



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Trevor Amarante	Project Number S1101
Project Title Bioreactors: Promoting Methanogenic Reproduction through the Recirculation of Leachate	
<p style="text-align: center;">Abstract</p> <p>Objectives Compare the rates of decomposition in a standard landfill environment to those of a system in which leachate is cycled through. Determine if the recirculation increases the rate of decomposition and has the potential of being beneficial to landfills in the context of energy.</p> <p>Methods The experiment was carried out in sealed systems simulating a landfill environment. There are two types: wet (bioreactor) and dry (leachate recirculation absent), of which three units each was built and used in each trial. Each was constructed with the capability to maintain pressure and contain all gases produced until the time of measurement and release through the use of a GEM 2000 (Gas Emission Monitor). Once constructed, waste (materials with a higher proportion being biodegradable) was placed inside each system between layers of soil, after which the system was sealed to ensure the containment of any gases produced. Water was introduced into the bioreactor systems at the beginning of the trial in amounts related to rainfall measurements and cycled through the system without any additions during the period of experimentation.</p> <p>Results The percentages of gases related to the processes of decomposition were found in higher concentrations in the systems simulating the bioreactor conditions. There was a 0.8% increase in methane production from the control to the bioreactor, which when applied to the scale of an observed landfill is an increase of 8,904,508.8 BTU a day having the potential energy equal to 1,200,149.7 kWh.</p> <p>Conclusions The determination that the establishment of bioreactor conditions increases the rates of decomposition can be used by landfills in efforts to both improve efficiency in waste management and become sites of renewable energy production. By increasing rates of decomposition, the concentrations of methane are more likely to reach levels at which they are capable of being used in energy production, a practice that if started, could serve as a source of economic benefit and job opportunity. In just the landfill observed, the economic value of such increases is a \$144,017.96 (US average kWh cost) or \$215,666.90 (California average kWh cost) a day increase.</p>	
Summary Statement Sealed environments were created to simulate both a standard landfill environment with dry conditions and a bioreactor with the recirculation of leachate in order to compare the decomposition rates and determine a more efficient system.	
Help Received I designed the testing apparatus and carried out the research and experimentation by myself entirely. I consulted engineers at a functioning land fill on the approval of the design as well as on the needed research on landfill processes and procedures.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Danya Balagopal	Project Number S1102
Project Title The Effect of Bio-coagulants on the Adsorption of Waste Oil and the Reduction of Turbidity from Oil-Produced Waters	
<p style="text-align: center;">Abstract</p> <p>Objectives Through deep sea drilling and hydraulic fracturing, California annually produces about 8 billion gallons of oil and 130 billion gallons of oil-produced waters. Aluminum sulfate is used to treat these produced waters prior to releasing into the environment. This treated water is acidic and damages both aquatic ecosystems and groundwater aquifers. There is a need for an environmentally safe, sustainable, and efficient alternative to aluminum sulfate. As scientific literature on natural alternatives to treat oil-produced water is limited, the goal of this project is to study the efficacy of plant-based coagulants (<i>C. arietinum</i>, <i>S. potatorum</i>, and <i>R. sativus</i> seeds) on oil and suspended solid (turbidity) reduction on oil-produced waters. The hypotheses are that these bio-coagulants will adsorb 75% of waste-oil and reduce turbidity by 50%, as compared to the aluminum sulfate which adsorbs 70% of oil and reduces turbidity by 46%.</p> <p>Methods Produced water was simulated using distilled water, clay, and vegetable oil. <i>C. arietinum</i>, <i>S. potatorum</i>, and <i>R. sativus</i> seeds were ground and made into a filtrate. Adsorption experiments were performed in quadruplets by treating the produced water with the filtrates and the control by varying the temperature (15C, 25C, 35C, 45C, 55C), dosage (10g, 20g, 30g, 40g, 50g), and pH (4,5,6,7,8). The supernatant was measured using a novel application of the calcium hydride test and a turbidity meter for each variation.</p> <p>Results The removal efficiency (RE%) was calculated and statistical significance established using ANOVA. The results showed that <i>C. arietinum</i> removed 81.5% of oil at pH 6 and <i>R. sativus</i> reduced oil by 88.7% at 35C with 40g dosage. <i>S. potatorum</i> reduced turbidity by 59.9% at pH7, at 35C and dosage of 40g.</p> <p>Conclusions The objective was met as the bio-coagulants had a mean oil reduction efficiency of 83.4% and mean turbidity reduction of 56%. The functional groups on the surface of the bio-coagulants helped with coagulation. Flocs formed and settled to the bottom due to gravity. The bio-coagulants destabilized the colloids by neutralizing the forces that keep them apart, thus clarifying water and adsorbing oil from oil-produced waters. This project proves that bio-coagulants are a sustainable and viable alternative to the conventional aluminum sulfate treatments used by oil companies which directly and indirectly harm the environment.</p>	
Summary Statement My experiment studied the adsorptive properties of bio-coagulants on oil and turbidity reduction and proved their efficacies as sustainable alternatives to the commonly-used aluminum sulfate to treat oil produced waters.	
Help Received I designed, experimented, and analyzed the results on my own. I d like to thank Mr. Dan Coltrin, of Forensic Analytics Laboratories for answering my questions on adsorption and using different types of oils, my teacher Dr. Sean Wilmot for his support, and my parents for buying the materials.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Francisco Catanzaro; Isabella Catanzaro	Project Number S1103
Project Title Measuring Chlorophyll Fluorescence and Spectral Reflectance for the Remote Sensing of Agriculture	
<p style="text-align: center;">Abstract</p> <p>Objectives The intent of this project is to create a device that will monitor the health of plants in order to maximize plant production using less water. Given that there is no standard for remote sensing of agricultural crops, we want to compare the sensitivity of the two leading methods: fluorescence and spectral reflectance. We believed that chlorophyll fluorescence will be a more sensitive method of detecting stress in agricultural crops.</p> <p>Methods We decided to test our hypothesis by creating two custom sensors: a reflectometer and a fluorimeter. The reflectometer was configured with LEDs a photodiode and a condenser lens to collect the light. The chlorophyll fluorimeter was configured with a blue LED, a long pass filter of 650nm, and a monochrome camera. For five days, we measured the reflectance spectrum and chlorophyll fluorescence of 18 dehydrated (Experimental) and 18 healthy (Control) plants. At night, we measured the reflectance of each plant with blue, red, and green LEDs; and immediately after we measured the chlorophyll fluorescence of the plant. We analyzed the fluorescence data, normalizing by the illumination, using Matlab to find the average fluorescent yield of the leaves.</p> <p>Results The chlorophyll fluorescence data showed a consistent decrease in fluorescence over time as the plants were not watered. A T-Test of the chlorophyll fluorescence data comparing the control and experimental groups showed that after only three days the T-test showed that there was a probability of less than 0.04 that the variation in the two groups was due to random behavior. However, the reflectance data did not show a relationship between the population of the control and the population of the experiment.</p> <p>Conclusions The spectral reflectance data was identical for both the experimental and control groups, while the fluorescence data could distinguish between the two groups after water was withheld from the plants for three days. This proved that chlorophyll fluorescence is a more sensitive way of detecting plant health than spectral reflectance. The control and experiment plants were nearly visually identical for all five days. The fluorimeter can detect the decline of plant health before it is visible to the human eye. This proves our hypothesis that a fluorimeter can detect a decrease in plant health, correlated with a decrease in chlorophyll fluorescence, better than a reflectometer.</p>	
Summary Statement We created a device that monitors the health of plants in order to maximize plant production by measuring the plant's chlorophyll fluorescence.	
