kwath (a mixture of holy basil, cinnamon, ginger, and black pepper), Ashwagandha (winter cherry), and Pippali Churna (long pepper) are Ayurvedic medicines which are known to have anti-viral properties and used in India during the COVID-19 pandemic. To test their anti-viral effectiveness, a plaque assay was conducted using E. Coli and T4 bacteriophage. It was hypothesized that Ayush Kwath which is a mixture of ayurvedic herbs, would have the strongest results, based on its widespread use and literature supporting its anti-viral capacities. The plaque assay determined all three medicines were effective in reducing the number of plaques formed when compared to the T4 bacteriophage positive control. Ayush Kwath gave the best results with a 29.5% reduction at 5% concentration, and a 60.6% reduction at 10%. Pippali Churna showed a 22.1% reduction at 5% concentration and a 39.9% reduction at 10%. Lastly, Ashwagandha had a 27.1% reduction at 5% and 32.8% reduction at 10%. This investigation demonstrated the potential of these Ayurvedic medicines in the treatment of viral diseases. The next steps are to test these medicines with other viruses and determine proper concentrations for optimal symptom reduction and recovery, both in lab and in clinical settings.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project): MI 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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
98	LS	3055

Title: Better Honey

Student Name(s): D. Boudreau

Abstract:

Honey has been used since ancient time as an antibacterial agent. Even so, there has been limited research conducted on the effects of various types of honey to wound care and antibacterial properties. Limited studies have been conducted on manuka honey and honeydew honey. This study expands the research to include wild flower honey. Nonpathogenic staphylococcus bacteria were introduced to petri dishes. The bacteria were allowed to grow for 48 hours. After, honey was introduced to the cultures and the samples were incubated for a further 4 days. Culture counts were obtained using ColonyCounter and results were analyzed.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
182	LS	3056

Title: The Benefits of a Passive Solar House

Student Name(s): R. Crozier

Abstract:

The purpose of this lab was to measure the temperature of two identical houses, one with the glass facing south or the heat lamp and one with the glass facing north or not facing the heat lamp. The hypothesis of this lab is, if a house utilizes passive solar design characteristics, then the house's energy consumption will be greatly reduced because the house is being heated and cooled passively without the use of an non-renewable energy or HVAC systems. In order to complete this lab one must build two identical houses with a roof, walls, insulation, floors, and window. Then, one must set up a lamp light to mimic the sun and face one house north (away from lamp light) and one house south (facing towards lamp light).Turn the lamp on and collect data. The results found were that the south passive solar house heated quickly and trapped the heat while the north house temperature did not increase. This lab is very successful in showing how a well-designed passive solar house performs extremely well with just the sun's energy.

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

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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	Fair Category	Project Number
249	LS	3057

Title: The effects of different soil environments on the rate of HDPE and LDPE degradation by Bacillus subtilis

Student Name(s): E. Park

Abstract:

Plastic pollution has become one of the most critical environmental issues. Scientists estimate that more than 8.3 billion tons of plastic have been produced since the 1950s. Approximately 60% of that plastic generated has accumulated in landfills, dumps, or the natural environment. Plastic waste persists in the environment for centuries because the chemical composition of plastics makes them unlikely to decompose naturally. Recent studies have shown that certain microorganisms can degrade and assimilate plastics, a process known as biodegradation. Biodegradation can potentially provide an environmentally-friendly solution to manage plastic waste. Bacillus subtilis has been shown to degrade polyethylene utilizing a biosurfactant called surfactin. This experiment studied the ability of Bacillus subtilis to degrade high-density polyethylene (HDPE) and low-density polyethylene (LDPE) in soil to test its viability in tackling plastic waste in landfills. In landfills, plastics together with other municipal solid waste are compressed into layers. Each layer is covered with six to twelve inches of soil and compacted further. Rates of HDPE and LDPE degradation were studied and compared across soils at different temperatures (20°C, 35°C, 43°C) and pH (6.0-6.5, 7.0-7.5, 8.0-8.5) that simulate conditions within landfills. Degradation of HDPE and LDPE occurred in soil samples maintained at 35°C regardless of pH conditions. HDPE and LDPE degradation were also observed in soil samples maintained at 43°C with pH of 7.0-7.5 or 8.0-8.5. This study supports the hypothesis that Bacillus subtilis can potentially be utilized to help degrade plastic waste in landfills.

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

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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	Fair Category	Project Number
256	LS	3058

Title: What is the Difference Between Expensive Surgical/Cloth Masks and Cheap Surgical/Cloth Masks? Should One Be Preferred Over the Other?

Student Name(s): D. Rajbongshi

Abstract:

COVID-19: The pandemic that initiated mask mandates around the world has been controversial, partly due to mask effectiveness. The purpose of this experiment is to determine which masks are the most effective against bacteria. Testing if bacteria can pass through the masks will indicate their ability to prevent viral transmission; viruses are approximately 100 times smaller than bacteria. In this experiment, five of the most popular masks were tested; one-ply cloth, two-ply cloth, cheap surgical, expensive surgical, and KN95. Each was tested twice for effectiveness other than one-ply because the initial results could not be determined due to high water absorption. Brain-Heart Infusion Agar was used to test which mask allowed the least amount of respiratory bacteria (Neisseria sicca) to pass through and grow. The initial hypothesis stated the KN95 mask would have the most protection since it is recommended by the CDC and medical experts. After observing the first trial, an alternate hypothesis suggested the cheap surgical mask would have the most protection due to its non-absorbent material. Studies show bacteria pass through wet materials more easily than dry. The BHI Agar is composed of bovine and porcine cells, amino acids, and glucose to cultivate the Neisseria sicca in a suitable environment. This experiment is closely related to reality, considering how these aerobic bacteria are found in the respiratory system; they were also grown in agar made of mammal cells and essential organic molecules. The final results indicate the cheap surgical mask was the most effective of the five.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) ME MI 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	Fair Category	Project Number
252	LS	3059

Title: The Influence of Social Capital on Covid-19 Vaccine Hesitancy

Student Name(s): Z. Haque

Abstract:

Covid-19 is the most critical issue currently facing humanity. As such, it is vital to conduct research on the factors that contribute to Covid-19 vaccine hesitancy, so that we can better understand which populations and communities are most vulnerable to this virus, and which regions will be most resistant to use of vaccines. Specifically, this research investigates whether 'Social Capital' (the measure of trust in a geographical region) is correlated with Covid-19 vaccine hesitancy. Increased Social Capital within a community leads to a stronger sense of trust within the community and between the community and their government. Using county-level data from the US Senate and the CDC, multivariate regressions were used to statistically test the relationship between Covid-19 vaccine rates and Social Capital, using % of the population that are minorities, income, % of the population over 65, and population density as controls. The regressions found that Social Capital has a positive and statistically significant correlation with Covid-19 vaccination rates. Further, the component of Social Capital that is most highly correlated with Covid-19 vaccination rates is Community Health; suggesting that higher civic engagement leads to higher vaccination rates. Collectively, the notion that higher social trust leads to higher confidence and acceptance in vaccines, will be of interest to policymakers in combating vaccine hesitancy both in this pandemic and in future pandemics, should they occur. Thus overall, these results are and will continue to be helpful for the resolution of this pandemic and the prevention of future pandemics.

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

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	Fair Category	Project Number
247	LS	3060

Title: Evaluating Natural Coagulants for the Removal of Various Chemical Pollutants in Water

Student Name(s): N. Kathir

Abstract:

Phosphate, Iron and Copper are some of the largest contaminants of water. Fertilizer runoff, geological deposits, and chemical manufacturing cause large amounts of phosphate, iron, and copper contamination. The contamination of these chemicals in aquatic systems poses many adverse effects on aquatic life including suffocation, hindering growth, and changes in blood chemistry. In many cases, these situations can lead to death. It is important to identify water treatment methods to remove these contaminants. In order to combat the terrible effects caused by the pollution of these chemicals, multiple natural coagulants were examined as solutions to find an effective remover of these contaminants. Moringa Oleifera (MO), Strychnos Potatorum (SP), and Activated Charcoal (AC) were evaluated. The hypothesis stated that MO will be most effective in the removal of all the contaminants. All coagulants were incubated in contaminated solutions of each chemical for a total of 150 minutes. Data was collected every 20 minutes. The effectiveness of each coagulant was measured using test strips. The results showed that different coagulants are effective for removing different chemicals. For the removal of phosphate, SP was the most effective by a landslide. In the iron concentrations, MO was the most successful. All the coagulants were effective in removing copper, but AC removed the most by a slim margin. All of these coagulants are cost-effective, natural solutions to combat the challenges posed by phosphate, iron, and copper in water, forming a pathway for a positive future in which aquatic life can thrive.

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	Fair Category	Project Number
244	LS	3061

Title: A Novel Mitigation Technique to Control the Spread of the Invasive Spotted Lanternfly

Student Name(s): C. Carr

Abstract:

Lycorma delicatula poses a direct threat to the stability of New England's forest ecosystems due to L.delicatula's high spread rate and feeding habits. As an invasive species L.delicatula lacks natural predators, so a direct control method must be used to mitigate the population. It is proposed that cardiac glycosides, found in herbaceous dogbane plants, are a potential organic pesticide candidate. Cardiac glycosides are extracted from milkweed using a 8:2 ethyl alcohol 95%/methanol extraction. Cardiac glycosides are recovered for testing on L.delicatula with a 15:1 solvent:meal ratio and proven within the solution using a UV/VIS spectrophotometer and baljet reagent. Maximum yield of cardiac glycosides came from tropical milkweed stems yielding a .591 absorbance at lambda max. SLF are directly tested at the Connecticut Agricultural Research station in Ansonia CT. Using a control of Ailanthus altissima(SLFs favorite food) and a experimental plant of Asclepias curassavica the 18 SLF are put on each plant at 60% humidity and 25*C. The Asclepias curassavica had 100% mortality while the Ailanthus altissima had only 22.22% mortality. The SLF are then tested for cardiac glycosides. The UV/VIS spectrophotometer concluded that SLF on Asclepias curassavica had cardiac glycosides within them at an average absorbance of .035 at lambda max. Further testing on the tree of heavens will be done using different techniques such as charged biochar and tree injections of cardiac glycosides to see if the tree of heaven can sequester cardiac glycosides within its sap.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EM BI 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	Fair Category	Project Number
199	LS	3062

Title: Comparison of the Cognitive Ability of Musically Trained Children vs. Non-Musically Trained Children

Student Name(s): E. Moloney

Abstract:

Claims that young children who are trained to play classical music from a young age are superior in intelligence are due to the belief that developing brains, in their malleability, may enhance in maturity when they are stimulated by this learning experience. Specific behaviors that are said to be enhanced by classical music training in youth include verbal memory, second language pronunciation accuracy, reading ability and executive functions . This study focuses on basic functional differences displayed between children who have been trained in classical music vs. children who have not, showcasing contrasting cognition amongst the participants through levels of performance in various cognitively challenging tasks. Children between the ages of 7-11will complete 4 tests; the first 3 assigned to determine abilities such as mental processing speed, attention span, and short-term auditory memory, and the fourth test will test if there is a visible difference in rhythm, pitch and auditory recognition abilities between the musical and non-musical children. Results displaying a higher performance from the musical children are expected, with a significant difference between the results of the two groups' scores on the fourth test, as it is composed of tasks that are supposedly refined throughout musical training.

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

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	Fair Category	Project Number
257	LS	3063

Title: Design of a Wearable, Skin-Specific UV Sensor for Instantaneous Detection of Skin Damaging Radiation

Student Name(s): Y. Sakai

Abstract:

Overexposure to ultraviolet (UV) rays, an invisible light spectrum from 10-400nm that can penetrate skin cells and mutate the DNA, is the driving cause of skin cancer. While overexposure to UV has damaging effects on human health, some levels of absorption are necessary to produce Vitamin D, a nutrient essential to bone, muscle, and immune health, making it difficult for individuals to determine safe levels of daily sun exposure. Accordingly, this research developed a wearable, low-cost patch for instant visual indication of current UV exposure relative to the threshold appropriate for an individual's skin type. A phosphomolybdic acid and lactic acid solution (300:5 molar ratio) was evenly coated on filter paper. Subsequent analysis of the dried UV Sensor's spectral reflectance confirmed a gradual change in Sensor color (white to blue) with increased UV exposure. Lack of color change in the UV-Sensor after 5-hours of visible light exposure highlighted its selective response to UV light. The linear relationship between 457nm/530nm (corrected) spectral indexes and the B/R (corrected) indexes of the UV-Sensor support use of RGB values to quantify the Sensor's color change. Further, the direct relationship between RGB values of iPhone Sensor photos (using a newly-designed, light-tunnel case) and similar blue-gradient swatch standards validated the use of RGB values to objectively measure color change in the UV-Sensor. In use, iPhone-imaged UV-sensor color change is correlated to the Fitzpatrick Scale for each skin type, and interpreted as UV exposure that has reached the individual's Minimal Erythema Dose.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EN ME 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	Fair Category	Project Number
248	LS	3064

Title: Retracing Evolution: The Venus Flytrap

Student Name(s): T. Borowski

Abstract:

Venus flytraps are native to the pine savannahs of North and South Carolina. The soil usually contains high amounts of moisture. However, it severely lacks nitrogen and many other nutrients. This is what caused the plant to evolve to trap insects.

The Venus flytrap has been evolving for millions of years in order to survive in the nutrient-lacking soil. The goal of this experiment is to show how the adaptation developed. The Venus flytraps were observed to determine what would happen if it relied solely on the soil for nutrients instead of prey. To do this, one insect was placed on the trap of each plant. However long it took for it to close was timed every two days for six days. The RAW Nitrogen supplement was then added along with the water to the plants of the experimental group after each plant was fed, which was also every two days for six days. Once three trials were completed, a month passed, so that each plant became familiar with the new nutrients in the soil. Then tests resumed as before. In the first set of trials, Plants 1 and 2's reaction times slowed, while Plants 3 and 4's reaction times remained similar to their baseline. In the second trial, Plants 1 and 2 stopped reacting to the insect completely, while Plants 3 and 4's times still remained close to the baseline. This showed that adding nitrogen to the soil did affect the plants' behavior.

