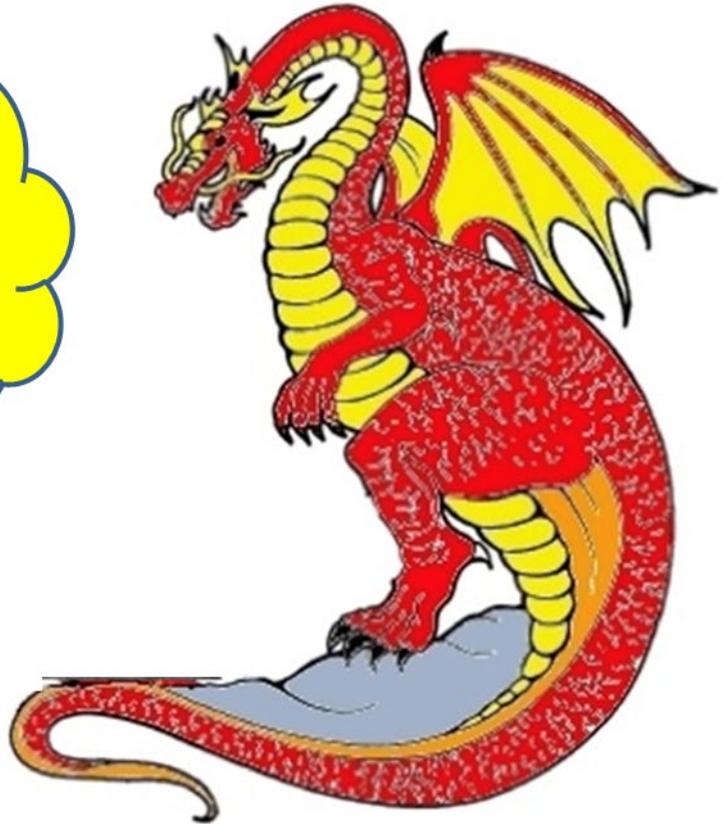


# ***THE RESEARCH DRAGON***

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less."  
-M. Curie



**COMMACK HIGH SCHOOL'S  
RESEARCH  
YEARBOOK**

**2019 - 2020**

Welcome to our Celebration of Science Research. We want to take the opportunity to pay tribute to the creativity, hard work, and success of our students over the past school year. Participating in the science research program requires personal commitment, dedication to the completion of a project from start to finish, and the enthusiasm to overcome the obstacles and enjoy the process along the way.

This year brought many new challenges, and many of the competitions our students would have been involved in were moved to new formats or, unfortunately, could not take place. The lack of an opportunity to share their science in no way minimizes the amount of work and dedication these students have put into their research. Being chosen to compete is an accomplishment in itself, as fair guidelines limit our numbers.

At each science fair that we were able to participate in, our students represented the Commack community in a respectful and professional manner. They were all well prepared and eager to share their efforts and results with science fair judges.

We recognize our students for their involvement and participation in the Commack High School Science Research program.

Thank you.

*Research Staff*

Ms. Andrea Beatty  
Ms. Jeanette Collette  
Ms. Alyssa DePinto  
Dr. Daniel Kramer  
Mr. Forrest Lipp  
Ms. Jeanne Suttie  
Mr. Matthew Zito

Dr. Alison Offerman-Celentano, Director of Science, K-12

*With gratitude, we would like to acknowledge the following people who have helped our staff and students in so many ways throughout the year to make our research program successful.*

Edris Anderson, Linda Andrews, Carol Barbagallo, Eric Biagi, Diane Cotter, Dr. Michael Cressy, Lisa DiCicco, Chris DiGangi, Fran Farrell, Kristin Holmes, Janet Husted, Paul Giordano, Dolores Godzieba, Keith Just, Dr. John Kelly, Dr. Barbara Kruger, Dr. Fred Kruger, Ricjhard Kurtz, Barbara Lazcano, Brenda Lentsch, Diana Lerch, Daniel Meeker, John Mruz, Frank Musto, Margaret Nappi, Dr. Stephanie O'Brien, Bill Patterson, Richard Schramm, Genny Sebesta, Thomas Shea, Dr. Lorraine Solomon, Laura Tramuta, Melissa Watkins, Fern Waxberg, Lois Webster, and Frann Weinstein.