Help Received None. We designed, built, and performed the experiments ourselves.	



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) Shreya Chaudhuri	Project Number S1104
Project Title The Effect of Growth Media on Algae's Ability for CO2 Biofixation	
<p style="text-align: center;">Abstract</p> <p>Objectives Carbon dioxide makes up 72% of all greenhouse gases produced, which makes it the leading source of air pollution. Certain green algal species such as <i>Chlorella vulgaris</i> are able to fixate the carbon dioxide into fatty acids present in cells in a process known as carbon dioxide biofixation. With an objective to make the process of carbon dioxide biofixation more efficient, this project tests out the effect of different algal growth mediums on the ability of <i>Chlorella vulgaris</i> for carbon dioxide biofixation.</p> <p>Methods In the testing process, <i>Chlorella vulgaris</i> was added to four different bottles each containing four different substances (distilled water, Blue Green 11 medium, Bold's Basal Medium, and Guillard's f/2 medium) and cultured for 8 days. Each algae and medium mixture was then divided equally into 3 smaller bottles and rotated for 3 days. To compare data, the change in carbon dioxide content was measured by subtracting the carbon dioxide content of the bottles with algae to a similar bottle without algae.</p> <p>Results The results for the average change in carbon dioxide content were 59.3 ppm for Blue Green 11 medium and algae, 50.6 ppm for Guillard's f/2 medium and algae, 22.6 ppm for Bold's Basal Medium and algae, and 10 ppm for distilled water and algae. The Blue Green 11 medium decreased carbon dioxide content of the bottles most effectively.</p> <p>Conclusions My results show that the algae's capacity for biofixation can be greatly enhanced through the effective use of mediums, a finding that has extensive real world benefits in reducing pollution.</p>	
Summary Statement I found a way to enhance algae's ability for carbon dioxide biofixation so that algae can be mass produced in algal farms to reduce both air and water pollution efficiently in an industrial scale.	
Help Received My biology teacher helped me with using the carbon dioxide gas sensor. My chemistry teacher helped me with using the pH meter. My engineering/robotics teacher assisted me with the building of the bottle rotator.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Abida Diep; Vittal Thirumalai	Project Number S1105
Project Title Keeping the Ocean Clean: A Novel Self-Sustaining Boat that Uses Vision Tracking to Collect and Sort Trash in the Ocean	
<p style="text-align: center;">Abstract</p> <p>Objectives Trillions of pieces of trash currently pollute the ocean, which greatly harm marine life and the environment. Our goal is to design, build, and test an autonomous prototype boat that collects and sorts trash in the ocean while being self-sustaining, eco-friendly, having a simple design to minimize costs of production, and having the capability to continually remove trash, including microplastics, from the ocean for years to come.</p> <p>Methods Our boat harnesses the natural oceanic forces of currents, winds, and waves to capture the trash in the boat's opening. In addition, the support underneath the boat acts as a stabilizing force that naturally directs the boat towards areas with the highest concentrations of trash. Once the boat collects the trash, a pump sucks the trash from the opening of the boat into the filtering system, while marine life can safely pass beneath the underwater support. Furthermore, a camera uses vision tracking to turn on the pump only when a significant amount of trash is collected, thereby greatly reducing energy consumption. Once the trash is pumped out onto the filtering system, it is then sorted based on size, which makes the recycling process much easier and efficient. Even small plastics are effectively captured by the specially designed microplastics filter. Finally, another camera uses vision tracking to notify when the filtering system is full and needs to be cleaned out.</p> <p>Results We designed, created, and tested a prototype of our boat fully equipped with a Raspberry Pi, camera, pump, solar panel, and filtration system. During the entire one week test phase, the prototype boat was self-sufficient and required no external energy source. In addition, the boat collected over 85% of the trash that we placed in our swimming pool, and it accurately sorted this collected trash more than 90% of the time. Furthermore, we tested the camera's vision tracking capabilities: in all 10 test cases, when over 50% of the boat's opening was filled with trash, the pump was properly activated. Finally, we also created a website that raises awareness of ocean pollution and also explains the details of our solution to combat this problem.</p> <p>Conclusions Our autonomous boat satisfied all of our experimental goals during the testing phase: it is self-sustaining through the use of solar power combined with minimal energy consumption, eco-friendly by allowing marine life to safely escape the system, has a simple design, and can stay in the water for long periods of time. In the future, after more testing, we plan to create a large-scale version of our boat that will be deployed into the ocean. Furthermore, through our website, we hope to raise awareness of this growing problem and partner with other companies to help deploy these boats all over the world.</p>	
Summary Statement We created a successful autonomous prototype boat that uses vision tracking to collect and sort trash in the ocean while being self-sustaining, eco-friendly, and having the capability to stay in the ocean for long periods of time.	
Help Received We designed, built, and tested the prototype boat ourselves, with the help of the 3D printer and machining tools available at our school.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Jessica Fairlie; Vivian Feldheim	Project Number S1106
Project Title Sweet Erosion: Analyzing Coastal Erosion Prevention Methods	
<p style="text-align: center;">Abstract</p> <p>Objectives The goal of our experiment was to determine the best coastal erosion prevention method based on three criteria: effectiveness at mitigating erosion, aesthetic appeal, and cost.</p> <p>Methods We built a wave machine out of recycled materials. We tested the effectiveness of four different erosion prevention methods at protecting a model cliff. The methods were sandbags (tea bags filled with sand), tetrapods (small, hand made cement structures), riprap (pieces of gravel), and beach nourishment (extra sand). We performed an anonymous survey asking adults which erosion prevention methods they found to be the most and least aesthetically pleasing. Finally we researched the cost and durability of the various erosion prevention methods.</p> <p>Results Sand bags were the most effective method for preventing coastal erosion. Beach nourishment was the most aesthetically pleasing method, and the most cost effective (over a fifty-year period) as well.</p> <p>Conclusions We concluded that beach nourishment was the overall best method because it was the second most effective at mitigating erosion, the least expensive, and the most aesthetically appealing.</p>	
Summary Statement We found that beach nourishment was the best coastal erosion prevention method by comparing cost, aesthetic appeal, and effectiveness.	
Help Received We received no help; we designed, built, and tested our erosion prevention methods ourselves.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Julianna Garcia; Siena Lum	Project Number S1107
Project Title Used Coffee Grounds: A New Source of Fuel	
<p style="text-align: center;">Abstract</p> <p>Objectives First, to discover an alternative, eco-friendly biodiesel fuel in place of petroleum or other fossil fuels we use today. Second, to find a way to reduce the input into landfills. This is done by transforming a previous waste product into something useful that will benefit our environment. We found that we could turn used coffee grounds into a cleaner biodiesel.</p> <p>Methods Three main procedures: extraction, distillation, and testing the energy. Extraction: soxhlet extraction apparatus, used coffee grounds, hexane-our solvent. Distillation: distillation tube to reuse hexane. Test energy: calorimeter, bohning alcohol burner, specific heat formula. Test for different cuts of coffee gounds</p> <p>Results We found that the medium cut coffee grounds produced more oil than the coarse ground coffee. However, the coarser cut coffee had more energy than the medium ground coffee grains. Overall this experiment only took two hours and the hexane and water we used can also be recycled for further experiments.</p> <p>Conclusions Medium cut grounds produce more oil because of the larger surface area. Hexane can extract oil from used coffee grounds, thus formulating a biodiesel. Our oil can be easily used as fuel for nearly anything and in mass production, will get the most out of the used coffee grounds. Although our process takes energy, the biodiesel will release less carbon emissions than petroleum.</p>	
Summary Statement We turned used coffee grounds into a biodiesel in order to reuse a waste product that results in a fuel that is cleaner for our environment.	