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):

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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	Fair Category	Project Number
247	LS	3065

Title: Effects of Tumeric & Green Tea on Mus Musculus Mammary Cells

Student Name(s): I. Simms , A. Sono, E. Hall

Abstract:

Some things that I have already completed as of now for this science fair capstone project is that I have conducted some interesting research about how turmeric aids in the death of cancer cells, also how we are going to test these theories. Some of the research has to do with the mus musculus mammary, cells which you might know as the common house mouse and preparing the media for when these cells eventually arrive using the sterile technique. Once these cells are ordered and arrived I can continue. This technique is a set of specific practices and procedures performed to make equipment and areas free from all microorganisms and to maintain them as sterile as possible, it is a way to deep clean the cells to make sure that they are not contaminated. I have tested different kinds of turmeric (statistics show that green tea and turmeric are number 4 and 6 on the best 8 supplements for slowing or preventing cancer) to find which one(s) are the most soluble with water. I have also started testing how to make the matcha powder soluble with water, this is a process in which I did using heat, in this case a bunsen burner. I did this because I noticed that it would not mix very well with room temperature, or cooler water. Once I have the musculus cells the plan is to test each supplement separately and then test the effects on both of them together.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) ME CB 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	Fair Category	Project Number
184	LS	3066

Title: Investigation into the Impact of Microplastics on the Growth of Cherry Tomatoes

Student Name(s): J. Larson

Abstract:

Microplastics have exhibited negative impacts on our environment, especially in soil ecosystems. They recently proved to have detrimental results on the growth of different plants, while the full influence of their presence in the soil ecosystem has yet to be concluded. By studying the presence of these microplastics, two very different forms of microplastics, in the soil, the scope of their impact can be observed. Polylactic Acid (PLA) and High-Density Polyethylene (HDPE) microplastics can hypothetically impact the pH and nutrients of the soil, the growth of the plants, the number of flowers, and ripened tomatoes that fruit, the biomasses of the plants, and their roots. In this study, Sweet 100 cherry tomatoes grew in soils containing one of these types of microplastics. Plants with exposure to PLA microplastics contained significantly less moisture content, both in the overall plants' weight and the weight in the living parts of the plants. Plants with exposure to HDPE microplastics had significantly larger roots. These impacts may be attributed to how the plants react with microplastics in their soil, either as a stress reaction or as permanent damage.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EV 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	Fair Category	Project Number
258	LS	3067

Title: Structural Determination of Novel Non-Canonical Base Pairs and Mismatches

Student Name(s): W. Bernfeld

Abstract:

With the arrival of the SARS-CoV-2 virus and its variants, humanity has suffered the destructive power of a global pandemic, the likes of which have not occurred since 1920. With over 4.5 million COVID-19-related deaths worldwide, the scientific community is rushing to find ways to slow the virus. Although viral tests and vaccines have been widely distributed, many tests yield false results and numerous breakthrough infections are being reported in vaccinated individuals. Thus, we must improve the tools by which we address the pandemic. To address this need, we synthesized a set of four novel nucleobase pairs – two from purines and pyrimidines, and two from pairs of pyrimidines mediated by transition metal ions – to expand the nucleobase language. We used the Python-based Hierarchical ENvironment for Integrated Xtallography (PHENIX), the Crystallographic Object-Oriented Toolkit (COOT), and ChimeraX to form predictive models of our pairs. We then ran simulations to predict their stability. Upon completion, we assembled the pairs in vitro and fitted them with sticky ends to allow for crystalline self-assembly. Through x-ray diffraction, with phasing and refinement, our findings suggest that these novel, unnatural base pairs are indeed stable. The presence of novel pairs, such as those designed herein, allows researchers to design more precise hybridization probes with fewer off-target effects to better monitor SARS-CoV-2. Moreover, with an expanded DNA/RNA language that can stably integrate into known nucleobase sequences, we could design enzymatic binding sites to encode novel amino acids into proteins, thereby developing new antiviral therapeutics.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CB BI 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	Fair Category	Project Number
260	LS	3068

Title: Computational Psychiatry: Application of Machine Learning Method to Analyze Marijuana Addiction and Craving

Student Name(s): S. Lee

Abstract:

Marijuana, the most commonly used substance of abuse in the United States after alcohol and tobacco, is known to induce long-term neurophysiological changes in the brain. Despite this potential for permanent physical damage, the exact mechanism of marijuana addiction is ambiguous relative to other forms of addictive substances such as alcohol and cocaine. Specifically, the underlying neurobiological mechanism of marijuana cue-elicited craving has not been studied extensively despite the significant role craving plays in drug relapse. Searching for patterns in the brain activity of marijuana-addicted patients with machine learning algorithms may offer insight into marijuana's mode of action. This project utilizes the logistic regression algorithm to determine which brain networks exhibit the greatest association with marijuana cue-elicited craving. fMRI data of both marijuana-addicted and non-addicted subjects presented with marijuana-related cues was downloaded. For each of the 90 brain regions tracked, a logistic regression model was trained with data from that singular region and tested in how accurately it could predict the addiction state of a subject given their fMRI data. The models trained with regions from the anterior salience and basal ganglia networks demonstrated the highest average accuracies of 87.5% and 86.25%, respectively—suggesting that these two networks, both part of the brain's reward system, play a critical role in marijuana cue-elicited craving. This result shows promise in enhancing the understanding of marijuana's addiction-inducing mechanism, and ultimately marks the beginning of future research in subduing the sensation of craving itself to help millions of people withdraw from various forms of addiction.

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

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	Fair Category	Project Number
252	LS	3071

Title: The essential 23S rRNA methyltransferase rv3579c confers intrinsic macrolide resistance in Mycobacterium tuberculosis

Student Name(s): Y. Sandmeier

Abstract:

According to the Centers for Disease Control and Prevention (CDC), in 2018, roughly 1.7 billion people were infected with Mycobacterium tuberculosis (Mtb). To treat tuberculosis (TB) infections, there has been a long-standing interest in using macrolides, a family of drugs that include clarithromycin and azithromycin (Z-pack), due to the fact that they are exceedingly safe and well-tolerated by most individuals. However, Mtb has intrinsic resistance to macrolides, generally rendering macrolide drugs ineffective at treating TB infections. The mechanistic basis for this resistance is only partially understood; thus, we aimed to determine whether there were additional factors responsible for this phenotype. A CRISPR interference (CRISPRi) screen performed in our lab identified rv3579c, a predicted 23S rRNA methyltransferase, to be a novel macrolide-resistance factor in Mtb. Using homology-based methods, we ascertained that rv3579c was closely related to the rlmB family of methyltransferases found in E. coli. We then demonstrated the essentiality of rv3579c in M. smegmatis (a surrogate of Mtb) and later showed that, with genetic knockdown of rv3579c, Mtb becomes more susceptible to clarithromycin, thereby highlighting a mechanism that will most likely facilitate successful treatment and elimination of TB in affected individuals. With these pivotal findings, we have laid the groundwork for further research to determine whether or not rv3579c can be targeted by chemical compounds to both inhibit Mtb growth and render the bacteria sensitive to macrolides. In the future, we aspire to use our findings to prevent the deaths and hospitalizations of countless millions of people.

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	Fair Category	Project Number
186	LS	3072

Title: Examining the Use of Navicula sp. as an Alternative Organic Fertilizer

Student Name(s): D. Mansfield

Abstract:

The use of synthetic fertilizers causes numerous different environmental problems such as chemical burn, fertilizer runoff, etc. Using organic fertilizers tends to reduce these environmental concerns due, primarily, to their ability to release macro-nutrients into the soil slowly. Algae/microalgae have been well documented as possibilities for organic fertilizers. Despite this, the Navicula sp. algae, which is extant worldwide and lives in almost all types of water, has not been well documented in its capabilities for plant fertilization. The objective of this research seeks to answer the research question: How will the application of dried Navicula sp. to the soil that Brassica Rapa plants are growing in impact its growth? I hypothesize that this will positively impact the growth of the Brassica Rapa plants, with fertilized plants growing faster, taller, and with more flowers. In this project, I intend to culture and dry Navicula sp. algae and then use it to fertilize soil that Brassica Rapa plants are growing in. Though the Navicula sp. has been successfully cultured and dried, due to delivery delays and other constraints, results are yet to be ready for disclosure.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) PS 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	Fair Category	Project Number
255	LS	3073

Title: Structural Determination of Bacteriophage P22 Genome Ejection with Cryo-Electron Microscopy and UCSF ChimeraX

Student Name(s): A. Tischer

Abstract:

Antibiotic-resistant infections are becoming increasingly common in bacterial infections of all types. These infections significantly increase treatment cost, hospital stay length and patient mortality and morbidity. With the increase in antibiotic resistance, there is a need to find alternative treatments for bacterial infections. A possible treatment is bacteriophages. Bacteriophages (phages) are a group of viruses that can infect and treat antibiotic-resistant bacteria. Bacteriophage therapy is a compassionate treatment for antibiotic-resistant bacteria, but more research is needed before it can become a commonplace treatment. Bacteriophage infection initiation is a poorly understood part of phage ecology. The simplified steps of infection initiation are landing, phages attach to the bacterial membrane, pinning, baseplate attaches to the bacterial membrane, needle penetration, phage needle punctures the bacterial membrane, and genome ejection. This study focuses on the genome ejection aspect of phage infection initiation. Bacteriophage P22 is a phage commonly used as a model for phage assembly and infection. In previous studies, phage P22 was found to construct an "trans-envelope channel" that is essential for successful genome ejection during infection initiation. The specific proteins that comprise and construct this channel are unknown. The purpose of this study is to determine the structure and proteins that comprise the trans-envelope channel. The results thus far determined that the trans-envelope channel is split into two parts: the inter and extracellular channels This study will bring more understanding to the understudied topic of bacteriophage infection initiation and provide more information vital for bacteriophage therapy to become a commonplace treatment.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CB ME 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	Fair Category	Project Number
244	LS	3074

Title: The Effect of Soil on The pH of Water

Student Name(s): K. Sisson, K. Sisson, K. Sisson

Abstract:

The purpose of this experiment was to identify how 3 different soils would affect water's pH. For this experiment the prediction was, if different soils are put into water then the pH will be variant for each because certain types of soils have varied pH levels. This lab was carried out by doing the following process: First plug the Vernier pH pro software into the LabQuest2, and take 3 beakers out, then fill each with 100 ml of water. Next take the pH of the water alone as a control using the pH pro, after fill each of the three beakers with 5 grams of different soil (peat moss, gravel, and local soil) and mix them. Once mixed, put the end of the pH pro into one of the mixtures and set a timer for 2 minutes, write down the pH level, then clean the pH pro and place it in the buffer solution to neutralize all substances. Repeat the same process for all solutions 3 times. The results for this lab's pH levels were water (6.94), local soil (6.73), peat moss (5.65), and gravel (6.91). This lab was important because soil is a huge factor in plant growth. If it has a crumbly texture, and neutral pH, then it will be beneficial for plant growth, but if it is too acidic/basic, and clumpy then it will be detrimental to plant growth. Therefore soil pH has great importance in regards to plant growth.

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

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	Fair Category	Project Number
249	LS	3075

Title: What Paint is Best: Effectiveness of Commercially Available Anti-Fouling Coatings

Student Name(s): L. Corsano-Leopizzi

Abstract:

Biological fouling or biofouling is defined as "the gradual accumulation of organisms such as algae, bacteria, barnacles, and protozoa on underwater equipment, pipes, and surfaces, corroding and impairing structures and systems." Biofouling almost always negatively impacts the function of a man-made underwater surface, but in the case of boat hulls, biofouling is extremely detrimental for multiple reasons. Fouling organisms destroy the integrity of the hull and they initiate and accelerate corrosion on metal surfaces. Fouling is also particularly harmful to boats because the formation of these organisms greatly increases drag as the boat moves through the water which increases fuel consumption and in turn the cost of said voyage. The goal of this study was to test five commercially available anti-fouling paints and determine the most effective one. This study also examines which coating performed best on a dented surface to mimic hull damage. A string of 12 PVC frames(5 painted and not dented, 5 painted and dented, 1 not dented control, 1 dented control) was deployed at a fouling site in Greenwich Point Park, Greenwich CT. Plates will be photographed and analyzed monthly (using Coral Point Count with Excel extension). Expected results are that the higher copper content paints will be more effective at controlling fouling. Understanding what the most effective anti-fouling paint is can help anyone trying to mitigate fouling on their surface but will be most helpful to individuals or companies who profit from marine travel and need to minimize fuel cost.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
165	LS	3076

Title: Determining the Risk of Future Forest Fires Due to Fuel Flammability

Student Name(s): A. Price

Abstract:

The way that I will conduct my research is by first, collecting data from my different criteria. I used Palmer Hydrological Drought Index Data for August-September 2021, mean temperature and precipitation, and major roads. Using QGIS Software, I am able to overlap and analyze all base layers to predict vulnerable regions in the continental United States. By gathering this data, I will be able to visualize the vulnerability and expect which regions will suffer the most fires in that time period. I then compare my results to an updated map of the fires that had occurred during that time period. I had expected that Colorado, Southwest California, New Jersey, and the Midwestern Plains were the most vulnerable. However, Colorado suffered less fires than other regions due to higher elevation. This research is beneficial for advancing reliability of GIS technologies and enhancing forest fire research. Fire research is valuable in the sense that it has the ability to save countless lives, money, and natural sites.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
227	LS	3077

Title: The Impact of Covid-19 Pandemic and Restrictions on the Socialization,Stress, and Anxiety of College Students

Student Name(s): E. Coakley

Abstract:

During the COVID-19 pandemic people have experienced significant changes in lifestyle, and socialization. Changes in routine such as these have often been identified as triggers for mental disorders and the stress of the pandemic as presumably escalated these struggles. I believed that students would demonstrate increased stress and anxiety in social situations due to restrictions the pandemic placed on a person's ability to interact, attend classes and social events, as well as impacts on everyday life. I then distributed a survey via. google forms which inquired about the state of college students mental health through the results of the survey it became clear that most students felt their schools loosely enforced CDC Guidelines however they generally felt comfortable attending large social gatherings. Additionally, the majority (87.5%) of students interact with peers more than 5 times a week while 62.5% felt that the pandemic had negatively impacted their ability to socialize. It was clear that most students felt that the pandemic had impacted their stress and anxiety levels to an extent. From these results I determined that while there is little concern among students regarding contracting COVID -19, and it appears that the pandemic has had minimal impact on students ability to socialize, the pandemic has increased stress and anxiety among students as many worry about the implications on their futures, and negative impact on their education.