Dr. Lutz Kockel, Stanford University, for his unwavering collaboration with the StanMack program.

Michael Litterello, Marc Caruso, Robert Dubriske, and our fabulous custodial staff.

Ms. Boritz, Ms. Shapiro, Mr. Keltos, Ms. Allen, Dr. Santorello, and the administrative staff for their continued support.

Dr. James, Ms. Newman, Ms. Ryan, Ms. Goldberg, Dr. Inforna, Mr. Cox, Mr. Santiago, and the members of our Board of Education for their support and recognition of our program.

# **SCIENCE FAIR PARTICIPATION**

## **REGENERON SCIENCE TALENT SEARCH**

Kimberly Liao – National Semifinalist  
SShamtej Singh Rana – National Semifinalist

## **REGENERON INTERNATIONAL SCIENCE AND ENGINEERING FAIR**

Ethan Sontarp - ISEF Finalist  
Jordan Walsh – ISEF Finalist

## **JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM**

*Students must apply to the symposium and be selected to present their projects.*

Emma Karadenes  
Ruth Lee – 3<sup>rd</sup> Place, Computer Science  
SShamtej Singh Rana  
Ethan Sontarp – 1<sup>st</sup> Place, Earth and Space Science, Advancing to Regional Competition

## **JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM, NORTHEAST REGIONALS**

Ethan Sontarp

## **TOSHIBA/NSTA EXPLORAVISION PROGRAM**

Ashley Hsu  
Zeynep Tasoglu  
David Yang

## **MEDICAL MARVELS CHALLENGE**

Ashley Moon – 3<sup>rd</sup> Place  
Melina Nicou – 3<sup>rd</sup> Place  
Lakxshanna Raveendran - 3<sup>rd</sup> Place

## **LONG ISLAND SCIENCE AND ENGINEERING FAIR, ROUND 1**

*(Round 1 finalists advance to LISEF 2 for awards)*

Defne Aktuna  
Candace Arneaud  
Michael Chacon  
Theresa Haupt  
Kimberly Liao  
Izza Malik  
Ashley Moon  
SShamtej Singh Rana  
Lakxshanna Raveendran  
Ethan Sontarp  
Rohan Surana  
Jordan Walsh  
Mariam Zahran  
Chapin Zerner

## **LONG ISLAND SCIENCE AND ENGINEERING FAIR, ROUND 2**

*No Special Awards Given for 2020*

Defne Aktuna – Honorable Mention, Animal Science  
Michael Chacon – Honorable Mention, Animal Science  
Ethan Sontarp – 3<sup>rd</sup> Place, Earth and Environmental Science

**LONG ISLAND SCIENCE AND ENGINEERING FAIR, JV DIVISION**

*Fair Cancelled for 2020*

Gavin Cressy  
Ashley Hsu  
Michael Jang  
Sarah Levine  
Harry Poulouse  
Zeynep Tasoglu  
Mariam Waqar  
David Yang

**NEW YORK STATE SCIENCE AND ENGINEERING FAIR, ISEF DIVISION**

*Fair conducted virtually with no Special Awards for 2020*

Defne Aktuna  
Candace Arneaud – High Honors  
Michael Chacon  
Theresa Haupt  
Kimberly Liao – High Honors  
Izza Malik – High Honors  
Ashley Moon  
SShamej Singh Rana  
Lakxshanna Raveendran  
Ethan Sontarp – Lightning Round Selection, Highest Honors, ISEF Finalist  
Rohan Surana – Lightning Round Selection, High Honors  
Jordan Walsh - Lightning Round Selection, Highest Honors, ISEF Finalist  
Mariam Zahran  
Chapin Zerner