Help Received Our chemistry teacher bought us the needed supplies and supervised our experiment. Otherwise than that, we all of the work ourselves.	



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) Dimple Amitha Garuadapuri	Project Number S1108
Project Title Na/Ca/K Pollution Scrub: A Domestic Approach to Chemical Carbon Capture	
<p style="text-align: center;">Abstract</p> <p>Objectives Every day you charge your phone and drive your car, but have you ever wondered about the amount of CO₂ you release into the air by doing those actions? Atmospheric levels of CO₂ have never been higher than today during the time humans have lived on Earth. Many processes and methods have been developed to capture CO₂ from the air, and some industrial power plants have been made. I want to find a way to redesign those processes to be used in a domestic (home) setting. My goals were to prove that a chemical process could capture CO₂ and find the best concentration/chemical/material to be used as an absorbent in a prototype.</p> <p>Methods The chemical process outlined by Prof. Lackner and Prof. Zeman is made of multiple steps/processes to capture CO₂ from the air, which I broke down into phases. To experiment with the first Phase, I created a closed environment in which I exposed different concentrations of different chemicals to the ambient air within it. A CO₂ monitor recorded the CO₂ PPM and computer software allowed me to analyze changes that were caused by the solutions. The same environment was used when testing with a cheese cloth as well. I am currently testing the second step which allows us to separate the CO₂ from the solutions used above to eventually sequester the CO₂.</p> <p>Results NaOH may be used to capture CO₂ and higher concentrations yield better results. The solutions also have maximum capacities, which differ based on the concentration. KOH can also be used and seems to be better than NaOH, when one compares maximum capacities. Carbonate can be found in the resulting chemicals, which is a foundation to continue to eventually sequester CO₂. Using cotton cheese cloth that is saturated with KOH can be used as an effective air filter.</p> <p>Conclusions Though initially there was minimal data to support this study, tweaking and altering protocol led to positive results. Domestic carbon capture is possible, and separating the CO₂ is the next phase of this process. With that study, and information already gathered, a prototype can be developed in the near future.</p>	
Summary Statement Repurposing a chemical process developed to capture carbon dioxide from the ambient air to function in a domestic setting had many steps and so far, this study has shown results that support the development of a domestic pollution scrub.	
Help Received I was supervised by Mrs. Bowles when dealing with raw chemicals in school and my parents when performing trials at home. I was also advised by Prof. Lackner and Prof. Zeman, who shared journals and gave me some additional insight on the chemical process.	



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) Jonghyun Hong; Jad Soucar	Project Number S1109
Project Title Producing a Corrosion Resistant and Environmentally Friendly Concrete by Using the Salt Water Carbonate Buffer System	
<p style="text-align: center;">Abstract</p> <p>Objectives In order to minimize the Carbon dioxide emission from concrete production, our project sought to find an environmentally sustainable method that would allow for the formation of a Calcium Carbonate based concrete, instead of the carbon dioxide producing silica-based concrete in the status quo. The first target was to achieve a form of Calcium carbonate crystallization around a series of aggregates. The second goal was to improve the corrosion resistance of concrete, to protect against acid rain.</p> <p>Methods To create the concrete, different combinations of CaCl₂, Mg (OH)₂, H₂O, and aggregate were placed in a vacuum chamber saturated with various torr of CO₂ over the course of 50 trials. The series of chemicals used, helped imitate the saltwater-carbonate buffer system which produced carbonate ion that promptly reacted with the calcium cations in the solution. The end product was a calcium carbonate lattice that binds together aggregate. In order to protect the calcium carbonate in our concrete from corrosive elements, a super hydrophobic coating, made from stearin, microcrystalline, carnauba, and micro beads was created. The stearin emulsified the non-polar materials, whereas the microbeads and a mesh procedure increased hydrophobicity and resistance to corrosive materials by promoting capillary action and collection of air molecules within the crevasses.</p> <p>Results Our results suggested that a 6.25/.6/2.5/192.5/1 mole ratio for CaCl₂, Mg(OH)₂, Ca(OH)₂,CO₂ and water, allowed for the production of CaCO₃ based concrete, that sequestered carbon dioxide. Next, the super hydrophobic layer created consistent 150-degree angles between water droplets and the surface and repelled a diluted 4 pH solution of sulfuric acid, meant to replicate acid rain, repeatedly over the course of 50 trials.</p> <p>Conclusions By the end of the experiment a novel procedure to creating environmentally friendly concrete was created, as well as a non-toxic corrosion resistant spray that can be applied on any concrete or material.</p>	
Summary Statement W produced a corrosion resistant and environmentally favorable concrete, using various ingredients and sequestered carbon dioxide.	
Help Received We conducted our experimentation in Julia Patton's Lab at Crescenta Valley High School, and received feedback from Orenda Tuason.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Shloka Janapaty	Project Number S1110
Project Title A Novel, Fast, Low-Cost Approach to Achieve Near 100% LDPE Degradation: Bioremedial Landfill Implementation	
<p style="text-align: center;">Abstract</p> <p>Objectives Low-Density Polyethylene (LDPE) is a common plastic that takes 500 years to degrade. Current methods to remove LDPE are unsafe or ineffective, and less than 5.7% is recycled. The goal of this project is to achieve maximum LDPE degradation without producing toxins, in a rapid timeframe, for viable landfill implementation.</p> <p>Methods Research was divided into two phases: achieving near-100% degradation and streamlining for landfill viability.</p> <p>Phanerochaete chrysosporium (PC), an aerobic lignin-degrading fungus, was the biodegradation agent. Landfill leachate, a wastewater, provided a C/N rich source to enhance PC s degradation potential.</p> <p>In Phase 1, the effect of four pretreatments (baking, etching, presence of leachate, and inoculation with PC) on degradation of 3 mg LDPE was tested. The control was LDPE alone. It was hypothesized that if LDPE is baked, etched, exposed to leachate, and inoculated with PC, maximum degradation would occur. Degradation was measured through surface area reduction and byproduct gas production using a self-designed pneumatic trough. Leachate remediation was shown using NH₃-N, NO₃⁻, and NO₂⁻ tests and ESI-MS (Electrospray-ionization).</p> <p>In Phase 2, the most successful group from Phase 1 (Group 8) was adapted for landfill viability. The effect of baking, etching, and inoculation with PC on the degradation of 30 mg of LDPE in a simulated landfill environment was tested. The control was LDPE alone. Surface area reduction was measured.</p> <p>Results In Phase 1, the experimental group in which LDPE was baked, etched, exposed to leachate, and inoculated with PC (Group 8) showed 99.5-99.9% reduction over 6 days for 80 samples. One-way-ANOVA showed $p < 0.001$. Microscopy correlated with this finding. Byproduct production for all groups was in accordance with Ideal Gas Law calculations.</p> <p>ESI-MS data demonstrated that NH₃-N levels decreased by 69% and salt content reduced over 12 days. Tests of PC-treated leachate showed conversion of ammonia to nitrates over 12 days.</p>	
Summary Statement This project develops a novel method to achieve near-100% LDPE degradation in a simulated landfill environment in 6 days using a combination of LDPE pretreatment methods and Phanerochaete chrysosporium bioremediation.	