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

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	Fair Category	Project Number
227	LS	3078

Title: Identifying Prognostic Genes of Prostate Cancer andExploring Their Expression Patterns Using Single-Cell Analysis

Student Name(s): J. Ma

Abstract:

Prostate cancer (PCa) endangers men's health and life worldwide. It is the second most common cancer and the fifth leading cause of cancer death among men. So it is urgent to find reliable prognostic molecular biomarkers in PCa for risk stratification, personalized treatment, and prognosis improvement. This study analyzed differentially expressed genes of PCa using microarray dataset from GEO. Then prognosis analysis was performed in UALCAN to find prognostic genes. Finally, the differential expression of the identified prognostic genes in PCa was verified in scRNA-seq data from GEO141445 using single-cell analysis with Seurat V3 (R package), and their cell expressions were explored in the tumor microenvironment. 7 differentially expressed genes were identified as prognostic genes. They were BDH1, CRACR2B, GRK6, MZT2B, NOP16, SLC25A27, and SURF6 respectively. These prognostic genes were all mainly expressed in PCa epithelial cells but were also expressed with small amounts in other cells in the tumor microenvironment such as T-cells, mast cells, endothelial cells, monolytics, and fibroblasts. Overall, this study indicates single-cell analysis can be used for screening differential genes and exploring the role in the occurrence and development of the tumor by their cell expression in the tumor microenvironment. The 7 prognostic genes for PCa identified by this study have never been reported before. They are novel molecular biomarkers and may be potential therapeutic targets for prostate cancer.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CBIO 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	Fair Category	Project Number
218	LS	3079

Title: Antibacterial Perfluorocarbon Emulsions: The Role Temperature plays in the Formation and Efficacy of Integrating Perfluorocarbon (PFC) and Tobramycin

Student Name(s): L. Affini

Abstract:

Background: With diseases such as Cystic Fibrosis, the production of excess mucus often causes blockages which prevents the medicine from reaching certain areas within the lungs. Tobramycin emulsified within liquid perfluorocarbons may assist in airway penetration and achieving spatial uniformity. The investigation of which temperatures should be used when delivering this antibacterial emulsion will be used to formulate a claim on whether temperature does play a role in the effectiveness of the antibacterial emulsion.

Methods: Emulsions will be made with Tobramycin, Perfluorocarbon, and a Copolymer. Before being emulsified, mixtures will be heated or cooled to their testing temperatures. For the testing period, Petri dishes will have K12 E.Coli cultured on them and each temperature will be tested using one petri dish.

Results:10°C appeared to look the most effective amongst the rest of the plates as only a small amount of bacteria grew on one of the three total plates. However, 35°C is still a very effective temperature as bacteria only grew notably on one of three plates. Room Temperature is not a good option for this antibacterial emulsion as there was notable growth on two of the three plates. Non-Antibiotic PFC is not a good option either as it looks to have no positive effect on the bacteria. Bacteria continued to grow on all three plates.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
250	LS	3080

Title: How images and colors impact people's short term memory

Student Name(s): S. McDonald

Abstract:

The purpose of this lab is to investigate and discover how images and color impact how many things people remember. The hypothesis for this lab is if people are shown images containing colors, then it will improve the amount of terms they remember, because colors and images increase someone's attention level, and the more attention focused onto one thing someone has, the better chance of remembering it there is. The participant would be told 20 different words or phrases and would be told to repeat them in the correct order after a 30 second pause in between. They would then be shown 20 black and white images of different objects or things and be asked to repeat them in the correct order after a 30 second pause in between. Following that, they would be shown 20 images in full color of different objects or things and then would be asked to repeat them in the correct order after a 30 second pause in between once again. However many they got right in the correct order for each stage would be recorded in the data set. Those steps would be repeated for all the remaining participants in the lab. (Insert Results here) This lab is important because it can show and teach people more about how their mind and memory works and help them find out if they are more of an auditory or visual learner and memorizer, which could potentially help them if they need memorization strategies in the future.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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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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	Fair Category	Project Number
257	LS	3081

Title: Investigation of Nucleic acid concentration in three layered or surgical masks among children with and without asthma

Student Name(s): T. Rogers

Abstract:

Asthma is a very common chronic illness among children but much is unknown about wearing three-layered masks during the COVID-19 pandemic, especially among those with asthma. So with the help of my mentor, Dr. Jessica Hollenbach, I devised a project that was a piece off of her larger research. I investigated nucleic acid concentration in three layered masks among children with and without asthma. I received the concentration of nucleic acid from Dr. Hollenbach's team. Then I organized the data simply to look at trends. It was decided that the data didn't fit a normal bell curve, and more data analysis was needed. Therefore, with the guidance of Dr. Hollenbach, non-parametric testing was completed. Kruskal-Wallis Test was used to distinguish between the three layers for both asthma and non-asthma data and the Mann-Whitney U test was used to distinguish between asthma and non-asthma data sets. It was found that there is a statistical difference of nucleic acid between each layer in both cases, but there was not a statistical difference across asthma and non-asthma masks. Still, this study provides crucial knowledge about masks. Based on the data, it was found that most nucleic acid resides in the inner layer of the mask. This could suggest a redesign of the mask but, in general, more research on masks should be done. Lastly, since there is no difference in the distribution of nucleic acid for those with asthma it suggests that masks are equally protective and safe for children with asthma.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
243	LS	3082

Title: Forest Restoration after Wildfire: The Effect of the Addition of Saccharides on Seedling Survival After Replanting in Burnt Soil

Student Name(s): R. Finn

Abstract:

Forest Fires are a threat to wildlife, leading to lasting changes in ecosystems by burning trees and affecting soils' water retention properties. As seedlings require moist soil, a solution is crucial to survival, especially for trees that are fire-sensitive, such as sugar maples. It is hypothesized that introducing saccharide solution to burnt soil will improve water retention and subsequently increase the survival of seedlings. This study aims to determine 1) the effects of adding simple glucose on trees suited for drier climates and 2) the effects of adding saccharide solution on trees not naturally affected by fires. In phase one, eight boxwood (Buxus sempervirens) seedlings were individually planted in 300ml of heated soil indoors and treated with three different quantities of glucose either once or repeatedly. Survival was determined by signs of dehydration in leaves through color and texture. Part 2 investigated the effect of the addition of maple water to sugar maple (Acer saccharum) seedling survival after planting in burned soil outside. The addition of 3.50 grams of glucose to boxwood seedlings was associated with the longest survival time of 5 weeks. The addition of the 7.50 g dosage of maple water to sugar maple was associated with the longest survival, indicating the benefit of higher levels of saccharides and other helpful nutrients to aid in sugar maples' survival. In conclusion, the results of this study suggests that addition of a saccharide solution can aid in the regrowth of forest ecosystems.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EA PS 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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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	Fair Category	Project Number
250	LS	3083

Title: The Effects Ocean Acidification has on the Antimicrobial properties of Sulfur Nanoparticles from the Marine Sponge Species Halichondria bowerbanki.

Student Name(s): M. Hatfield

Abstract:

This experiment evaluated the antimicrobial properties of sulfur nanoparticles from the sponge Halichondria bowerbanki living in optimal conditions and an acidic environment representing ocean acidification.

The sponges were cultivated in separate tanks for thirty days. The conditions in one tank were consistent with those optimal for sponge growth. In another tank, the pH was decreased to create an acidic environment. The sponge structure in optimal conditions was maintained throughout the cultivation period. The sponge in optimal conditions flourished. As time progressed, the structure of the sponges in acidic conditions deteriorated.

To extract sulfur nanoparticles, sponge samples were put in a centrifuge. To find the most effective concentration of sulfur nanoparticles, samples of pellets, supernatant, and raw pieces of sponge were used as inhibitors. Samples were put on SDA and nutrient agar dishes inoculated with unknown microbes from decaying matter. SDA is selective for fungus and Nocardia. Nutrient agar is selective for bacteria. Kill zones on different types of agar can indicate if sulfur nanoparticles are antibacterial or antifungal. The supernatant showed lawns on SDA. Raw pieces of sponge showed lawns on nutrient agar but minimal growth on SDA. The pellets showed no growth on SDA but a lawn on nutrient agar.

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

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CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
250	LS	3085

Title: Potential Role of Filaggrin within Different Stages of Osteosarcoma

Student Name(s): M. Brink

Abstract:

Osteosarcoma (OS) is a rare and vigorous form of bone cancer. Its primary tumor is frequently located within the appendicular skeleton, while metastatic tumors are commonly seen in the lungs. Osteosarcoma is life-threatening, with survival rates dropping as low as 27% for tumors that have undergone metastasis.

Over the past three decades, there have been limited discoveries in relation to Osteosarcoma and its metastasis. Therefore, my project revolved around pinpointing a gene that may have a previously unknown role in the metastasis of OS so that the scientific community can finally have a new angle to combat this lethal disease. After researching a plethora of genes, I found that the gene entitled Filaggrin (FLG) has had strong ties to other cancers and a strong potential to be connected to OS metastasis. FLG is a gene that encodes an intermediate filament-associated protein that aggregates into keratin intermediate filaments. Its mutation and ability to alter the cytoskeleton has been known to facilitate metastasis of other cancers, ultimately giving me evidence to believe that it could also facilitate the metastasis of OS. To test this, I performed immunohistochemistry with the FLG primary antibody on multiple OS tumor samples. I then photographed these sections using epifluorescence and further analyzed them by pseudo-coloring the images using Image J software. The analysis is to determine if FLG is differentially expressed within the metastatic and primary tumor samples, which will allow us to know if Filaggrin truly does have a role in Osteosarcoma metastasis.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
201	LS	3086

Title: Predicting a Rise in Smoking Due to the Physiological Effects of the Coronavirus Pandemic

Student Name(s): C. El-Masry

Abstract:

The data collected from the Severe Acute Respiratory Syndrome (SARS) epidemic in China showed an increase in depression during that period of time. The coronavirus pandemic has likely created a similar effect. Depression can lead to vaping, especially among youth. I hypothesize that there will be an increase in depression and anxiety rates among youth in America that will lead to an increase in vaping among high school students. I am using data taken in China during the SARS epidemic regarding the increase in depression, and the data taken by the Center for Disease Control (CDC) regarding depression rates in youth and vaping. I will then use machine learning and deep learning to determine by what percentage depression increases the risk of vaping. I predict that I will see an increase in the depression rates similar to what was recorded in China. I predict that due to this increase I will see a spike in vaping across every state in the U.S. Vaping is extremely harmful to a person's health, but even more so to youth. Predicting which areas will be hit the hardest by depression will help organizations that educate against vaping, to pinpoint where they should distribute their resources.

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

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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	Fair Category	Project Number
212	LS	3088

Title: Daphnia Heart Rate and Sound Pollution

Student Name(s): D. Lanche-Flores

Abstract:

Sound Pollution is emitted in the form of vibrations (via sea traffic) which disrupts marine life's ability to utilize their sonar to navigate, hunt, and communicate. A project on a smaller scale was created using Daphnia Magna and Sound Decibels to examine the effects of sound pollution on marine life. The observation of the heart rate of Daphnia Magnas and vibration emissions from a speaker was used to imitate the effect of sound pollution. Daphnia Magnas are well suited for this type of experiment as they are microscopic crustaceans with an externally visible heart. Daphnias were placed in a watch glass and placed over a speaker (that exerted vibrations at each decibel level at 100 Hz) for one minute and then was observed under a microscope for 15 seconds. By adjusting the amplitude of the speaker from 55, 70, to 100 dBs, the strength of the vibrations were gradually increased. After the 15 seconds, the heart rate was multiplied by 4 to record the bpm. The data obtained demonstrated an increase in averages from 98 bpm at 55 dBs, 176 bpm at 70 dBs, and 246 dBs at 100 dBs. This outcome of increased abnormal heart rate was assumed to be a negative outcome associated with higher mortality and lower life expectancy.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) AS 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	Fair Category	Project Number
172	LS	3089

Title: The Effect of Diphenhydramine on the Cognitive Behavior of Drosophila Melanogaster

Student Name(s): D. Mirin

Abstract:

Benadryl is a commonly used allergy drug, as well as to induce sleep. It impairs cognitive abilities and simple functions as it induces drowsiness. Using drosophila melanogaster wild type, benadryl will be distributed through food to two groups of flies, while two other groups will remain undrugged. One group from the control and one test group undergoes a test of behavioral control through environmental stimuli in the form of a treat that tests how long the drosophilae take to respond and interact with the stimuli. The other test being performed is a shake test which also tests reaction times but with the sense of danger and a change in the environment instead of stimulus. The subjects receiving medication are expected to have lowered cognitive function and slower reaction times as the medication affects their ability to stay awake and correctly respond to the changes in their environment during testing. Studying this will allow for deeper understanding of affects and implications of long term continuous use of diphenhydramine for alternative purposes to allergies.