**WAC LIGHTING FOUNDATION INVITATIONAL SCIENCE FAIR**

*Fair Cancelled for 2020*

Defne Aktuna  
Candace Arneaud  
Samantha Borre  
Michael Chacon  
Wonjong Choi  
Gavin Cressy  
Emily DiPrima  
Mikayla Elferis  
Theresa Haupt  
Ashley Hsu  
Michael Jang  
Emma Karadenes  
Charlson Kim  
Grace Kim  
George Lee  
Matthew Lee  
Ruth Lee  
Sarah Levine  
Kimberly Liao  
Izza Malik  
Ashley Moon  
Madeline Pettit  
Harry Poulouse  
Faizali Rahim  
Lakxshanna Raveendran  
Marlee Reiter  
Funda Sahin  
SShamtej Singh Rana  
Kiera Spahn  
Ethan Sontarp  
Rohan Surana  
Zeynep Tasoglu  
Louis Viglietta  
Jordan Walsh  
Maryum Waqar  
Angela Won  
David Yang  
Mariam Zahran  
Chapin Zerner

**THE KATHY BELTON SCIENCE FAIR AT MOLLOY COLLEGE**

*Fair Cancelled for 2020*

Gabriella Barth  
Benjamin Bloom  
Rishin Chatterjee  
Richard Clements  
Kristin Colluro  
Lorenzo Cristiano  
Justin Davitashvili  
Jack Giovannini  
Mikayla Giramonte  
Jeremy Gordon  
Ethan Gullo  
James Haupt  
Sydney Kalmaer  
Alisha Khan  
Lia Maglione  
Marissa Mauro  
Matthew Pace  
Grace Papazoglou  
Heetak Ra  
Shreya Sriram  
Colin Suszczynski  
Asmaa Zahran  
Jeffery Zhou

**LONG ISLAND SCIENCE CONGRESS – JUNIOR DIVISION**

*Fair Cancelled for 2020*

Brandon Berkhoff  
Calvin Bode  
Christopher Buscemi  
Magdelene Byrd  
Matthew Campisi  
Jasmine Carpio  
James DeBenedetto  
Gian Carlo DiFava  
Ryan Dituro  
Christian Dreyer  
Lola Duff  
Dominick Faini  
Sarah Franzen  
Julianna Gembs  
Tiana Geter  
Madeline Gottlieb  
Kevin Henris  
Aareb Jatoi  
Devin Kirschner  
Ashley Lewis  
Meiya Lin  
Patricia Lubin  
Alasdair Newman  
Warnakulasuriya Perera  
Robert Petruzzi  
Gavin Primis  
Max Schweitzer  
Daniel Shoemaker  
Inaya Syed  
Bryan Youn  
Bryan Yuk  
Marnie Ziporkin

**LONG ISLAND SCIENCE CONGRESS – SENIOR DIVISION**

*Fair Cancelled for 2020*

Ethan Abbe  
Jayson Bromberg  
Annika Chang  
Wonjong Choi  
Lindsey Chung  
Anthony Citera  
Krish Dayal  
Jessica DeYulio  
Katerina Efthymiou  
Elena Gnilitzkaya  
Nicholas Greco  
Avi Gupta  
Steven Homenides  
Eric Huang  
Robin Hwang  
Kylie Iannuzzi  
Daphne Koutsoukos  
Karen Li  
Sally Ma  
Abigail Pappachen  
Jayden Prestiano  
Brennan Thomann  
Caroline vonHof

**NEW YORK STATE SCIENCE & ENGINEERING FAIR - ANDROMEDA DIVISION**

*Fair Cancelled for 2020*

Victor Angielczyk  
Daniel Baek  
Nathan Cheung  
Alyssa Collado  
Joseph Cramer  
Elizabeth Demacopolous  
Jordan DiPrima  
Jason Duffe  
Nicholas Gembs  
Mia Goren  
Brianna Han  
Emily Hartman  
Amy Held  
Annabelle Hohne  
Gina Kim  
Christian Kraus  
Yashica Kumar  
Aspen Levine  
Flora Lin  
Amy Liu  
Alexis Maikowski  
Jane Maloney  
Eshani Mukherjee  
Evan Ni  
Melina Nicou  
Daniel Realmuto  
Alexa Scotti  
Joseph Strickland  
Amber Syed  
Kevin Tuzinowski  
Nicholas Vazquez  
Michael Zareif

**NEUROLOGICAL SURGERY P.C. HEALTH SCIENCE COMPETITION**

*Fair moved to Virtual Format for 2020*

Gavin Cressy

Krish Dayal

Jessica DeYulio

Jordan DiPrima

Theresa Haupt- 8th Place Biology - Microbiology/Genetics (\$500)