Help Received I designed and conducted all experiments myself at school. I received technical guidance from Dr. Tracy Hughes (Presentation High School) and Dr. Katherine Walker.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Eshani Jha	Project Number S1111
Project Title A Novel and Affordable Water Filtration System for Complete Removal of Heavy Metals	
<p style="text-align: center;">Abstract</p> <p>Objectives Water potability is a key challenge of modern civilization. Worldwide, two billion people lack access to clean drinking water and heavy metals are the primary toxic contaminants. This research created a highly efficient, sustainable, and affordable water filtration system for the rapid removal of heavy metals from water using enhanced biochar.</p> <p>Methods Biochar was enhanced using manganese dioxide, cysteine, and potassium permanganate solutions. Enhanced biochar was tested for proper chemical composition using X-Ray Absorption Near-Edge Structures and Transmission Electron Microscopy. It was then placed in a prototype constructed using PVC riser plus coupler pairs. Sand and calcite (common filter materials) were also placed in the prototype for particulate matter removal.</p> <p>For lab testing, water with variable heavy metal concentrations was passed through the filter at various flow rates to characterize filter effectiveness. Then, enhanced biochar, sand, and calcite were left in contaminated water for an extended period of time to test reversibility of contaminant removal. For controls, experiments were repeated without any enhanced biochar. Final heavy metal concentrations were determined through Inductively Coupled Plasma Mass Spectrometry (calibrated to 1 ppb).</p> <p>For field testing, residential water samples from Flint, MI and surface water samples from Flint River were collected. As per standard EPA methods, original and post-filtration contaminant levels were determined by Brejle & Race Laboratories, Santa Rosa, CA.</p> <p>Results All contaminants were removed for slow and medium flow rates. For fast flow rates, no mercury or cadmium was detected. Trace amounts of arsenic and lead detected were well below EPA guidelines. No heavy metals were detected after extended time periods, demonstrating effective long-term heavy metal removal. In practical application, the water filter completely removed heavy metals at various flow rates.</p> <p>Conclusions Through creative design, rigorous testing, and cutting-edge technology, a novel water purification system has been developed by integrating environmental chemistry with engineering. This filter completely and rapidly removes heavy metals. Mass manufacturing is expected to lower the floating cost to twenty-five</p>	
Summary Statement I have created a novel and affordable water purification system for the rapid and efficient removal of arsenic, lead, mercury, and cadmium from contaminated water using enhanced biochar.	
Help Received Prof. Bhoopesh Mishra at the Illinois Institute of Technology gave me laboratory access and equipment. Dr. Krista Hennig at the Pasca Lab of Stanford University deepened my understanding of heavy metal toxicity. Mr. Nelson Brock at the Greenfield Labs of Ford Motor Co. established an industrial partnership	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Nicole Krockenberger	Project Number S1112
Project Title Creating a Renewable and Biodegradable Bioplastic from Bambusa multiplex	
<p style="text-align: center;">Abstract</p> <p>Objectives The objective is to create a biodegradable and renewable plastic foam from the cellulose of Bambusa multiplex, a species of bamboo.</p> <p>Methods Commercial microcrystalline cellulose was immersed in a sodium hydroxide solution to make it amorphous, and the amorphous cellulose was combined with different amounts of a plasticizer. The plastics were cured in the oven. After plastic had been successfully made with the commercial cellulose, the same procedure was used to make plastics out of cellulose extracted from bamboo. To extract the cellulose from bamboo, stalks of Bambusa multiplex were cut and grated to break them down into small pieces to dry. Then, the cellulose was isolated by submerging the bamboo particles in ethanol, and nitric acid, sodium hydroxide and sodium sulfite, and sodium hypochlorite solutions. With this cellulose, the procedure used to make plastics from commercial cellulose was repeated. Finally, biodegradability, compression, and insulation tests were performed on the plastic samples.</p> <p>Results The biodegradability tests suggested that the plastics made with bamboo cellulose degraded at a higher rate than those made with commercial cellulose, and that plastic samples with a higher cellulose content degraded faster than those with a lower cellulose content. The compression test suggested that the plastics made with bamboo cellulose had a compression rate similar to that of a polyethylene foam with the same open-cell characteristics. Finally, the insulation test suggested that the plastic foams made with 10% cellulose insulated better than those created with 20% cellulose.</p> <p>Conclusions A biodegradable plastic foam was created using cellulose from bamboo. Through tests, it was determined that the ideal percentage of cellulose in these plastic foams is in between 10% and 20% because the samples with 20% cellulose do biodegrade faster, but the samples with 10% cellulose have better insulation properties and have a higher rebound rate after they are compressed. The experiments and studies suggest that the plastic foams created could be a solution to the world's problem of plastic waste, however, further testing is necessary to confirm this. Future studies include testing the biodegradability of the plastic foams in soil, testing the tensile strength of the plastics, and testing the ability of the plastics to insulate hot objects. A promising application for the plastic foams created from bamboo is a packaging material, in which the plastic foams could protect or insulate an object, and after their use, they would biodegrade.</p>	
Summary Statement A biodegradable plastic foam was created by extracting cellulose from bamboo and combining it with a plasticizer; the biodegradability, compression, and insulation characteristics were determined through testing.	
Help Received Guidance and help while handling chemicals and creating solutions was received from Cathy Messenger, teacher and mentor at Los Gatos High School, and Jeff Kraus provided an Insteon tensile/compression tester at the company TE Connectivity for compression testing.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Pranav Moudgalya	Project Number S1113
Project Title Assessment of Organic Waste Materials in Nitrate Filtration of Southern California Waters	
<p style="text-align: center;">Abstract</p> <p>Objectives The purpose of this study was to evaluate the use of fruit peels as a novel & natural bio-adsorbent to remove nitrates from water.</p> <p>Methods The experiment(s) involved using fruit peels, dehydrated and crushed into a fine powder, as a treatment for various water sources (Woodbridge Lake, Heritage Lake, Distilled Water, and a KN03 Solution). Baseline nitrate measurements for each water source were taken via the use of a Vernier Nitrate Selective Electrode. Every water source was tested in 100mL batches. For every 100mL of water being tested, 0.05g of each fruit peel was added into the water and underwent a 30-minute agitation process (250 rpm on a magnetic stirring plate). After the mixing of the treatment with the water sources, the solution was filtered using a coffee filter/cheesecloth apparatus and the remaining liquid was measured for nitrate concentration. For every water source/fruit peel combination, three trials were conducted.</p> <p>Results Results partially supported the hypothesis. In the control samples (distilled water), the nitrate concentration of the water went from a pre-treatment level of 0.51 mg/L down to 0.15mg/L in the lemon peel treatment, 0.08 mg/L in the orange peel treatment, and 0.27 mg/L in the banana peel treatment. A two way ANOVA was used to verify statistical significance between means. A post-hoc Tukey HSD test confirmed significance of every fruit peel tested against the means of all other groups ($P < 0.01$). In the Heritage Park and Woodbridge Lake samples, a two-way ANOVA suggested that the introduction of the fruit peel treatments, on net, increased in the nitrate concentration of the sources ($P < 0.01$). Finally, in the experiment involving the KNO3 solution, the analysis performed via a two-way ANOVA indicated no significant correlation between treatment groups and either an increase/decrease in nitrate concentration ($P < 0.01$).</p> <p>Conclusions This study indicates that in samples of distilled water, the introduction of fruit peels as a treatment decreases the nitrate concentration of the water. In the distilled water samples, the most efficacious treatment group was the orange peels, decreasing the nitrate concentration by up to 84%. However, in the field water samples, the introduction of the treatment significantly increased the nitrate concentrations of the water sources, with no discernable hierarchy between the results of different treatment groups. More research is necessary to understand why results found in the distilled water samples are not consistent among all water groups.</p>	
Summary Statement In this study, fruit peels were assessed as being potentially effective bioremediants of nitrates in select water sources.	