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

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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
230	LS	3090

Title: Growth of Organic VS. Nonorganic Green Bean Seeds

Student Name(s): E. Bausch

Abstract:

Over the past few years, many people have been attempting to grow vegetables and other plants within their own homes. Potential gardeners will have to decide whether to buy nonorganic or organic seeds. Organic seeds come from plants grown without fertilizers or using natural fertilizers such as manure or other natural means, and nonorganic seeds are obtained from plants that had pesticides and other harsh chemicals that they've been treated with or applied to them. As a result, organic seeds are less harmful to pets or young children that might encounter them unsupervised. Based on previous research, it is shown that nonorganic seeds grow faster with fertilizers but tend to not grow as effectively when grown without pesticides or fertilizers. Organic seeds, however, grow more efficiently without fertilizers and do not require the use of pesticides. This experiment was performed by planting both nonorganic and organic seeds in the same environment and measuring their growth over time. They were planted in standard gardening topsoil without fertilizers. The plant's growth was measured in inches every five days for twenty-four days. When analyzing the data gathered from the experiment, organic seeds were shown to be more efficient to grow to obtain faster and healthier results. It can be concluded that the lack of pesticides and fertilizers make the vegetables produced by organic seeds healthier and efficient to grow for home use.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
261	LS	3091

Title: Development of an Accessible Machine Learning Diagnostic for Early-Stage Mild TBI Using Eye Tracking Methods

Student Name(s): A. Malkin

Abstract:

1.5 million Americans suffer a traumatic brain injury every year. Without proper rest after even a mild concussion, repeated injuries to the brain build up and can lead to complications such as Chronic Traumatic Encephalopathy (CTE) later in life. Yet, especially in high school athletes, it is estimated that over 50% of concussions go undetected, as coaches/parents lack adequate training to make on-field diagnoses, and subsequent visits to medical professionals are often overlooked. A diagnostic device that can rapidly and easily diagnose concussions, on-site and in real-time, is needed. This research develops a portable, rapid eye tracking exam for concussion diagnosis, based on two eye-movement metrics, fixation time and pupil dilation. Each portion of the exam is based on a unique neural network written in Python with Tensorflow-based architecture, which identifies the subtle signs of a concussion that may be missed by human observers. Both models are trained on data from Wetzel, et. al., using fixation and pupil dilation datasets with 3058 and 1112 data points, respectively. The fixation model examines 11 metrics relating to eye fixation, saccades, and gaze velocity, while the pupil dilation model uses 4 metrics relating to pupil area. After training, the fixation model reached 93% accuracy and the pupil dilation model reached 80% accuracy, much higher than the 50% rate of existing concussion diagnostic methods. In use, an athlete who suffered a brain injury will take this new 2-minute eye tracking test, on the field-of-play, using a laptop/eye-tracker. A concussion diagnosis is given immediately after.

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

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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	Fair Category	Project Number
162	LS	3092

Title: The Effect Different Genres of Music Have on Teenage Boys Heart Rate

Student Name(s): C. Lucuk

Abstract:

The project was completed to see the effect listening to different genres of music has on teenage boys' heart rates. If young boys ages 14-15 are to listen to different genres of music then their heart rate will change based on the genre of music because different tempos cause different changes in heart rate. To carry out the lab 10 boys ages 14-15 were given 5 songs all in different genres to listen to while having their heart rate monitored. The results showed that the tempo of music influenced heart rate as genres with fast tempo such as rock, pop, and classical caused a large increase in beats per minute (BPM), and genres with a slow tempo such as country and rap caused a small increase in BPM. The data is important as it gives an understanding of how heart rate is affected by music and listening to music can cause your heart rate to increase to an unhealthy amount of BPM.

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
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☒ Yes ☐ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
225	LS	3093

Title: The Effect of Placebos and Nocebos on Pain Perception

Student Name(s): A. White

Abstract:

The placebo effect is a relatively well-known concept, but few people are familiar with the nocebo effect. The placebo effect is a term that describes a supplement or treatment plan that has no effect on a person's body but creates the sense that something is getting better, in this case pain relief, due to the anticipation or expectation associated with taking the supplement. The nocebo effect, on the other hand, is based on a person's negative expectations or prior information about their treatment, causing the treatment to have a worse overall outcome than it would otherwise. This is related to pain and how people tend to exaggerate the severity of their pain merely due to negative implications/reactions in the moment. This project will consist of figuring out how the placebo and nocebo effects affect the perception of pain through the use of neurological and psychological processes, and drawing suitable conclusions through the data being analyzed. What will and has been done is analyzing data from several studies and developing conclusions based on what other researchers have discovered. How this will be executed is through interviewing doctors and researchers about their studies and comparing data, as well as doing my own research, to come to a clear conclusion regarding how significant placebo and nocebo effects are when it comes to a pain relief treatment.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
251	LS	3094

Title: Visualizing Functional Magnetic Resonance Imaging (fMRI) Data through AR and 3-Dimensional rendering

Student Name(s): M. Daly

Abstract:

Functional magnetic resonance imaging (fMRI) evaluates brain activity by identifying changes in blood flow, this method is reliant upon the correlation between cerebral blood flow and neural activity. fMRI generates rich volumetric data that can be difficult to visualize, regardless this project explores the use of 3D rendering accomplished through vertex based projection or mapping.

Visualization of fMRI data is streamlined through the means of vertex based projections, which can be diverged into three steps By utilizing pre-existing data, a volumetric scan of the brain is extracted then a mesh generation is laid atop of the scan, creating a triangular mesh. This mesh is then cut and melded to the contour of the brain and is mapped into the functional volume. Then, the data is sampled at vertex locations to decipher whether anatomical space needs to be replaced. Lastly, the color of each pixel is determined by a 3-d renderer, clearly conveying particular regions of activation within the brain.

This proposed system will generate spatial information and display 3D rendered images. This study will be examining the functionality of this technology when indemnifying brain abnormalities. By gaining raw data from the fMRI system and translating it into an immersive 3D image, identifying brain abnormalities such as the effects of a stroke that cannot be found in other imaging techniques. This project is a data mining experiment, through processing information from differing sources and comparing the success rate of identifying brain abnormalities, the functionality of this technology can be discovered.

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

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

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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	Fair Category	Project Number
274	LS	3095

Title: Pre & Post Emergent Control of Invasive Amaranthus palmeri via Prolonged, Time-Release of Polymer Nano-herbicides

Student Name(s): J. Trudeau

Abstract:

Invasive species currently pose one of the largest threats to ecosystems and global commerce. Plants, like Palmer amaranth (A. palmeri), are perhaps the most damaging, due to their aggressive tendency to outcompete native species. In this research, the effectiveness of atrazine and mesotrione herbicides, encapsulated in chitosan-alginate nanoparticles (AC-NPs), was evaluated both as pre-emergent and post-emergent treatments, against A. palmeri. AC-NP encapsulation of herbicide was conducted as per De and Robinson; these newly created nanoparticles demonstrated full dissolution in 10 hours, in moistened soil. When applied in pre-treatment experiments, AC-NP-encapsulated, singular herbicides (500 ppm content) were twice as effective at preventing growth, relative to the singular, free-herbicide application, over 26 days. Most notably, pre-emergent treatment with the combined Atrazine/mesotrione-AC-NPs did not allow growth for up to 26 days. In the post-emergent trials, plants that were sprayed with AC-NP encapsulated herbicides showed 66% reduction in growth, relative to control groups. Further, EDS analysis of atrazine-treated leaves reveal a 2.7x increase in oxygen content for plant leaves sprayed with atrazine encapsulated nanoparticle atrazine, as opposed to a 1.4x increase for the free-herbicide solution. This provides direct evidence for AC-NP-induced increase of atrazine absorption, which causes subsequent oxygen accumulation within the plant tissue. SEM and photographic data provide further evidence of the damage that mesotrione and atrazine caused to the plants as well. Summarizing, combined and AC-NP encapsulated atrazine-mesotrione herbicides prevented A. palmeri growth as a pre-emergent spray, and provided 66% reduction in plant growth, as a time-release post-emergent, through increased herbicide absorption.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EN EM 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	Fair Category	Project Number
251	LS	3096

Title: Drosophila melanogaster locomotion, myonuclei size, and myonuclei position are affected by differential gene expression

Student Name(s): G. Armetta

Abstract:

Muscular Dystrophies (MDs), characterized by progressive muscle wasting, are associated with 1 in 2,500 deaths in the United States each year. Many MDs can also be characterized by mispositioned nuclei within the muscle fibers. However, it is unclear whether diseased muscles malfunction due to the inability to exert sufficient force or because they experience increased muscle fatigue as a result of how mutations affect exertion levels. Using the GAL4-UAS expression system, eight genes critical to correct muscle function and/or mitochondrial function were either over expressed or knocked down to simulate muscle disease in the model organism, Drosophila melanogaster. Mutant behaviors during locomotive assays were subsequently analyzed to determine whether the defective muscles were incapable of contracting or if the muscles were merely fatigued. All mutant larvae stopped more frequently and moved slower than controls, and in some cases, the larvae were too weak to move at all. However, when the larvae did move, the step sizes between mutants and controls were comparable, suggesting that mutant muscles properly contract. Paired with the observation that mutant larvae stop more frequently, these data indicate that mutant muscles fatigue more easily than controls. These findings highlight an important distinction that has long eluded researchers and sheds light on the mechanisms that lead to muscle disease. Now, future research can focus on identifying therapies, both genetic and physical, that specifically address improving muscle endurance instead of merely increasing a patients range of motion to provide a better quality and prolonged life for affected individuals.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
251	LS	3097

Title: The effect of microplastic ingestion on the health of parasites (Cryptocotyle lingua) in periwinkles (Littorina littorea)

Student Name(s): A. Enters

Abstract:

Microplastics, plastics smaller than 5 mm, threaten marine life as they are hard to distinguish from food sources and are easily ingestible. Parasites also threaten marine organisms as they make their way between hosts through the food web. For trematodes specifically, it is important that the entire ecosystem is healthy so the parasite can complete its life cycle; if microplastics make their way into the food web of a specific ecosystem and impair the health of the organisms in that ecosystem, it may become more difficult for parasites to thrive with a lack of viable hosts. Microplastics have been shown to impair the health of marine organisms, and may prevent parasites from completing their life cycles if there are no healthy hosts to inhabit. Limited research has been done on the interactions between parasites and microplastics. The purpose of this experiment was to determine if microplastic ingestion impacts the health of parasites, Cryptocotyle lingua, in periwinkles, Littorina littorea. To test this, L. littorea infected with the parasite C. lingua were fed microplastics adhered to seaweed (Ulva lactuca), and the cercarial output of each snail was quantified. This value was compared to the control cercarial output of each snail. The soft body tissues of all L. littorea were digested in KOH to confirm microplastic ingestion. No correlation between microplastic ingestion and cercarial output was found after statistical analyses. These inconclusive results suggest the need for further research on the microplastic-parasite relationship and the need for revised methods of testing this relationship.

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

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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
233	LS	3098

Title: Understanding Attention Span: The Changes, How it Can be Manipulated, and Its Importance Today

Student Name(s): Z. Neiss

Abstract:

Over the past twenty years, technology has rapidly developed, giving little time for researchers to study how technology is affecting its users. Recently, phones and other forms of technology have become known as major distractions inside the classroom, preventing students from paying attention in class. As informational technology is becoming increasingly more popular, time spent watching multimedia and using social media has increased. Research shows this prolonged exposure to multimedia has the potential to cause major changes in behavior and the brain itself. A current practice of social media is to utilize 30 to 90-second videos that people can scroll through, which leads many to spend hours watching these videos. This leads to the question: how does the constant scrolling through these videos and using digital technology affect attention span? The hypothesis of this study was to investigate if subjects spend more time watching multimedia such as YouTube or TikTok and determine if this prolonged exposure has any effect on their ability to concentrate, especially when tasked with activities requiring longer engagement and more concentration. After experimentation and observation, it was found that the constant scrolling through these videos has an effect on the human attention span, somewhat decreasing the length of time one was able to focus. Overall, this study can conclude that the constant watching of short videos and using technology both have an effect on a person's attention span.

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

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

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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	Fair Category	Project Number
258	LS	3099

Title: Impact of COVID Pandemic on College Applications for students with lower social economic status

Student Name(s): E. Huang

Abstract:

The COVID-19 Pandemic has had a great impact on all college applicants, and it may have a bigger effect on families with a lower socioeconomic status. In the SAT and Common App reports two most important results to pay attention to are the number and percentage of student using the SAT Fee Waiver, and the percentage of the students who use the Common App. It is thought that low income families may have a higher percentage of students using the SAT Fee Waiver and the common App. The objective of the study is to determine who is most greatly affected in the college application process during the pandemic using these statistics.

Using data from the SAT and Common App reports for each state along with the median household income, we found: 1) The percentage of SAT Fee Waiver usage has no significant correlation with the median household income by state ($r=0.126$, $p=0.38$); 2) The absolute change in the percentage of SAT Fee Waiver usage from 2019 to 2020 had a negative trend while non-significant correlation with median household income by state ($r=-0.25$, $p=0.086$); 3) The percentage of Common App usage has no significant correlation with the median household income by state ($r=-0.15$, $p=0.287$).

Our results indicate that there is no significant correlation between SAT Fee Waiver usage or Common App with median household income by state. In addition, there is no significant correlation between the change in the percentage of SAT Fee Waiver usage and median household income by state.