Steven Homenides

Ashley Hsu

Karen Li- 4<sup>th</sup> Place Bioengineering and Computational Biology (\$1,000)

Kimberly Liao

Sally Ma

Ashley Moon

Evan Ni

Melina Nicou

Harry Poulouse- 4<sup>th</sup> Place Biology - Microbiology/Genetics (\$1,000)

Lakxshanna Raveendran

Zeynep Tasoglu

Maryum Waqar

Mariam Zahran

**SAAWA FAIR**

*Fair Cancelled for 2020*

Lindsey Chung

Jessica DeYulio

Jordan DiPrima

Nicholas Greco

Anabelle Hohne

Steven Homenides

Gina Kim

Flora Lim

Amy Liu

Melina Nicou

Abigail Pappachen

Shreya Sriram

Amber Syed

Asmaa Zahran

## **STUDENT SUMMER RESEARCH PLACEMENTS**

*Each year, Commack students participate in a variety of summer research opportunities. These diverse experiences include;*

Angion Biomedica Laboratories  
Brookhaven National Lab High School Summer Research Program  
Cold Spring Harbor Internship Program  
Cold Spring Harbor Laboratory DNA Summer Camp  
Cold Spring Harbor Laboratory Partners For The Future Program  
Dr. Bessie F. Lawrence International Summer Science Institute  
Engineering Summer Academy at University of Pennsylvania  
Genome Science at DNALC  
Huntington Breast Cancer Action Coalition  
New York University Biology Department  
ICaRe Cancer Research Program at SUNY Old Westbury  
I-Stem Biotech Scholars Program  
iResearch Institute  
Independent research laboratory assignments  
SUNY Stony Brook Garcia Program  
SUNY Stony Brook Simons Summer Research Program  
SUNY Stony Brook Laboratories  
SUNY Stony Brook Biotechnology Summer Camp

# ABSTRACTS

## STANMACK PROGRAM

*Emma Downey, Matthew Feigenbaum, Nicholas Greco, Marina Khan, Sophia Mastroianni, Sarah O'Connor, Abigail Pace, Caitlin Tolentino*

### **Exploring the Function and Development of Insulin-producing cells in *Drosophila melanogaster* with the Goal to Improve Diagnosis and Treatment of Diabetes.**

*Drosophila* are highly suitable for research since they serve as a model for studying the role of the transposable element. Mechanisms of glucose homeostasis are conserved between flies and humans, and the fruit fly allows for easier access for conducting genetic manipulations when compared to the common rodent model.

The goal of this project is to create a stable stock of *Drosophila* with a gene analogous to the human gene. By the end of this project, a unique line of fruit flies could be used to study insulin-producing cells in *Drosophila*, comparable to the human gene. Transposons are sequences of DNA that move from one location in the genome to another using a cut and paste mechanism. This transposable element would migrate from the X chromosome to the second or third chromosomes. This project began by creating an F0 cross using females from the Bloomington *Drosophila* Stock Center (BDSC) fly stock line (StanEx1) and males with the gene for transposase, which cuts out the transposable element and allows it to jump into another part of the genome. From this cross, jump starter males were found based on phenotypic attributes that carried the StanEx1 gene and crossed with Double Balancer virgin females. From the F1 cross, males with the StanEx1 gene transposed from the X chromosome to another were found. These males were crossed with virgin Double Balancer females. Afterwards, a brother-sister cross was performed using the same phenotypic offspring from the F2 generation to create the F3, where the stock would then become stable and only contain flies who have the StanEx1 gene either on chromosome 2 or chromosome 3.

After stable stocks were achieved, flies from each line were then picked and prepared for a process known as inverse PCR, by first digesting and ligating the fly DNA. Inverse PCR is a process that amplifies the genomic fly DNA. By using select primers, the P-element and the DNA around it can be isolated and then sent out to be sequenced. Afterwards the DNA can then be located using online databases. Once the P-element has been located, it can then be sent to Stanford for use in their ongoing research. Successful students have the opportunity to achieve publishable research.