Help Received The design, execution, and analysis of my project was done completely independently. My parents supported me morally and financially, driving me around to collect water samples and buy materials. In addition, Claudia Weihe of the UCI Martiny Lab assisted me with advice on good research practices.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Aarthi Muthukumar	Project Number S1114
Project Title Interdisciplinary Approach to Deforestation and Lung Disease: Using Photovoltaic Systems to Build Low-Cost Solar Cookers	
<p style="text-align: center;">Abstract</p> <p>Objectives Design an affordable immersion heater that can alleviate the high numbers of indoor air pollution in the global developing population. The heater must cost less than \$2 in raw materials, and feed a small family of four.</p> <p>Methods This project is a novel approach to create a sustainable immersion heater, consisting of an outer metal tube, a thermally conductive and electrically insulative composite, and a diode chain. Created immersion heaters using recycled aluminum soda cans and diodes chains with bimetallic temperature switches. Connected the cookers to a DC power supply to mimic the effects of a power source.</p> <p>Results The final design was an oil-based heater made out of recycled aluminum soda cans that costs \$1.48 to build. Further testing would be to attempt to cook dry goods, as immersion heaters can only be used on wet goods.</p> <p>Conclusions Globally, more than 1.3 million people die prematurely each year because of exposure to indoor air pollution due to the burning of biomass. By implementing low cost approaches to solar cooking and eliminating the need for fires, the rates of deforestation and consequently respiratory disease will decrease. This project was a regional finalist in the Junior Humanities and Science Symposium. It is also on its way to be published in the Journal for Emerging Female Scientists.</p>	
Summary Statement I developed an immersion heater that costs less than \$2 to build in order to decrease the levels of indoor air pollution in the global developing population.	
Help Received I designed and built the immersion heater myself. I was allowed access to DC power supplies from my high school, and my AP Biology teacher helped me with statistical analysis.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Charlotte Park	Project Number S1115
Project Title Conductive Materials Based Reusable Electrostatic Particulate Matter 2.5 Filters	
<p style="text-align: center;">Abstract</p> <p>Objectives Two main aspects of a particulate matter 2.5 μm (PM 2.5) filter were examined for their impact on filtration (i) presence of static electricity and (ii) pore diameters. Five different kinds of materials were tested for filtration efficiency based on the variety of their conductive ability and pore sizes with a hypothesis that the novel graphene oxide (GO) and polyaniline (PANi) composite filter will have a high and the best filtration efficiency.</p> <p>Methods The experimentation was carried out in a sealable chamber with an accelerating automobile acting as a PM 2.5 producer. The filtration efficiency was derived by comparing the PM 2.5 concentration with and without the use of each filter. To verify the significance static electricity, three other conductive cotton, silk, and rayon filters were prepared and tested with and without applied static electricity. A novel hybrid graphene oxide (GO) and polyaniline (PANi) composite filters were developed and tested for the effect of pore diameters and static electricity. Using the same experimentation method, different thickness of GO/PANi filters (5 μm and 20 μm) were tested. All filters increased in efficiency after static charging.</p> <p>Results The cotton filter had an efficiency up to 69.3% uncharged and 78% charged. The rayon filter had an efficiency of up to 85.6% efficiency uncharged and 93% charged. The silk filter had the efficiency static of up to 85.6% and 99.3% uncharged and charged. The GO/PANi (5 μm) had a comparatively lower efficiency of up to 93.7% uncharged and 97% charged. The GO/PANi (20 μm) had the higher efficiency of up to 98.7% without static electricity and 99.7% efficiency with static electricity.</p> <p>Conclusions The GO/PANi had a high filtration efficiency with and without the static electricity charging and can be utilized as an effective and practical filter. The results of the experiment prove that the two main aspects of PM 2.5 filtration is highly influential and when combined together can create high efficiency filters. The current price of creating PM 2.5 filters with GO/PANi similar to the one created for the experiment estimates around \$5 for 12-15, 1.5 inch diameter filters. Not only do the results demonstrate the high efficiency of the material, but also opens up possibilities for the novel GO/PANi filter to mass produced and sold as a product.</p>	
Summary Statement I created a particulate matter 2.5 micron (harmful air-borne pollutant) filter using a graphene oxide and polyaniline composite hybrid material that had a high filtration efficiency of up to 99.3%.	
Help Received I built the filter and performed experiments testing filtration efficiency. Professor Richard Kaner from the department of chemistry and materials science and engineering at the University of California, Los Angeles and his research team provided the GO/PANi material and ran characterization tests.	



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) Jacqueline Prawira	Project Number S1116
Project Title Ocean.Bioplas: The Plasticity of Marine Exoskeleton-Inspired Materials and their Degradability in the Environment.	
<p style="text-align: center;">Abstract</p> <p>Objectives To develop alternative materials to plastics, inspired by the concept of marine exoskeleton composition and to test their tensile strength, flexibility, and degradability.</p> <p>Methods The Preliminary Stage varied ratios/combinations of shell waste compounds for the formation development of Chitosan (CH) and Chitosan+Calcium Carbonate (CHCC). Poor quality samples were eliminated. In the Experimental Process, trials were conducted on Chitosan (CH1-7) and Chitosan+CaCO₃ (CHCC1-21) samples for tensile strength and flexibility testing. The Degradation testing added Squid Ink. Data was generated through observation in 5 different settings for 12 weeks. In the Final Development Stage, Partially Hydrolyzed Collagen was added to enhance tensile strength.</p> <p>Results Chitosan compounds are thin, transparent and flexible with plastic-like quality; while the inclusion of CaCO₃ produces a thicker, porous and composite-like quality. Chitosan and CaCO₃ have positive correlations to tensile strength while diminishing flexibility. Each gram of Chitosan increases tensile strength by 154% in CH and 15%-44% in CHCC, while each gram of CaCO₃ increases tensile strength by 5%-13%. The presence of partially hydrolyzed collagen improves tensile strength up to 5x and stretchability in CHCC. Melanin in squid ink speeds up the degradation process slightly, with minimal effect to tensile strength and flexibility, by absorbing the UV light and turning the light energy into heat energy. Biodegradation in organic soil occurs faster than photodegradation in saltwater/seawater. Salinity contributes to buoyancy, while water circulation wears down the samples by jostling and friction. Ratios/combinations were formulated as mathematical inequalities.</p> <p>Conclusions Compounds derived from crustacean shell waste can be utilized to synthesize alternative materials to plastic. However, the properties of each material once extracted are similar but altered. Finding the ratios/combinations is crucial to achieving certain qualities as each compound brings each own challenges and solutions. OceanBioplas meets ASTM D6400 for 60% degradation within 180 days in organic soil without high temperatures and has the potential to photodegrade in saltwater/seawater with longer time. OceanBioplas has comparable or better tensile strength than some regular plastics based on ASTM D638. Prototypes were successfully created.</p>	
Summary Statement I formulated Ocean.Bioplas as an alternative material to plastics using the marine exoskeleton concept to combat the plastic problem, meet the biodegradation standard and has comparable tensile strength to some regular plastics.	