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

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	Fair Category	Project Number
244	LS	3100

Title: The Effects of a Social-Emotional Education on Elementary Students: A Study of an SEL Meta-Analysis and the Greenwich Country Day School SEL Curriculum

Student Name(s): T. Loverro

Abstract:

Considering all of the current global stressors and the detrimental aspects of COVID, social-emotional support in schools has become especially valuable when dealing with the aftermath of isolation, uncertainty, and ineffective online learning, as well as increased anxiety, academic struggles, and developmental delays. Social-Emotional Learning (SEL) focuses on the intersection of education and human development by working on collaboration skills, empathy, care, positive attitudes towards learning, relationships, emotion management, and healthy self-identity. My study involves interviews and a survey of Greenwich Country Day Lower School teachers in order to explore their implementation of SEL. I will then compare my findings to the Durlak et al. 2011 meta-analysis of SEL across the United States. I am sending my survey out to at least four teachers from each grade Pre-K through Fifth in the Lower School. The analysis of both GCDS and Durlak et al. 2011 involves a general rating scale, graphing, and development tracking of SEL capacities self-control/self-management, cooperation, and empathy. Past studies and meta-analyses on SEL have continually displayed the benefits of the program towards improved academic performance, thoughtful decision making, behavior, social-emotional skills, and attitudes towards education-- for both the short term and long term. I expect my results to show the success of SEL, to be informative for GCDS, and to emphasize the potential of social-emotional considerations in maximizing a child's educational and personal development, especially considering COVID and world stressors.

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

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

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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	Fair Category	Project Number
254	LS	3101

Title: TopoDX: A Novel Approach to Topological Network Analysis for the Early Diagnosis of Non-Small Cell Lung Cancer

Student Name(s): I. Wu

Abstract:

Lung cancer accounts for about 25% - the highest - of all cancer deaths. My research focuses on non-small cell lung cancer (NSCLC), lung cancer's primary histological form. NSCLC is often undetected until symptoms appear in the late stages, making it imperative to identify more specific and sensitive tumor-associated biomarkers for early diagnosis. Many studies fail to evaluate the effectiveness of their methods, achieving low performance(75-80%). In this study, I first identified significant differentially-expressed-genes (DEGs), or biomarkers, using functional enrichment analysis, novel complex network methods, and AUC to robustly validate the diagnostic performance of biomarkers. Unlike existing studies, I utilized a diverse range of network topological metrics to identify the most comprehensive set of biomarkers. Secondly, I introduced a novel and systematic method to identify the top topological metric in protein networks that is essential for biomarker selection. Compared to selection by conventional metrics, the diagnostic performance is improved 17%. In addition, I proposed a novel composite selection index (C-index) that concurrently considers complementary factors in biomarker selection, greatly increasing the diagnostic performance from 75% to 92%. Finally, I explored a clinicogenomic machine learning model with top biomarkers selected and clinical covariates to enable more accurate diagnosis. The proposed methodology of finding top metrics is effective and general, and can be applied to various cancers. I expect my work to fundamentally advance topological network research, which is widely applied to identify biomarkers. I anticipate my overall research to contribute immensely to personalized medicine, improving the vital search for therapeutic targets.

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

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

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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	Fair Category	Project Number
262	LS	3102

Title: Recombinant Expression and Purification of Regulating Region of Human DNA-Polymerase ι

Student Name(s): D. Pintavalle

Abstract:

Ubiquitin conjugation to protein substrates targets them for proteasomal degradation but its fate can be reversed by deubiquitinating enzymes (DUBs), which rescue substrates by removing ubiquitin tags. Ubiquitin-specific protease 7 (USP7) is a prominent DUB, with an extensive network of interacting partners and established roles in cell cycle activation, immune responses and DNA replication. Characterized USP7 substrates primarily interact with one of two major binding sites outside the catalytic domain. These are located on the USP7 N-terminal TRAF-like (TRAF) domain and the first two UBL domains (UBL1-2) within the C-terminal half. Recently human polymerase iota (Pol-ι) is recognized as a novel USP7 substrate that interacts through its regulatory region (C-terminal half) with both the substrate binding sites on USP7. We hypothesize that this interaction could lead to structural changes in USP7 domain's arrangement leading to increased activity of USP7 enzymes. Thus, this study aims to test this hypothesis.

For the purpose there was a need to discover a protocol of expressing and purifying the C-terminal half of Pol-ι as wild-type and mutants that would prevent Pol-ι from interacting with TRAF or UBL1-2 or both sites of USP7. Our study established a protocol of expressing recombinant WT_Pol-ι regulating region in the bacterial E.coli system. Overexpressed protein was purified by Affinity followed by Size Exclusion Chromatographic techniques and was confirmed by gel electrophoresis. This protocol will be applied for purification of Pol-ι mutants and the effect of binding site mutation on USP7 catalytic activity as compared to WT will be tested.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CB 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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
252	LS	3103

Title: The effect of aerobic and anaerobic exercise on oxygen saturation, visuospatial task performance, and short term working memory: implications for sixteen to seventeen year old female student athletes.

Student Name(s): I. Costello

Abstract:

The study of the effect of moderate to intense anaerobic and aerobic exercise on cognitive function is important because studies have shown that different types of physical training directly impact cognition. However, little is known about the cardiovascular effects of different training intensities on short term working memory. The purpose of this study is to compare the effect of moderate to intense anaerobic and aerobic exercise on the short term working memory, specifically visuospatial, of 16-17 year old female student athletes.

Four female student athletes ranging from 16-17 years old were divided into two groups; one group performed anaerobic exercise and one group performed aerobic exercise. The participants' heart rates were recorded to validate and prove the different cardiovascular intensities. Oxygen saturation levels were measured with pulse oximeters. A visuo-spatial task exam that targets short-term working memory was taken before and after the exercise and exam performance was compared.

This study did not have a sufficient number of participants and will be further expanded upon with a larger sample size. Almost all the participants, regardless of which cardiovascular intensity they were assigned, experienced a decrease in oxygen saturation. Preliminary results indicate that participants performing the anaerobic exercise produced higher visuospatial exam scores after exercise completion, but results from the aerobic group are inconclusive. These limited results indicate that anaerobic exercise may enhance visuospatial memory skills. This study will allow athletes to make better decisions regarding how specific cardiovascular intensities affect their application of short-term working memory after a workout.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) ME CB 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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3. This project was conducted at a Registered Research Institution. ☐ Yes ☒ No
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
201	LS	3105

Title: Comparing the efficiency of chemically and enzymatically derived chitin supplements in increasing plant growth in low water areas.

Student Name(s): L. Dougherty

Abstract:

The purpose of this project was to investigate various methods of extracting chitin from crustacean shells in an effort to identify the most effective chitin-based hydrogel for use in agriculture. Shrimp and Lobster shell fragments were collected from local fish markets and various methods were used to remove the proteins and calcium carbonate bound to the chitin. One molar HCL was a constant and used in each extraction method in combination with varying molarities of NaOH and digestive proteins including gastric pepsin. Following this removal, the chitins were baked at 250 ºC and ground into a fine powder using a mortar and pestle to produce a hydrogel supplement for the soil. The effectiveness of each product's ability to maintain soil moistness was tested using tomato seedlings with total water input and average height being calculated after two weeks. Additional supplements including raw lobster and raw shrimp, as well as no chitin, served as control groups. It was concluded that all of the chitins increased the rate of growth and decreased the amount of water required for growth, as compared to the controls, and that the purest form of chitin, had significantly better water absorbency as compared to the other supplements.

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

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	Fair Category	Project Number
238	LS	3106

Title: Assessing the Efficacy of Botanical Tick Repellents Against Blacklegged Ticks

Student Name(s): A. Anderson

Abstract:

Lyme disease is the most commonly transmitted vector-borne disease in the United States. A key method of reducing cases is the use of insect repellents. The gold standard for repelling ticks is DEET. DEET has decades of safety data research, but a few cases of encephalopathy in children after DEET usage has turned many consumers away from the repellent. As a result, many consumers turn to botanical repellents which are often ineffective. The purpose of this experiment was to determine the efficacy of new and existing botanical repellents as compared to DEET.

To compare the effectiveness of the repellents, a filter paper assay was conducted. The repellents compared were DEET (pos. control), ethanol (neg. control), Nantucket Spider Original (a popular botanical repellent), and Nootkatone (a new ingredient approved for repellents) at 3 and 5% concentrations. All trials were conducted with lab raised ticks with the exception of one conducted only by Dr. Connally using field-collected ticks.

It was clear that DEET was significantly more effective than the other repellents. Nootkatone performed far worse than expected, likely due to quality issues. Nantucket Spider Original performed better than expected, possibly due to the lack of a human stimulus.

This research indicates that there needs to be more education about repellent safety and consumers should be encouraged to use DEET over botanicals. Additionally, it indicates that quality and concentration of botanical repellents plays an integral role in their effectiveness.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
305	LS	3107

Title: Inhibition of Covid-19 Induced Cell Inflammation via R-954 B1R Antagonist Disruption of the Bradykinin Storm

Student Name(s): E. Moore

Abstract:

Recent studies by Roche provide strong evidence that COVID-19 complications are due to a bradykinin (BK) storm. Once the virus enters the host cell via the transmembrane protein angiotensin-converting-enzyme-2 (ACE2), the BK-regulating activity of ACE2 is disrupted, causing sudden increase in extracellular BK, and its metabolite des-Arg9-bradykinin (DABK), for the infected and neighboring cells. Heightened DABK trafficks through the Bradykinin-1-receptors (B1R), causing cell inflammation and respiratory distress. Discovery of a B1R antagonist to block this DABK passage could prevent acute respiratory distress syndrome of COVID-19, decreasing the disease's threat. Herein, the R-954 B1R antagonist was investigated in-vitro for such use. A bradykinin storm was simulated as 2.5x the normal level of plasma (~3.5ng/ml), with 35.0ng/ml R-954 added in three configurations; DABK/no R-954, simultaneous R-954 with DABK, and R-954 prior to DABK. Untreated DABK storm results depict 0.9x/0.8x the original DABK storm content after 15/30min respectively, providing direct evidence for DABK-B1R migration. For simultaneous R-954/DABK, competition of DABK and R-954 for B1R-sites produced a 2.4x increase in extracellular-DABK in 15min, and 3.2x in 30min, highlighting R-954's ability to block DABK-B1R trafficking. Pre-addition of R-954 promoted its binding to B1R-sites before the addition of DABK, and was most successful, producing increased extracellular-DABK of 3.4x/4.5x at 15min/30min respectively. DABK-induced cell inflammation was measured via increased intracellular-Ca+2 for simulated COVID-19 DABK-storms, with/without pre-addition of R-954. While untreated DABK-storm RBCs exhibited 4.3x intracellular-Ca+2 (vs. normal), those pretreated with R -954 exhibited near-normal intracellular-Ca+2, further demonstrating R-954's efficacy in blocking DABK-B1R migration, to prevent COVID-19-induced cell inflammation.

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

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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	Fair Category	Project Number
250	LS	3109

Title: Utilizing Micronutrient Activity to Facilitate Metabolic Reprogramming in Mucopolysaccharidosis Type IIIA

Student Name(s): K. Smith

Abstract:

Mucopolysaccharidosis Type IIIA (MPS IIIA) is a genetic mutation that prevents the human body from breaking down monosaccharides by the loss of gene code SGSH. These carbohydrates are supposed to be converted into the Krebs Cycle to later be converted into the electron transport chain system to have an output of ATP and release CO2. Due to MPS IIIA, the human body is unable to break down sugars which leaves long sugar molecule chains in the body which starts degeneration in the brain and spinal cord which turns into biological waste which is a major loss of ATP production. The Krebs Cycles purpose is to produce ATP, NADH, FADH2 and release CO2. MPS IIIA patients cannot release CO2 as quickly because there is an extremely slow breakdown of food which keeps CO2 in the mitochondria. It is proposed that a micronutrient supplement of thiamine will facilitate the metabolic reprogramming necessary to stimulate the Krebs Cycle. To establish the ethicathy of this proposal eukaryotic cells are treated with CO2 output measurements. Glucose will be inputted into yeast as well as supplements. Each test will be run for 10 minutes with a total of 3 trials. Glucose and thiamine demonstrated an average output of 4,171.6 ppm while glucose, thiamine and niacin demonstrated a 17,526 ppm difference. This is a 23.80% increase of CO2 output with thiamine and niacin. In other words, the increase of CO2 output will establish a higher rate of ATP production to overall benefit in maintaining a nervous system.

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

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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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
259	LS	3110

Title: Classifying Alzheimer's Disease with Machine Learning via Wavelet Transform Subband Combinations

Student Name(s): A. Bhattacharya

Abstract:

The 3-D wavelet transform has been used with machine learning techniques to help identify Alzheimer's Disease (AD) and Mild Cognitive Impairment (MCI) through magnetic resonance imaging (MRI). Although this approach resulted in high accuracy, a large number of subband permutations were obtained due to the usage of the 3-D wavelet transform, which causes redundancy and computational inefficiency during classification. To address this issue, this study discovers the combination with the minimum subbands giving a comparable accuracy with the original approach that used all subbands. The Alzheimer's Disease Neuroimaging Initiative (ADNI) was used to gain de-identified MRI scans for classification with 75% training and 25% test scans. The scans were standardized by pre-processing through skull stripping, segmentation, and smoothing using the MATLAB toolboxes Statistical Parametric Mapping 12 (SPM 12) and Computation Anatomy Toolbox 12 (CAT 12). Feature extraction was then completed through different 3-D wavelet transform subband combinations. Support vector machine (SVM) classification was used with radial basis function kernels (RBF) to screen patients for AD, MCI, or cognitively normal (CN) status 3 times per subband combination. The mean and standard deviation of the test accuracy for each combination were recorded. Among the tested combinations, the maximum mean test accuracy was 95.3%. To prevent overfitting, five-fold cross-validation was performed on the top 40% subband combinations based on the mean test accuracy. The maximum cross-validation accuracy is 97.3%. Therefore, this study shows the potential of using less 3-D wavelet transform subbands to help screen patients for AD or MCI in the future.