# **SENIORS**

***Ethan Abbe***

## **Looking at Regeneration Rate of the Planarian *Dugesia dorotocephala* in Regard to Varying Concentrations of Imidacloprid Solution.**

Imidacloprid is currently the most widely used insecticide in the world, but it has had many side effects, such as causing colony collapse for bees via the killing or disorienting of the bees. Imidacloprid, a neonicotinoid is a systemic insecticide that acts as an insect neurotoxin. Because imidacloprid bonds more strongly with insect neurons than mammal neurons, it presents minimal risk to humans upon exposure. Planarians, specifically *Dugesia dorotocephala*, are commonly used as model organisms due to their prevalence and sensitivity to environmental changes, and often are used to visualize the effect a pesticide may have on an ecosystem. One way this is studied is by monitoring regeneration rates in transversely cut planarians. The purpose of this experiment is to test the effect of imidacloprid based pesticides on *Dugesia dorotocephala* as a model organism to study its effects on local ecosystems and environments. The methods used to obtain the data is exposure and cutting. To get the data, the planarians are put into a solution whole for a week to become accustomed to their new environment. Once a week has passed, the planarians are cut in half transversely and the half that contains the head is removed from the solution. Then the planarian regeneration rate is recorded and added to a data table. To refine the data after being put in the table the mean of each concentration are found and then the results are run through a Z test to determine if they are statistically significant.

***Candace Arneaud, Izza Malik***

## **The Effect of *Aster amellus* and *Carex morrowii* on the Absorption of Metals in the Groundwater**

The accumulation of heavy metals is recorded yearly along the coast of Long Island to ascertain any potential health concerns. One way to address the issue of heavy metal pollution is through phytoremediation. Phytoremediation utilizes either terrestrial or aquatic green plants to remove, contain, inactivate, or degrade environmental pollutants. The purpose of the investigation was to determine whether terrestrial plants *Aster amellus* (Aster) and *Carex Morrowii* (Japanese Sedge) could be possible phytoremediators. These plants were chosen because plants in their families have shown signs of phytoremediation due to their expression of genes such as metal chelator, metal transporter, metallothionein (MT), and phytochelatin (PC). The plants were tested for being an adequate phytoremediator based off whether they could absorb levels of arsenic, chromium, barium, lead, silver, mercury, selenium, and cadmium, which were administered to the plants through the soil prior to experimentation. The concentration of heavy metals was tested each week for six weeks using the Bruker S1 Titan XRF spectrometer. The soil and parts of the plant were tested twice a week, to determine any uptake of the metal solution.

Statistical tests on the X-ray sample data and the Bioconcentration Factor and Accumulation Factor were evaluated. *Aster amellus* illustrated the most success after testing. The bioconcentration factor of barium, arsenic, chromium, and lead were significant enough to label *Aster amellus* a phytoremediator. On the other hand, *Carex morrowii*, lacked evidence to be considered a successful phytoremediator.

***Wonjeong Choi***

### **The Effect of High Fat Diet Feeding in *Drosophila melanogaster* on the Upd2 Protein**

Obesity is a serious concern since it is linked with numerous health risks. Controversy surrounds the role of the fat-cell-produced hormone, leptin. Its function is to regulate fat storage and the number of calories taken in. Since leptin is produced by fat cells, the more body fat an individual carries, the more leptin is produced. To study the process of obesity and the leptin hormone, *Drosophila melanogaster* were used. Rajan et al. discovered a protein, Upd2, and when Upd2 reaches the brain, it regulates insulin secretion. This, in effect, “tells” the fly to store nutrition and expend energy on growth. This study looked at significant changes in triglyceride concentration of *D. melanogaster* under normal feeding and high fat diet (HFD) feeding then going back to normal feeding to conclude if there was resistance to the Upd2 protein. Due to the sexual dimorphism between males and females of *D. melanogaster*, only the male flies were experimented. Six tubes of normal food were prepared for the flies. Then three tubes of high fat diet food were prepared following the HFD Feeding Assay protocol. The Triglyceride (TAG) Colorimetric Assay protocol was followed to measure the TAG content of the flies. It was hypothesized that there will be a significant difference in the triglyceride concentration in *D. melanogaster* when under normal feeding and HFD feeding then going back to normal feeding concluding that there is a resistance towards the protein Upd2. Thus far no results were obtained due to the pause in research. For further study, the leptin stimulant, Omega-3 fatty acids, and its relationship with leptin and obesity can be studied.