Help Received I developed and conducted the experiments myself. Mrs. Gillmore and Mr. Brown from SJCOE provided feedback and support. My parents provided materials and adult supervision as required.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Melanie Quan	Project Number S1117
Project Title Developing Compostable and Water-Soluble Algal Bioplastics by Repurposing Waste Products of Algal Biofuel Production	
<p style="text-align: center;">Abstract</p> <p>Objectives Plastic pollution is becoming an environmental crisis, with over 40% of the ocean being covered in floating plastic. The purpose of this research was to determine the sustainability of algae-based bioplastics as alternatives to conventional petroleum-based plastics. The ultimate goal was to develop an algal bioplastic recipe using byproducts of algal biofuels that was compostable, water soluble, and exhibited similar physical properties in strength to conventional plastics.</p> <p>Methods The research consisted of three parts. In Phase I, four species of algae (<i>T. suecica</i>, <i>N. oculata</i>, <i>H. droebakensis</i>, and <i>C. vulgaris</i>) common to biofuel production were cultured in a homemade photobioreactor. Cell counts were taken daily using hemocytometry. The algae species were then harvested, and lipids were separated from the algal biomass and converted to biodiesel via mechanical extraction. The resulting biomass was used to create bioplastics. In Phase II, various percentages of algal biomass to pure starch ratios were tested in the bioplastic recipe. The plastics were tested for strength. In Phase III, the potential environmental impacts were tested and the bioplastics of various starch to biomass ratios were tested for biodegradation in soil, water solubility, and ability to increase plant growth as a natural fertilizer.</p> <p>Results Results indicated that <i>C. vulgaris</i> was the optimal species for bioplastic production due to fast proliferation and stronger bioplastics. When comparing various ratios of algal biomass in the recipe, higher starch contents yielded stronger bioplastics. In tests for environmental impact, trends between starch and biomass ratios were identified. Data suggests that higher percentages of algal biomass resulted in faster water dissolution, increased biodegradation in soil, and taller plant heights. Bioplastics with 25% biomass performed best in testing, supporting 633 grams, losing 19.2% mass in water (7 days), losing 97.5% mass after composting (7 days), and increasing plant heights by 46% and 28.5% in pea and radish plants respectively (12 days).</p> <p>Conclusions Results suggest that environmental impacts and strength can be manipulated with adjustments to the starch/biomass ratios. Algae-based bioplastics show promise as sustainable alternatives to petroleum-based plastics, specifically single use plastic items.</p>	
Summary Statement I used algae biomass (a typical waste product in biofuel production) to create plastic that was compostable in soil, water soluble, a natural fertilizer, and exhibited similar physical properties to conventional petroleum-based plastics.	
Help Received None. I designed, built, and performed the experiments myself.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Alicia Roice; Ashlyn Roice	Project Number S1119
Project Title Trash to Treasure: Biofuel from Agricultural Waste by Saccharification and Fermentation Using an Arduino Ethanol Sensor	
<p style="text-align: center;">Abstract</p> <p>Objectives Fossil fuels are non-renewable, and combustion of fossil fuels releases pollutants and greenhouse gases into the atmosphere, causing global warming. Ethanol is a renewable and environmentally friendly biofuel. It reduces carbon dioxide emissions by 60% compared to petroleum. 95% of US ethanol is produced from corn grain. Corn is a food grain and uses valuable agricultural land, making scaling up production of ethanol impractical. The purpose of our project was to produce ethanol from everyday waste materials like fruit and vegetable peels, paper and cardboard, and yard waste.</p> <p>Methods Phase 1. Pretreatment: Feedstocks prepared by drying and grinding to increase surface area. Samples heated in water bath for 30 minutes to expose cellulose. Phase 2. Enzymatic Saccharification: 1 mL cellulase enzyme added to samples. Samples then placed in incubator at 50 degrees Celsius for 24 hours. Phase 3. Fermentation: 1 gram yeast added to samples. Samples placed in incubator at 37 degrees Celsius for 24 hours. Four trials conducted for each sample for a total of 28 tests. Samples with no enzymatic saccharification was used as control. Glucose and ethanol readings taken before and after each phase. Used glucometer to test glucose. Arduino-based ethanol sensor used to measure ethanol content.</p> <p>Results All the samples produced varying amounts of ethanol. The orange and lemon sample produced highest amount of ethanol: 1.70% (by volume). The mixture of cardboard and paper produced 1.54% ethanol (by volume). The leaves and twigs sample produced least amount of ethanol - 0.79% (by volume). We combined the two samples that produced the most ethanol. This mixture of orange and lemon peel with cardboard and paper produced 1.92% ethanol (by volume).</p> <p>Conclusions Our hypothesis was partially correct. We hypothesized that cardboard and paper would produce the most ethanol and leaves and twigs will produce the least ethanol. However, mixture of orange and lemon peels produced the most ethanol. The leaves and twigs produced the least ethanol. Ethanol from agricultural wastes is cost-effective, renewable, and abundant. We believe it is a viable alternative to petroleum from fossil fuels, and helps with reducing pollution and waste.</p>	
Summary Statement We produced ethanol biofuel from various waste materials through enzymatic saccharification with cellulase and fermentation with yeast using an Arduino-based ethanol sensor for measuring ethanol content.	
Help Received Mr. Eric Harness at BioCurious provided us with space and equipment. Our parents took pictures and supervised us during experimentation.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Brantley Ryan	Project Number S1120
Project Title The Effects of Simulated Rain on Varying Types of Erosion Control Methods	
<p style="text-align: center;">Abstract</p> <p>Objectives The objective is to analyze different types of methods to minimize hillside erosion after a forest or hillside fire and define which method is the most effective in reducing sediment runoff. It must take into consideration cost of implementation and practicality.</p> <p>Methods In order to properly study the effect of varying hillside soil retention methods, a simulated hillside must be built. There will be 5 tested groups, the control group will be rye grass only. The experimental groups will be rye grass and mulch, rye grass with mulch and burlap netting, rye grass with straw, and rye grass with hydro-seed. The experiment will have a sample size of 3. The independent variable will be the varying soil retention methods used in each group. The dependent variables will be the amount of sediment run-off, and the weight of each sediment capture material to determine the amount of erosion. The hillside must be able to isolate the varying soil samples and retention methods. There are three phases of procedures; phase one set-up, phase two growth and monitor, phase three simulate rain and measure run-off.</p> <p>Results The results showed evidence that the Rye Grass with Straw method had the least amount of soil runoff and the entire root system was connected, demonstrating the strongest roots out of all the methods. There was a similar erosion outcome with the Mulch with Netting method, however, the root system was not as strong and would not be as universally practical and cost effective to implement. The Hydroseed and the Rye Grass method pulled out small clumps of soil, clearly demonstrating an ineffective method of erosion control. Finally, the Rye Grass with Mulch method pulled out in large clumps, which demonstrated a small root system and was extremely loose, so this method was also considered ineffective when compared to the Rye Grass with Straw method and the Mulch with Netting method.</p> <p>Conclusions This experiment undoubtedly displayed that using soil retention methods post hillside burn is beneficial and essential to keeping mudslides and erosion from occurring during rainfall. It was evident that the Rye with Straw method prevented erosion and sediment runoff the most effectively, as that was the method with the least amount of runoff, the strongest root system, and the most amount of grass growth. The Rye with Mulch Netting method also prevented soil erosion very well, but slightly less than the straw. It also fell behind in the growth of the grass over time. The Rye with Mulch method and the Hydroseed method both had increased amounts of sediment runoff, showing that those methods were ineffective at preventing erosion.</p>	
Summary Statement My project, "The Effects of Simulated Rain on Varying Types of Erosion Control Methods", is about identifying the most effective way to mitigate the threat against catastrophic destruction by mud slides in hillside burn areas.	