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

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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	Fair Category	Project Number
240	LS	3113

Title: BLAST-based Characterization of Protein Drug Targets in Protozoan Parasites

Student Name(s): R. Jones

Abstract:

This experiment examines the primary structure in several protein drug target candidates for a variety of parasitic protozoa. The selected proteins have little known information regarding their three-dimensional structure and function, however, their amino acid sequence can indicate much about both their structure and potential function. The selected unknown proteins were Plasmodium falciparum serine-repeat antigen 5 (PfSERA5), Trypanosoma brucei metacaspase 3 (TbMCA3), and Toxoplasma gondii doublecortin domain-containing protein (TgDCX). What is shown in previous research about these proteins, is that they are likely involved in the protein quality control. By comparing the composition of these unknown proteins to structures stored in the BLASTp database, similar known proteins may become apparent. Once similar proteins were identified, Cobalt sequence alignment allowed for comparison of identity and similarity in specific regions of the proteins to identify potential binding sites and critical structural components of the unknown proteins. Orthologous proteins or proteins with similar primary structure in sections may be able to outline the specificity or indicate potential experiments that can be conducted to further the understanding of these unknown proteins. A few orthologous and similar proteins were found during experimentation, potential functions and structures were identified and much future work was proposed. An extremely important facet of this experiment was that many of these unknown proteins contain orthologs in relative species of these protozoan parasites, so the work found in this experiment can be tested on these related parasites, too.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) BI MI 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
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
250	LS	3115

Title: Applying an Integrated Diffusion Framework to Identify Interactions Between Chromatin Regions and Gene Expression using a Multimodal Embryoid Developmental Dataset

Student Name(s): A. Acharya

Abstract:

Chromatin accessibility, or what genes are available for proteins to bind to, can regulate gene expression, or turning on a gene to make RNA and proteins, but much about their relationship is unknown. New technology has been developed so that gene expression and chromatin accessibility data can be taken from the same cell. Combining that data creates multimodal data, or data that contains multiple data types. Typical analysis of multimodal data involves analyzing each modality separately before integrating the results. However, an optimal framework, or interface for easy development of machine learning models, would integrate the modalities before analyzing data. The purpose of this project was to determine how multimodal analysis using an integrated diffusion framework, which models any complex data distribution from both modalities, compares to separate single modality analysis. The independent variable was the type of analysis and the dependent variable was the ability of each analysis to identify cells' key factors. The hypothesis was that multimodal analysis will be more informative because by integrating the data, there is more information about the cell. The mentor developed the integrated diffusion framework, and the student analyzed single-cell data with separate single modality and multimodal analysis. The data supports the hypothesis, suggesting that single modality analysis is not an effective method to analyze the multimodal data. This project could help better analyze multimodal data and understand the relationship between chromatin accessibility and gene expression, which could lead to the controlling of gene expression to help people with medical conditions.

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

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	Fair Category	Project Number
254	LS	3116

Title: Determining the Association Between Commercial Fishing Presence and Mako Shark Locations using GPS Tracking Data.

Student Name(s): I. Berkery

Abstract:

Data from the past 20 years reveals the mako shark population is quickly dropping due to a major overfishing problem, to fix this problem we need to understand patterns in mako shark movement in relation to vessel presence. The purpose of this study is to find the association between areas with a higher presence of long-line fishing boats and mako shark populations. It is hypothesized that areas with a higher presence of long-line fishing boats are associated with lower mako shark populations because of the by-catch and habitat damage associated with long-line fishing. I used data from the Global Fishing Watch Map, Guy Harvey Research Institute, and The University of Rhode Island. I started by setting quadrants on a map of the North-Eastern Atlantic Ocean that were 50mi x 68 mi. Next, I found the number of mako shark location transmissions and amount of time (hours) vessels spent in each quadrant. A linear regression model was created to determine whether there is an association between presence of fishing boats and mako shark presence. Results show a weak positive correlation between mako shark and vessel presence. There was a large amount of variation in the data, reflected in a low R^2. It is hypothesized that the number of mako sharks in the available data set will reveal more about the correlation between the two variables. Through this research, I can help locate areas where mako sharks are in the most danger and provide the evidence necessary to establish conservation zones.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
260	LS	3117

Title: Development of a Home N-Terminal Pro-Brain Natriuretic Peptide Assay for Early Detection of Congestive Heart Failure

Student Name(s): M. Chiravuri

Abstract:

Congestive heart failure (CHF) affects millions of patients and is associated with a high mortality rate. Early detection and treatment can improve outcomes and avoid hospitalization, but it is often difficult to tell if symptoms are specifically due to CHF or another cause. N-Terminal Pro-Brain Natriuretic Peptide (NT-proBNP) is an excellent biomarker for CHF. The lateral flow assay (LFA) is a technology that can be adapted for use as a home test. The hypothesis is that an LFA can qualitatively detect NT-proBNP and ultimately be used to create a home CHF testing kit. A NT-proBNP assay was created using a universal LFA kit with the appropriate capture and detection antibodies. Recombinant NT-proBNP was used to test the assay at varying concentrations. NT-proBNP was readily detectable using this system and the visual bands on the LFA strips were quantified using an optical densitometry protocol. After optimization of the reagents, NT-proBNP levels down to 5,000 pg/mL were detectable. This puts the test in the range of NT-proBNP levels that have been described for patients hospitalized with CHF. This test was repeated with purchased human serum spiked with recombinant NT-proBNP and showed detection at similar concentrations. Ultimately the goal is to create a simple visual test and so the LFA strips were shown to 20 blinded volunteers confirming detection of NT-proBNP at levels of 5,000 pg/mL and higher. These results show that a home NT-proBNP test is feasible and could be used for early detection and treatment of CHF.

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

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	Fair Category	Project Number
248	LS	3118

Title: Essential oils from thyme and rosemary in combination as an antibiotic-sparing agent to treat Escherichia coli-caused urinary tract infections

Student Name(s): M. Subramanian

Abstract:

Antimicrobial resistance (AMR) is one of the largest healthcare emergencies today, with urinary tract infections (UTIs) caused by antibiotic-resistant uropathogenic Escherichia coli (E.coli) (UPEC) as a critical offender. The development of biofilms, matrices of UPEC, further complicate treatment. Antibiotics struggle to pierce the biofilm, leading to longer infections and antibiotic use, increasing AMR. Little has been done to identify efficient UTI treatments which inhibit both bacterial and biofilm growth. Previous research demonstrates that essential oils (EOs), especially T.zygis (thyme) and R.officinalis (rosemary) EOs, can combat bacterial growth as effectively as antibiotics, as well as inhibit biofilm growth. EO combinations have shown enhanced antibacterial and antibiofilm activity over individual EOs, but ratios of EOs in combination have not been optimized. T.zygis and R.officinalis EOs were tested on E.coli in different ratios to establish an optimal EO combination to inhibit bacterial and biofilm activity. Agar disk diffusion evaluated antibacterial activity(n=2) and a colony forming unit/mL assay measured antibiofilm activity(n=30). 100% T.zygis, 0% R.officinalis and 90% T.zygis, 10% R.officinalis had the highest antibacterial activities, with similar activity to ciprofloxacin control. 90% T.zygis, 10% R.officinalis and 60% T.zygis, 40% R. officinalis had the highest antibiofilm activities, with inhibition levels of 80.89% and 80.09%, respectively. 90% T.zygis, 10% R.officinalis was more effective than T.zygis (70.87% inhibition;p=0.03034) or R.officinalis (37.95% inhibition;p=0.0011) alone, and the most effective treatment overall. These results could indicate EO combinations for utilization in alternative antibiotic-sparing treatments for UPEC-caused UTIs.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) ME 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	Fair Category	Project Number
201	LS	3119

Title: Development of LMMD (Lower Methane, More Degradable) Bag Using Marine Bio-Waste from Sargassum

Student Name(s): R. Lee

Abstract:

With the second most amount of food waste produced per capita, the U.S disposes 52.5% of it's 35.5 million tons of food waste in landfills in 2020. Consequently, the methane and landfill production continues to wreak havoc upon nature and aggravate the global warming phenomenon. Due to the unprecedented rise in the ocean's temperature, invasive species like algae, specifically the Sargassum strain (Sargassum horneri), have overpopulated, endangering the majority of oceanic ecosystems. All told, this research was undertaken to address these problems by creating a biodegradable bag that can contain methane emissions from food waste and decompose at a faster rate using the algae strain of Sargassum. The development of generating such products required three major procedures: the production of a flexible material for the BioVinyl bag, the assessment of the BioVinyl bag's influence on the decomposition rate of food waste, and a simulated experiment in landfill using the final prototype of the BioVinyl Bag. Altogether, through this research, the LMMD food waste bag produced using marine bio-waste and earthworm enterobacteria to accelerate the decomposition of food waste in landfills; proved to reduce of methane and leachate generation; and has shown that it is a low-cost, eco-friendly product.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
262	LS	3121

Title: Effects of Cannabinoids on Verbal Learning and Memory: Relationship to Biological Sex

Student Name(s): E. Gu

Abstract:

Cannabinoid effects include acute and long-term impacts on cognition, especially in verbal learning and memory (VLM) deficits. Men and women may experience cannabinoid effects differently, but differences in cannabinoid-induced VLM deficits are not well-categorized. Delta-9-tetrahydrocannabinol (THC), the principal psychoactive constituent of cannabis, produces VLM deficits acutely similar to herbal cannabis and can be used to model the acute effects of cannabis in human laboratory studies. A man-made version of THC, dronabinol, was used, avoiding potency variability in cannabis products and any effect from other cannabinoids. The project's purpose was to examine acute VLM deficits induced by oral THC in healthy humans and analyze sex-related differences in this response. The hypothesis was that oral THC will acutely induce VLM deficits measured using the Rey's Auditory Verbal Learning Task (RAVLT) compared to placebo and this deficit was influenced by participant sex. The IV was the drug condition. The DV was the RAVLT results. The student analyzed, interpreted, and presented data from a double-blind randomized placebo-controlled human laboratory study in healthy individuals conducted by the mentors. Data was first analyzed using paired t-tests and the results were insignificant, showing no relation between drug condition or sex. The data was then re-analyzed with paired t-tests while considering subject age. The results were still insignificant. Several factors may have contributed to the statistical insignificance, like onset of action. Edible cannabis products are increasingly available to the public. It is important to characterize the acute cognitive effects associated with them as well as any sex influences.

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

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	Fair Category	Project Number
256	LST	3501

Title: How Can Changing or Adding a Habit to a Daily Routine Reduce Stress and Improve the Overall Well-being of Young Adolescents?

Student Name(s): T. Adeniran, M. Arnold

Abstract:

People encounter stress in numerous ways. The American Psychological Association revealed in a 2020 survey that teens are experiencing depression and elevated stress levels. This project aims to determine how adding a new habit to young adolescents' daily schedules affects their well-being and stress levels.

Thirty-five volunteers were recruited from the ages of 11-15, with their progress monitored via Google Classroom. Participants anonymously answered a pre-survey, choosing what emotional, social, or physical habit they wanted to perform daily. Everyone recorded whether they had completed their habit that day and how they felt afterwards.

Many participants chose an emotional habit, like journaling. Five people stopped doing their habits, with others acknowledging that it was hard to maintain a consistent schedule. Stress levels were measured using a 1 (not stressed) - 5 (extremely stressed) scale. 50% of our original participants started out somewhat stressed, but 64.7% of our ending participants reported minimal to no stress. A modified version of the WHO-5 well-being questionnaire was used to measure participants' well-being levels. The average amounted to 62.5%, with higher scores translating to a better well-being.

Completing a positive habit that improves upon a weaker area in one's life was found to be beneficial. For reference, one participant decided to complete an emotional habit of making time to read everyday. They completed their habit daily and reported higher reading scores on district assessments. Emotional habits had the most significant effects on our participants, as their mental health improved, greatly impacting their overall well-being results.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) BE 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	Fair Category	Project Number
250	LST	3502

Title: Metal-Mediated Electromagnetic Radiation: Effects on chlorophyll production and overall growth of Medicago sativa

Student Name(s): C. Eschricht, H. Spiess

Abstract:

The purpose of this project was to study the development of alfalfa plants when metals were used to protect the plants from electromagnetic fields created from everyday electrical appliances. It was hypothesized that if the plants were affected by electromagnetic fields, then the plants with copper in the soil would experience the smallest impact due to copper's natural property of being able to absorb a large number of different wavelengths of electromagnetic radiation. Alfalfa were grown in fifteen separate pots, twelve of which had metals surrounding their soil in order to shield electromagnetic radiation. The three metals used in these twelve pots were: aluminum, zinc, and copper. Eight of the pots, two per metal, and two without any metals, were placed in an area with very high electric and magnetic fields of around 200 mG (milligauss), as measured with an electric field meter. The other pots were placed in a separate location with little to no electric and magnetic fields. The pots were given the same amount of water and light for a growing period of 10 days. Data collection consisted of using a spectrophotometer to measure the level of chlorophyll in the leaves of the plants after the 10 day growing period. After analysis of the data, it was concluded that electromagnetic fields actually had a positive impact on the levels of chlorophyll in the plants, and that the metal zinc was the most effective at increasing the effect the electromagnetic fields had, while tin had the smallest effect.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) PS EV 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	Fair Category	Project Number
231	LST	3503

Title: Comparing the Effects of Sugar Beet Juice on River Microenvironments to Traditional Ice Salt Runoff

Student Name(s): D. Diaz, J. Podziewski

Abstract:

Ice salts are made with chlorides, an ion dangerous to marine life. This is a problem as after ice salts clear the roads, they are often washed into nearby bodies of water, laying waste to the local ecosystem. This study looks at the safety of an all-natural alternative already being used in some states, beet juice. Beet juice is being touted as an environmentally safe replacement for ice salt, but if you look, there are not many studies on whether or not it truly is safe. People just claim it is as it is all-natural. We were planning to study if beet juice was the environmentally friendly alternative it said it was by testing its effects on river microbe growth. We did this by growing river microbes in cultures and media with added beet juice and comparing it to growth in cultures and media with added ice salt. The results, however, show the opposite of a safe alternative. In solid media experiments, excessive growth was seen on the beet juice plates. Yet, in liquid media experiments, growth was stunted when cultured in beet juice broth. Both results are equally harmful to the environment as they create an unbalanced, and therefore unsustainable, ecosystem. Our data suggest that States' Departments of Transportation should end the use of beet juice and instead switch to a safer alternative that has been studied thoroughly.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) MI 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	Fair Category	Project Number
233	LST	3504

Title: Potential Impact of Acidity in Culture on Early Stage Artemia Sp. Nauplii

Student Name(s): R. Blustajn, G. Spata

Abstract:

The ever increasing impact human activities have on the coastal ocean is a deeply studied research topic, with most of the impacts being documented in microorganisms such as corals and bivalves. Our understanding of the impact ocean acidification has on the microworld of ocean zooplankton has only recently begun to ramp up. With that in mind, this study was designed to evaluate the potential impacts that acidified conditions have on arthropod nauplii. Replicated conditions over a gradient of pH conditions (8.0, 7.6, 7.4) were set up, and artemia cysts hatched for each. Upon hatching, each replicate was exposed to experimental conditions for 24 hours and then enumerated for comparison of survivorship. Control treatment showed a measurably larger survivorship than acidified conditions (53% mortality versus 82% and 87% respectively, $p<0.005$, $\alpha = 0.05$). With developmental stages like zooplankton playing such a pivotal role in the long term viability of coastal ocean populations, it shows that impacts to the foundational trophic levels of our ecosystems should be the subject of many more future studies to better understand our role and responsibility in the changing ecosystems we all agree need protection. The mortality seen in nauplii serves as a suitable model for higher trophic level larvae as arthropods are noted for a more direct link to ocean acidification. It will be interesting to see if larvae of other species (fish, crabs, etc.) also show similar patterns.

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):

☐ 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	Fair Category	Project Number
125	LST	3505

Title: Be Gone Shell Rot!

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

Abstract:

To test how to reduce the amount of shell rot on red eared sliders, the researchers investigated two different methods of treatment on two different turtles. One of these methods was an unconventional technique, using Neosporin, while the other was a more common technique, using API Turtle Fix. For ten days, the red eared sliders received their treatment daily along with their necessary care such as feeding and cleaning. The researchers lathered Neosporin onto the shell of Turtle A every day of the experiment to treat the illness. Turtle B received 30 mL of Turtle Fix in her water every day. After 10 days of testing, the results showed that Neosporin was 92% more effective than API Turtle Fix in the treatment of shell rot.

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):

- ☐ human subjects
- ☒ vertebrate animals
- ☐ potentially hazardous biological agents
- ☐ 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	Fair Category	Project Number
199	LST	3506

Title: The Effects of Stress on the Immune System

Student Name(s): K. Kibwe, R. Tunes-Muniz-De Souza

Abstract:

Our project is about how stress affects the immune system and body, especially in adolescents. When conducting this research, the most significant findings showed that adolescent students have high levels of stress, which results from a heavy workload and poor time management (Britz & Pappas, 2010). We wanted to figure out whether mindfulness meditation sessions could reduce stress levels without the help of drugs. It was hypothesized that if the subjects participated in a 15-minute MM session, they would report having lower levels of stress and average heart rate. Our methodology required 31 high school participants. During the experiment, they evaluated their stress levels and indicated their heart rate according to a scale, both before and after each session. The data was graphed and exhibited many essential findings. On average, participants had a decrease in their stress level and heart rate. Their stress levels were within the range of 3-5 (low amount of stress – high amount of stress), with 5 being the most common level overall. This concluded that mindfulness meditation does have a profound influence on teens' stress levels. It leads people to become aware of how beneficial meditation can be to the body instead of medication use.

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

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	Fair Category	Project Number
186	LST	3507

Title: Identification and purification of algal supplements as a means to reduce methane production within ruminants

Student Name(s): J. O'Connor, W. Gorman

Abstract:

The purpose of this project was to investigate the effectiveness of local seaweed extract in the reduction of methane production in ruminants. Seaweed was collected locally from the western-most end of Long Island Sound, identified, and dried at 350 degrees fahrenheit for ten minutes and then ground into a fine powder. Next the cow's digestive process was recreated using sourced ruminant fluid, sodium bicarbonate buffer solution, and alfalfa greens. Various seaweed samples were added to the aforementioned control in various trials. Ruminant mixtures were placed at room temperature in a 250ml biochamber equipped with a CO2 gas detector and data collected using Vernier's LoggerPro software. The amount of methane was derived by inserting carbon dioxide data into an algebraic formula representing the percentage of gasses produced from livestock emissions (FAO, 2021) and solving for x. Analysis of the data suggests several of the seaweed species lowered the release of CO2 during the digestive process which in turn suggests methane production was also reduced. That said, CO2 was only a proxy, and further testing involving the direct measurement of methane levels would need to be conducted.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EV PS 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	Fair Category	Project Number
175	LST	3508

Title: Microbial Fuel Cells: Generation of Clean Energy by Electrogenic Bacteria

Student Name(s): H. Ferguson, T. Pope

Abstract:

The purpose of our project was to gain an understanding of the factors contributing to the efficacy of a microbial fuel cell, a device which utilizes certain bacterias' anaerobic metabolic processes where electrons are extracellularly excreted and harnessed, and to evaluate the growth in voltage output over a span of six days as it correlates to the population growth of either their endogenous or exogenous electrogens. Experimentation entailed the construction of several fuel cells each containing a soil base(soil, mud, pond water), additional growth media, nickel anodes, copper cathodes, carbon felt, insulated wires, and a capacitor and LED attached to a PCB. Variations of each fuel cell included changing 1) the source and consistency of base soil, 2) using liquid v. solid growth media, 3) the addition of external bacteria to the base soil, 4) the overall surface area of the anode and cathode, and 5) physical size of the fuel cell. Data was collected and analyzed across each variable in order to determine the optimal fuel cell design in terms of energy produced.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) AT CB 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	Fair Category	Project Number
155	LST	3509

Title: Utilizing the Mycorrhizal Relationship between Plants as a Biological Control to Prevent Disease Infection in Plant Populations.

Student Name(s): J. Morningstar, S. DeAngelis

Abstract:

The purpose of this study was to research the disease-resistant properties of two fungi, Glomus and Metarhizium anisopliae, and how an established mycorrhizal link between fungi and plants can aid in pest and disease prevention (Hughs 2004). Tomato plants were germinated in an aquaponics system until plants laterally branched and reached 6 inches in height. Plants were transferred into six growing bins which held two tomato plants separated by a mesh bi-layer barrier to prevent direct root connection, but allow for mycorrhizal linkage. The fungi were added to the bins independently and in combination, and allowed to grow for four days. In accordance with the fungus, plants were then infected with Tobacco Mosaic Virus and left until lesions formed. Leaf samples were collected and proteins extracted. A spectrophotometer was used to run a Bradford assay to determine protein quantitation of each sample and compare to the control which served as a standard curve.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) PS CB 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	Fair Category	Project Number
191	LST	3510

Title: A comparative analysis of the presence of microplastics in soil and rainwater between rural areas, urban areas, and areas adjacent to trash burning facilities

Student Name(s): J. Wolfram, T. Delgado

Abstract:

The purpose of this project was to compare the presence of microplastics in soil and rainwater between rural areas, urban areas, and areas adjacent to trash-burning facilities. It was hypothesized there would be a direct correlation between the number of microplastics in the soil and the number of microplastics in the rainwater, and that the greatest density of microplastics would be found adjacent to trash burning facilities in both soil and water. Rainwater and soil samples were collected on two occasions. Rain collectors obtained 20ml water samples and a soil-sampler probe used to collect 2 inches at depths of 2-4inches and 4 -6inches. Rainwater samples were placed directly into a fine vacuum filter, where microplastics were filtered onto a 47mm collection disks. The soil was pre-treated for filtration by adding 100ml of distilled water to form a viscous liquid solution, and pre-filtered to remove large dirt chunks and particles. Filtered sample disks were examined under a stereomicroscope to look for microplastics. When examined, the number and size of microplastics were recorded per type of location. Data was analyzed for statistical significance, graphs were plotted, and conclusions were drawn.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EV EA 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	Fair Category	Project Number
209	LST	3512

Title: Optimization of Nitrogen fertilizers for Triticum aestivum using NIR spectroscopy

Student Name(s): C. Officer, H. Sorbaro

Abstract:

The purpose of this project was to use NIR spectroscopy (near infrared) to measure nitrogen uptake in wheat plants grown in soil with various concentrations of nitrates. The endgame was to create a device that could be used in agriculture settings to externally identify when a plant has reached its optimal nitrate concentration in order to prevent excessive use of fertilizers that leads to eutrophication and nutrient runoff, as well as determining if additional nitrogen is needed to increase growth. Phase one of the process entailed growing many groups of wheat samples, differing in soil nitrogen concentrations, with the intent of measuring the plant consumption of nitrogen. Phase two saw the creation of a battery-powered breadboard containing NIR light-emitting LEDs and a black-out box in which to place the device. Using a camera capable of capturing NIR light, pictures were taken of every wheat sample and 5 RGB values were sampled from each of the pictures. Images containing darker leafs signified a higher concentration of nitrogen, as the NIR light has a harder time traveling through leaves denser with nitrates. Ultimately, the imaging was able to determine the maximum nitrogen consumption possible of the Triticum aestivum, and gave insight into the amount needed for optimal growth.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) PS EA 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	Fair Category	Project Number
166	LST	3513

Title: The Juvenile Hormone from Tenebrio molitor Affects Larvae Development and May Decrease Growth of Tumors in Humans

Student Name(s): M. Netopski, K. Gray

Abstract:

Diabetes and Tumor growth are two serious diseases that affect humans. Both disorders are treatable but not curable. Juvenile Hormone (JH) is found in many insects. The role of JH is to regulate the growth and development of the insect from the larva stage to the pupae stage. JH is also known to regulate the insulin pathway in insects. This experiment studies the effect of JH on the growth period of Tenebrio molitor (mealworms) from larva to pupa. If the growth period can be stunted then there are opportunities to use JH to stunt tumor growth in humans.

We tested this by setting up three groups and feeding mealworms different amounts of food over the course of a one month period. None reached the pupae stage and all of them died over the course of the one month period. We were unable to make a connection between insulin and the Juvenile Hormone therefore future studies will be held in order to test this theory once again.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) 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	Fair Category	Project Number
185	LST	3514

Title: computational hydroponics

Student Name(s): Z. Watson, K. Windum, V. Weir

Abstract:

Hydroponics is a way of growing crops without the use of soil. Using rich nutrient solutions, oxygen, and water hydroponics systems can grow plants faster, and healthier, all while using up to ten times less space. Although hydroponics holds many benefits, it can be very tricky to maintain for everyday people. In a hydroponic system, you have to constantly check and level the pH of the water, due to the plant absorbing the nutrient solutions.

Therefore by creating a computer-controlled automated device that tests and adjusts the pH in a hydroponic nutrient solution, people can wield the benefits of hydroponically grown crops without the difficulty of precision and maintenance. The project consists of building a hydroponic(DWC) system, using two peristaltic pumps. A pH probe is added to continuously measure the pH of the solution. An Arduino UNO board connected to an L298N Dual H-Bridge Motor Controller was used to program the pH probe to read the pH of the water and make adjustments by distributing either alkaline or acidic solutions through our peristaltic pumps until the pH probe reads the set pH.

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

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	Fair Category	Project Number
249	LST	3515

Title: Biodegradation of Polystyrene by Bacteria Found in The Gut of Tenebrio Molitor Larvae

Student Name(s): S. Smith, T. Simmons

Abstract:

Polystyrene (PS), commonly known as styrofoam, is a long-lasting form of plastic that is resistant to biodegradation. It is estimated to take 500 years to decompose. Mealworms may be a partial solution to this problem. If the gut microflora of the mealworm larvae that feeds only on polystyrene can be isolated without a symbiotic relationship, then it can be used to degrade polystyrene directly, and increase biodegradation. In our experiment, three groups of mealworms were studied. Group A of mealworms fed on a diet that consisted of potatoes, carrots, and oatmeal. Group B of mealworms fed on a diet of potatoes, carrots, oatmeal and polystyrene. Group C only fed on polystyrene. We measured the polystyrene before consumption. After about two weeks of eating, groups B and C showed a loss of polystyrene mass. Five mealworms from each group were chosen and their midgut was extracted to isolate the bacteria responsible for polystyrene degradation. The bacteria was grown in tubes before being streaked onto plates. Once growth was prominent, colonies were transferred onto new plates and grown before polystyrene balls were directly applied onto the bacteria. The mealworms successfully consumed and digested the polystyrene but the biodegradation of polystyrene was not successful when the styrofoam balls were applied directly to the bacteria. In conclusion, we determined that a symbiotic relationship is needed between the mealworm and the bacteria living in their gut to biodegrade polystyrene. Future studies are needed to investigate the relationship between mealworms and their gut bacteria.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CB MI 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	Fair Category	Project Number
167	LST	3516

Title: A Comparative Analysis of Denitrifying Bioreactors as an Abatement of Heightened Nitrous Oxide Levels

Student Name(s): W. Klein, J. Fels

Abstract:

The purpose of this project was to conduct a comparative analysis of existing nitrous oxide mitigation techniques currently used in agriculture, then use collected data to help inform the development of a novel device aimed at the same end. In the conduct of this experiment, airtight microcosmic environments equipped with a heat source, automated water irrigation, and alfalfa-based root systems were created. These environments were augmented with a nitrogen-rich fertilizer, gaseous nitrous oxide, and some were subjected to mitigation techniques. Data was collected on subsequent environmental changes such as temperature, pH of the water runoff, and relative nitrogen content. During analysis of these results, it was concluded that both initial mitigation techniques tested resulted in environments with significantly less nitrous oxide levels in comparison to control environments, and the technique of supplementing levels of denitrifying bacteria in the root system was most effective. This data then informed the subsequent creation of our novel device, which also demonstrated efficacy in reducing nitrous oxide emissions in environments.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EM EV 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	Fair Category	Project Number
202	LST	3517