Help Received My father helped drive me to various places in order to gather supplies for my project. He also helped me build my raised platform and taught me how to use a mitre saw to cut wood. An employee from Lowe s Hardware Store cut the longer pieces of wood to my specifications. My mother helped me proofread my	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Mirabella Smith	Project Number S1121
Project Title Desalinating Water Using a Centrifuge and Varying Layers of Filtration	
<p style="text-align: center;">Abstract</p> <p>Objectives In this lab, an investigation was performed to determine whether centrifugal force would be able to remove salt from water. This project utilized technology (a centrifuge and personally designed centrifuge filters) in order to desalinate water, a process which can be used to aid in water reclamation and increase the supply of potable water within a community. Further, the design of this desalination system reduces the environmental impact of desalination in terms of a reduced material and energy footprint.</p> <p>Methods A saturated saline solution was exposed to centrifugal force via a small electric centrifuge (acquired through my high school physics department). In order to filter the salt from the saline solution, personally constructed filter capsule designs were placed inside plastic 5mm centrifuge tubes. Different combinations of filters were used to determine which materials provided optimal filtration. The three filter materials used were carbon (which was contained inside a cheesecloth capsule), coarse grain sand, and fine grain sand (both of which were contained in a cotton cloth capsule).</p> <p>Results Results show that the carbon and coarse sand filter combination removed 100% of the salt from the saturated saline solution. A T-Test was performed to determine that these results were statistically significant with more than 95% confidence. This indicates that desalination can be achieved using a centrifuge and the filter design used in this experiment.</p> <p>Conclusions Desalination using a centrifuge and the carbon and coarse sand filter design used in this experiment is possible, and because this method requires only one cycle of filtration, this method of desalination reduces the material and energy footprint left by traditional reverse osmosis desalination systems.</p>	
Summary Statement In this lab, a centrifuge and varying layers of filtration were utilized in order to attempt to desalinate a saturated saline solution.	
Help Received Julie Beckius, Andrea Brown	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Nathan Smith	Project Number S1122
Project Title Aqua Drone: A Novel Approach to Water Testing. An Autonomous Drone Used to Measure the Quality of Water	
<p style="text-align: center;">Abstract</p> <p>Objectives Currently, people see the practical use of drones in testing water with the scientists manning drones to collect water in dangerous situations such as that in Pit Lake. In Pit Lake, drones are used and the use of drones can be extended with the use of drones to avoid the trampling of virgin land in order to avoid disrupting the ecosystem. Engineering Goals: The goal of my project is to build a drone that has the ability to Test water autonomously, which will help relieve the problem of scientists getting hurt when testing for water quality. The drone will also have onboard testing which will make it more efficient than the current types of drones that take water to the lab to be tested.</p> <p>Methods In my project I 3D printed a drone and the landing gear in order to make something completely new. The drone was a 3D scanned drone, but was significantly modified by me in order to get the landing gears to work. The landing gears were designed by me to work on the drone I 3D printed. Getting the drone up and running I used many forums on the internet as well as people from my local hobby shop for guidance. The electronics (water testing) are Arduino boards with DF Robot PH, EC, and temperature sensors. In order to get these sensors to work together I had to download code on the internet, however these were not compatible with using the LCD screens I planned on. As a result, I had to modify the code to work with these screens, so I could see the results in real time.</p> <p>Results I based my results as a success or failure on whether or not I got an accurate reading from my drone. It did not matter whether the water was in good or bad condition, but rather I am basing it on a pass/fail basis. From the data collected I determined if there are algae blooms by analyzing the difference in PH from the morning and the evening. My results indicated that all the ponds tested had significant algae blooms, and thus the drone itself was a success. Of course improvements can be made, but the fact that it worked, makes this project a success.</p> <p>Conclusions This drone has the capability to revolutionize water testing. We can see in this day and age how manual labor that is not cost effective is being replaced by machines. Water testing is no different. Not only is it not cost effective, but testing water manually is potentially dangerous to the environment and the scientist. In the future expeditions to test the quality of water will look much different. Instead of a large group of</p>	
Summary Statement I built a drone with onboard water testing capabilities in order to test bodies of water in a much more cost and time affective way.	
Help Received I recieved advice materials for the electronics for the drone such as the power distribution board from an employee at RC Country Hobbies. The rest of the information I gathered was from the internet.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Ayushi Srivastava	Project Number S1123
Project Title The Milkweed Mesh: Cleaning Up Oil Spills in Aquatic Environments Using an Eco-Friendly Component	
<p style="text-align: center;">Abstract</p> <p>Objectives After horrific oil spills, think of a tainted image of minimal access to sunshine and prime gateways to deadly industrial chemicals for aquatic wildlife. In today's day, companies use an increased amount of compounds and bacteria to clean up their oil messes. These establishments do not belong in aquatic ecosystems and cause more harm than good. An eco-friendly solution, that is able to absorb industrial oil to clean the surface effectively without causing a chemical disturbance to wildlife, must be found.</p> <p>Methods Consumable materials include Milkweed plants (separated flowers and leaves), Water Spangles (Salvinia minima), and Dwarf water lettuce (Pistia stratiotes). The specific treatments include Cooking oil(Kirkland Oil to mimic a high viscosity substance for observation), water as constant and Petroleum (to imitate potential industrial oils). Software 3D Imaginer System: TINKERCAD is used to create an online prototype.</p> <p>Results Milkweed's seed pods' absorption rate for petroleum was 0.1oz/24 hours with a 0.04oz sample. For standard cooking oil, this rate of absorption was 0.15oz/24hrs. It absorbed negligible amounts of water. Overall, Milkweed's hydrophobic, cellulose-based seed pod fibers are greatly oil absorbent in comparison to the rates of other plant materials.</p> <p>Conclusions If Milkweed's seed pods and fibers can be inserted around tubes made up of polypropylene and mashed into a heavy paste to be laid throughout the net with the presence of water, then seed pods can repel water to attract the petroleum. This product could then be lifted once completely saturated and replaced with another mesh net to gather the crude oil up from the surface for proper disposal. As of now, there is no approved, fully eco-friendly method of oil spill clean up making this new research. It is incredibly important that wildlife is put as the priority when the environment comes into question and this mesh net aids in doing exactly that.</p>	
Summary Statement After observing the chemicals and harmful bacteria that are used to paradoxically "clean" water surfaces after oil spills, I used Milkweed's seed pods to create an eco-friendly mesh net that will absorb & recycle oil from the spill scenes.	
Help Received I spoke with UC Berkeley Alumni to direct my research on the creation of my online prototype of the mesh net. I also took the help of my dad while experimenting because the majority of my data collection was at home and required adult supervision.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Aditya Tadimeti	Project Number S1124
Project Title The Effects of Different Aquatic Environments on the Rate of Polyethylene Biodegradation by Bacillus subtilis	
<p style="text-align: center;">Abstract</p> <p>Objectives The purpose of this experiment was to determine if Bacillus subtilis could degrade High-density and Low-density polyethylene in Freshwater, Brackish water, and Ocean water environments. I hypothesized that rates of polyethylene degradation would be highest in Freshwater samples containing Bacillus subtilis.</p> <p>Methods I set up 72 30.0 mL test tubes each containing water and a uniform pre-massed strip of either HDPE or LDPE. I split the test tubes into 3 groups, the first one being Ocean water samples that were mixed with pre-made Instant Ocean chemicals, making for a salinity concentration of roughly 35 parts per thousand. The second group was comprised of Freshwater samples that contained no added chemicals, and the third group was comprised of Brackish water samples that contained a salinity concentration of roughly 15 parts per thousand. All test tubes were added with a low concentration nutrient medium, but the salinity concentration remained roughly the same after the addition. I streaked Bacillus subtilis from a cultured petri dish onto 8 HDPE and 8 LDPE pieces within each water group, leaving the remaining 4 HDPE and 4 LDPE pieces without bacteria to act as controls. After all the trials, I calculated an average rate of degradation for each aquatic environment with bacteria and compared it to the mass changes in its corresponding control.</p> <p>Results Overall, polyethylene samples in freshwater exposed to bacteria experienced the highest amount of degradation, with HDPE and LDPE pieces having an average of 5.79% and 5.77% decrease in mass respectively over a period of 1 month. Brackish water samples with Bacillus subtilis underwent a similar mass percent change, with HDPE and LDPE samples degrading by 5.08% and 5.30% respectively. Ocean water samples with the bacteria experienced the least amount of degradation, with HDPE and LDPE samples having an average of 3.61% and 2.47% decrease in mass respectively. Samples without the bacteria remained at approximately the same mass, having an average of a 0.04 % decrease in mass.</p> <p>Conclusions I hypothesized that the highest decrease in mass would be when polyethylene was exposed to Bacillus subtilis in freshwater at 35 degrees Celsius. This hypothesis was supported by the experiment. This conclusion is consistent with the theory of osmosis, which explains why Brackish water and Ocean water samples experienced less degradation. However, the ability for Bacillus subtilis to degrade polyethylene in a multitude of aquatic environments indicates the possibility for its use to tackle plastic pollution in the oceans.</p>	
Summary Statement I determined that Bacillus subtilis is capable of degrading HDPE and LDPE in Freshwater, Brackish water, and Ocean water environments.	
Help Received Mr. Jeff Sutton assisted me in using scientific instruments in our school laboratory. Aside from that, I designed, built, and performed all of the procedures in the experiment myself.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Visala Tallavarjula	Project Number S1125
Project Title Desertification Mitigation: To Grow Plants in Sand with Suppression of Percolation Water Loss Using Sequestered Carbon	
<p style="text-align: center;">Abstract</p> <p>Objectives Global population will exceed 9 billion by 2050. Food Production has to increase to meet the demand. Agriculture/Irrigation consumes 80% of the world's fresh water. Climate change is leading to increasing Aridity/Desertification and diminishing available water. This project focusses on methods to grow plants in sandier soils and also to reduce the amount of fresh water needed for irrigation by mitigating evaporation and percolation losses. Hypothesis: a) By using Percolation Control Layer (PCL) at the root zone it is possible to grow plants in the sand with a comparable yield to plants grown in soil, b) Compaction of PCL will improve water retention, and c) With PCL alone more than 25% water can be conserved.</p> <p>Methods Design of Experiments was conducted using nine samples. Water was added to the insert in the upper container until it begins to percolate through the netting base. After eight hours, the weight gain of the lower container is used to estimate water retention %. JMP statistical package was used to determine that compaction and PCL thickness had the largest impact on retention %. Radish and Kale were grown in containers with pure sand and with sand and PCL. Water addition was controlled to match the daily water loss over 70 days period.</p> <p>Results With PCL in the sand, both radish plants and kale plants show a 30% reduction in experimentally measured water use, while the plant weight and leaf size doubled. Theoretical predictions by Penman-Monteith calculation using local weather data agreed with experimental water usage. SEM images of roots grown in sand with PCL suggest microbial activity. Charcoal SEM shows 20µm pores while the hyphae of mycorrhizal fungi are 2µm wide.</p> <p>Conclusions The texture on the surface of the charcoal walls facilitates nutrient adsorption and mitigates the loss of nutrients through leaching. Soil can hold more carbon than the atmosphere, and hence carbon sequestration in the form of charcoal under the soil surface reduces net carbon dioxide emission. Compaction affects aeration of roots and requires further study. When plants grow at the boundary of the desert, soil erosion and desertification can be mitigated. Dense plant root structures will help to retain more water in deserts. PCL reduces water use by 30% while increasing plant yield by 30%.</p>	
Summary Statement With charcoal amended soil layer at the root zone percolation reduction, root health, carbon sequestration can be achieved in sandier soils.	
Help Received Dr. Greg Rudd, Technology Manager at Spectra-Mat, trained me to sputter my charcoal and root samples with gold and with sample preparation/imaging on the Scanning Electron Microscope (SEM). Dr. Fred Barez, San Jose State University mentored me discussing my ideas/experimental methods.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Jiaheng Wang	Project Number S1126
Project Title Contactless Buoyant Solar Desalination/Sterilization	
<p style="text-align: center;">Abstract</p> <p>Objectives The project focuses on avoiding fouling, the clogging of salt or left-over particles within a desalination device, by utilizing thermal radiation instead of heat conduction which achieves not only near max efficiency, but also superheats the evaporated steam within the system, while maintaining the goal of developing a buoyant, solar, and economical desalinators from previous year's research.</p> <p>Methods Theoretical models were first developed to predict numerous different temperature measures such as emitter, absorber, water, and steam. A simple lab-scale device was then developed using RVC foam and pyropel layers for insulation, and petri dishes for water reservoir. The simulated sun was at a constant 1000 W/m^2. Temperatures within the system was measured using thermal couples Properties of materials under infrared radiation were tested by using an infrared spectrometer and recorded electronically. A realized version of the device was then constructed. Temperature were measured using thermal couples.</p> <p>Results The cost of the device was around fifty dollars, which matched up with the cost model. Each temperature measure from both indoor and outdoor experiment matched up with the theoretical model, which then proved the prediction of an average of 2.8 liters of water generated each day from the device per meter squared.</p> <p>Conclusions In conclusion, thermal radiation is a viable mode of heat transfer to boil water under one sun illumination. In addition, the benefits of deploying thermal radiation configurations for desalinators bring new functionality such as low medical-grade sterilization to the device.</p>	
Summary Statement The project presents a breakthrough approach to water sterilization/desalination utilizing thermal radiation.	
Help Received All experiments were conducted independently in Rohsenow Kendall Heat Transfer Laboratory	