Title: Heat shocking Caenorhabditis Elegans with Congo Red Dye to Show buildup of Plaque leading to Alzheimer's

Student Name(s): J. Martinez, J. Lavender

Abstract:

C. elegans are able to replicate Alzheimer's Disease (AD) within the neurological system, which makes them ideal as a model species to humans when studying AD. When heat shocked, C. elegans show behavior consistent with AD. Research shows that C. elegans can form amyloid beta plaques which show symptoms of Alzheimer's disease. Congo Red dye is an indicator that highlights the plaque in the C. elegans. When doing this experiment, Congo Red dye will be added to the C. elegans before the heat shocking process to observe plaque build up. The hypothesis is that if the heat shock temperature increases, then more amyloid beta plaques will form because heat shock causes Alzheimer's disease behavior. To measure the plaques, Congo Red dye was used. We heat shocked the C. elegans at three different temperatures to induce Alzheimer symptoms and dyed them to see if any plaque formed in the worms. Our results showed diverse C. elegan reactions from the heat. We found plaque buildup in some of the trials but not all of them. In the future, we would like to find other protocols to dye our worms because we were not able to find specific Congo Red Dye procedures for C. elegans.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CB AS 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	Fair Category	Project Number
138	LST	3518

Title: Production and purification of Vibrio fischeri: An effort to create a self-sustaining light cube

Student Name(s): T. Williams, T. Danforth

Abstract:

The purpose of our study was to create a self sufficient light cube, powered by the bioluminescent capabilities of the bacteria Vibrio fischeri, that would be able to produce light, when needed, without an electrical current. Initially, varying concentrations of photobacterium broth were created and inoculated. Samples were aerated and incubated at various temperatures for 24 hours. Successful cultures were transferred into cuvettes and fluorescence measured using a Vernier Spectrovis Plus Spectrometer. It was concluded that .66g of dehydrated medium, combined with 10mls of distilled water, kept at 25°C and aerated continuously, produced the ideal growth conditions that optimized fluorescence of V. fischeri. This data was used to design a prototype in which the optimized growing conditions, combined with the push and pull of magnets to increase aeration and culture growth, were used to produce the light cube.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) BI 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	Fair Category	Project Number
182	LST	3519

Title: Palingenesis Project

Student Name(s): A. Ramos, B. Valdivia, K. Zayas

Abstract:

Current funerary practices are unsustainable due to the usage of harmful chemicals such as formaldehyde, nonrenewable resources like concrete, carbon emissions and excess land plots that are unusable for wildlife. In addition to the impact it has on our ecosystem, burial and cremation processes tend to be impersonal. To combat this, we designed a funeral home that's removes the need for chemicals like formaldehyde, is net zero because of its use of solar panels and reduced carbon emissions, does not need to use concrete, and connects those who are grieving in a more natural way. We designed and created a model that shows what the layout of the building would be. Our building contains an alkaline hydrolysis room, reception room/ compost pods, memorial garden, a bioswale, and a greenhouse. We designed the exterior with sustainable materials such as hempcrete and straw insulation. We also include native plants to attract native pollinators. This project is a prototype that can be modified to fit different building sites for the sake of accessibility. With this project we hope to spread awareness about unsustainable funerary practices.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EM BI 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	Fair Category	Project Number
251	LST	3520

Title: Development of an Autonomous WatchOS Application that uses HRV and Vibrational Pulses to Reduce Stress

Student Name(s): S. Munim, A. Liu

Abstract:

Stress is a reaction that can negatively affect people, and it has a strong correlation to HR (heart rate) and HRV (heart rate variability), a measure of the variation in time between each heartbeat. Research demonstrates that heartbeat-like vibrational pulses can reduce stress and increase HRV. The same haptic technology implemented in commercial solutions is also found in many popular and accessible smartwatches. This project developed a WatchOS application for the Apple Watch that autonomously emits vibrational pulses at a frequency based on the user's current HR and resting HR. The application was coded in the Xcode IDE in the Swift programming language, and the frontend UI design was created in Swift Storyboards. The application provides a user-friendly design that intuitively allows a user to easily start, stop, and view their session data. To test the application, participants were split into 2 groups: one group would receive the pulses while the other group would not. In the study, participants completed a 50 question Algebra 1 math test in a 10 minute time period and took a questionnaire reflecting their stress levels before and after the task. Results found that the group with the pulses scored higher on the task while reporting lower levels of stress. The group with the pulses also had an increasing trend in HRV and a lower trend in HR compared to the group without the pulses. The further widespread accessibility of this technology will help people focus and reduce their symptoms of stress and anxiety.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) BE CS 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	Fair Category	Project Number
248	LST	3521

Title: Bacterial Survival Based on Temperature: Testing E.Coli K12 Infested Chicken

Student Name(s): M. Lynch, M. Dahlen

Abstract:

The purpose of our experiment was to explore the survival of E.Coli in different temperatures, refrigeration times, and with/without chicken. Our hypothesis centered around the idea that bacteria-filled chicken's sterility would decrease with increased temperature.

To test this, we put E.Coli onto pieces of chicken. We then cooked the chicken at varying temperatures, putting some in the refrigerator for a week and plating the others then, incubating the rest in LB solution, and taking data from each at varying intervals. We repeated the experiment without chicken (the previous chicken may have been contaminated). To determine if the chicken was originally contaminated, we repeated the experiment, without adding E.Coli, and using PCR.

Multiple conclusions were found at the end. When looking at our refrigeration methods, we concluded that refrigerating leftovers isn't dependable, as our data varied (differences of up to 1440 cfu/mL). By comparing the results of our non-chicken and chicken, we discovered that if the E.Coli was by itself, it's more likely to die than if it were with chicken. Finally, when we surveyed the original chicken's sterility, and another packaged chicken's sterility, we found that the chicken we buy varies – we can't always count on it having bacteria or not– our first trial did, but the second did not (even when tested with PCR). As expected, we found that as the temperature increases, the number of Cfu/mL decreases. We found that in between 57°C and 60°C the E.Coli is killed.

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	Fair Category	Project Number
234	LST	3522

Title: Using Different Compounds To Reduce Hydrophobicity In Soil After A Forest Fire

Student Name(s): J. Lambert, H. Ruddock

Abstract:

When a forest fire burns through an ecosystem many properties of soil are affected; the biggest change in soil is an enhancement of hydrophobicity. Hydrophobicity does not allow the soil to absorb water, making it difficult for plants to grow in these areas. Our hypothesis is that if we introduce new compounds to the burned soil, then it should increase the germination rate due to the properties of the compounds decreasing the soil's hydrophobicity. In order to decrease the hydrophobic properties, our compounds were introduced to the burned soil in two different ways. One set of four planters will have the compounds mixed into the soil while the second set of four planters will have the compounds mixed into the water. The compounds we will be using are yucca root extract, sea kelp extract, bentonite clay powder, and dextrose. We planted grass seed, ferns, red clover, and tiarella cordifolia and their growth was measured over time. While monitoring the plants and their growth the soil with bentonite clay had the fastest growth. The bentonite clay properties combatted the waxy layer on the soil to allow enough water to get to our plants. After these studies, we would recommend bentonite clay powder to be placed on the soil in areas shortly after a forest fire takes place. This simple action will increase the germination rates of various plants in the area and restore the ecosystem.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) EV PS 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
2022

Word Count	Fair Category	Project Number
250	LST	3523

Title: Exploring New Potentials of Deep Brain Stimulation on Chronic Pain Management

Student Name(s): N. Bolineni, J. Guo, Y. Shirai

Abstract:

Deep brain stimulation, or DBS, is a treatment method known for being coupled with diseases that affect motor function. One or more electrodes are surgically implanted into the brain in the treatment of DBS. These electrodes will receive stimulation from a pulse generator at the collarbone, similar to a pacemaker. These electrical signals will trigger neural responses in the brain and mitigate the symptoms of diseases.

However, the purpose of this project was to explore other potential uses of DBS. Already, there has been some research conducted on the services of DBS in treating pain. This project aims to take that a step further and delve theoretically into the possibilities of implanting these electrodes for DBS into different areas of the brain.

The development of this project can be separated into two phases. In phase one of the project, research was conducted to better understand the potential outcomes of research expanding the uses of DBS. In phase two of the project, possible enhancements to DBS were considered. Most notably, changing the locations for where the electrodes are placed could be critical to broadening the uses for this DBS. For instance, placing these electrodes in the parietal lobe of the brain may also provide pain management by blocking pain in particular locations without affecting other parts of the body. In this way, patients would receive the pain relief and still maintain motor function in other areas with no pain, rather than dealing with side effects of prescribed painkillers such as opioids.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) AT 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	Fair Category	Project Number
165	LST	3524

Title: The Liquid Bulk Viscosity Effect on the Dynamics of a Single Cavitation Bubble

Student Name(s): T. Zoghol, D. Khatib

Abstract:

Sonoluminescence results in light emission generated by imploding bubbles due to sound waves. In this phenomenon, a small gas bubble that is acoustically suspended is periodically driven in water, using ultrasonic frequencies, resulting in bubble collapse. By starting with millimeter-sized cavitation in a 100mL round bottom flask, sonoluminescence is dependent on high ultrasonic amplitudes and high viscosities to implode the bubble. During an implosion, extreme temperatures are generated. Furthermore, the pressure inside a bubble and the maximum pressure value is extremely affected. At the end of the implosion process, and for a short time afterward, there are conditions of extreme energy-infused cavity collapse. High densities and temperatures achieve light emission. As a result of these factors, sonoluminescence is one of the current methods used for estimating the extreme temperatures generated in the bubbles during the implosion. Not only is this experiment educationally beneficial as it shows real physics phenomena, but also has industrial and medical applications which are being studied and tested today.

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

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	Fair Category	Project Number
234	LST	3525

Title: The Effect of EMS Personel Age on Patient Care Satisfaction

Student Name(s): K. Easterbrook, M. Reynolds, N. N/A

Abstract:

It is rare that the lives of a town's residents are in the hands of mere teenagers. Darien Emergency Medical Services - Post 53 is a student-run and operated volunteer ambulance program that serves the town of Darien, Connecticut. The focus of this project is to determine if there is a significant difference in patient care satisfaction based solely on the age of the EMS personnel. This survey-based research project assesses patient care satisfaction, or the emotional reaction of the patients, in response to the care they received. The surveys were sent to patients that had received care from Post 53 with student volunteers or with adult caregivers. The process of selecting patients for this study was determined by age restrictions and emergency severity. The survey consists of ten questions with answers ranging from poor to excellent that assess how satisfied the patient was with the care they received on the ambulance. Based on the responses, statistical tests (ANOVA and t-test) were used to see if there was a significant difference in patient behavioral response between calls with an adult paramedic and calls with only youth EMTs. It was hypothesized that there will be no significant difference between the age of the EMS personnel. The data trend supports the hypothesis and the idea that high-school EMTs are able to provide an equally high level of patient satisfaction as adult EMS personnel.

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

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	Fair Category	Project Number
245	LST	3526

Title: Effect of Lesson Delivery Media on Student Learning Outcome and Information Retention

Student Name(s): Y. Khan, H. Shi

Abstract:

The recent COVID-19 pandemic has caused many students and teachers to experience learning in a virtual environment. Previous studies studying the difference between classroom and virtual learning have generally supported that usage of electronics in a learning environment decreased the overall performance of the students/participants involved. The goal of this experiment was to determine if the nature of the learning itself caused the discrepancy between the affected students' performance comparing before and during the pandemic. The hypothesis was that the effectiveness of learning through purely electronic media would be less or equal to that of learning through non-electronic media. We attempted to recruit many students, and eleven students chose to participate and the groups were split randomly. One of the two groups, the electronic learning group, viewed a slideshow through individual devices (through Peardeck) and played a Kahoot, whereas non-electronic groups used mediums such as the blackboard and paper handouts. In separate settings, the same lesson material was taught to the two groups. The only change was the delivery medium. We found the average score of the electronic group to be 8.2/12.0, and the non electronic group to be 8.0/12.0, showing a difference of 0.2. Because this discrepancy is so small in a smaller sample group, the data was found to be close enough to determine both methods as equal. It was concluded that learning medium (or at least electronic vs non-electronic delivery media) made no difference in students' performance.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) BE 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	Fair Category	Project Number
247	LST	3527

Title: Determining Carbon Dioxide Levels in Classroom Settings

Student Name(s): Y. Zhuo, H. Zeng

Abstract:

Research shows a higher concentration of CO2 affects human concentration and memorization. In this experiment, we test the hypothesis that classroom occupancy has an appreciable effect on CO2 levels. Room A has 15 people and low ventilation. Room B has 15 people and high ventilation. Room C has 10 people and high ventilation. A Vernier CO2 probe was used to measure the change of CO2 level during 40 minutes sessions and generate graphs of the change in CO2 level throughout the sessions. The graphs of rooms B and C were analyzed to determine the effect of different classroom occupancy on CO2 levels. The graphs of rooms A and B were analyzed to test the influence of air circulation on CO2 levels. In the first experiment, An appreciable increase in CO2 level was observed (+882 ppm) in room B, but the CO2 level remained relatively similar (-67 ppm) in room C. In the second experiment, throughout the day, the CO2 level in room A increased from 1822 ppm to 4535 ppm; however, the CO2 level in room B increased from 1265ppm to 1346 ppm. To conclude, with the same ventilation, the change of CO2 level in the high occupancy classroom is more significant than the change of CO2 level in the low occupancy classroom. With the same occupancy, CO2 accumulates enormously more in the low ventilation classroom than in the high ventilation classroom. In future studies, a simple cognitive test will be used to assess student mental acuity.

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