***Anthony Citera***

### **Optimizing the Catalytic Activity of Mixed-Metal Oxides for Converting Solar Energy to Fuel**

Hydrogen gas is a clean energy carrier, similar to electricity, meaning that it can be used to move, store, and deliver energy in a form that can be easily used. H<sub>2</sub> is a product of the electrolysis of water and the HARPOON project is able to provide a possible way to discover a catalyst that could aid in optimizing the photoelectrochemical water splitting reaction. Metal nitrates can catalyze the half reactions of water into O<sub>2</sub> and H<sub>2</sub> and allows for the production of renewable electricity. By observing the amount of O<sub>2</sub>(g) released by each catalyst, their effectiveness was quantified and aided in the understanding of what oxides will allow for the greatest yield of energy. Calcium, copper (II), and erbium nitrates were spotted on an FTO-coated plate in varying. The plate was put into a kiln, in which the nitrates became oxides. The electrode was then observed under UV light and the amount

of O<sub>2</sub>(g) produced by the spots on it were analyzed using the computer program, ImageJ. This allows the measurement of “brightness values”, which represent the O<sub>2</sub>(g) production of a given spot on the electrode array. The relationship between varying the percent of Er within each solution and the catalyst activity calculated from the brightness values obtained was able to be overserved. It was seen that Er does increase catalyst activity of oxides, but to an extent as the optimal amount seen in this investigation was 20%. The ability of the lanthanide used means that cheap metals could be used to solve one of the most demanding tasks asked by our world today.

***Elizabeth Demacopoulos, Amy Held***

### **The Effect of Sulfur (S) and Calcium Sulfate (CaSO<sub>4</sub>) in Remediating Germination of *Phaseolus vulgaris* in Saline Environments**

A prevalent concern of the twenty-first century is climate change and the consequential increase in salinity of soil, causing a decrease in plant germination. Therefore, due to potential food impact, it is essential to discover a feasible method to remediate the plants affected. In a recent study, calcium has been shown to partially alleviate the salinity of soil and mitigate growth inhibition by allowing the sodium to be leached from rainfall or irrigation. Sulfur has also been shown to ameliorate the conditions of the soil through chemical features which suppress the uptake of harmful and toxic elements in the water that negatively impact germination. To model a saline environment, *Phaseolus vulgaris* seeds were soaked in a 3.5% sodium chloride (NaCl) concentration was utilized to model the salinity of the ocean. Various amounts of calcium sulfate (CaSO<sub>4</sub>) and elemental sulfur (S) were added to petri dishes of soil and *Phaseolus vulgaris* seeds to determine if either are effective at restoring normal germination processes in saline environments. The petri dishes were left in sunlight and the percent of seeds germinated was measured. According to the data collected, as the concentration of calcium sulfate increases in the petri dish, percent germination of *Phaseolus vulgaris*, in saline soil increases. CaSO<sub>4</sub> had a positive effect in the highest concentration, 7.00%, with a statistical difference since the p-value is .030. Also, with the addition of elemental sulfur in each petri dish, percent germination of *Phaseolus vulgaris* in saline soil increases. Sulfur had the strongest positive effect in the middle amount of sulfur, 5.00%, with a statistical difference since the p-value is 0.007002402. This shows promise for remediating the germination of plants in salty environments as a result of climate change.

***Emily DiPrima, Mikayla Elferis***

### **The Positional Effect of a Phenolic Hydroxyl Group in Cinnamic Acid Derivatives on Antimicrobial Activity**

The purpose of this experiment was to investigate the antimicrobial properties of cinnamic acid and various coumaric acids, on *Staphylococcus epidermidis*. Cinnamic acid derivatives, especially those with phenolic hydroxyl groups, are well-known antioxidants and have shown to have several health benefits due to their strong free radical-scavenging

properties. It was hypothesized that o-coumaric acid, m-coumaric acid, and p-coumaric acid would inhibit the growth of bacteria more so than cinnamic acid. It was expected that each acid would display a zone of inhibition against bacteria. To carry out this experiment, a culture of *S. epidermidis* was spread on an agar plate. Antibiotic disks soaked in cinnamic acid, o-coumaric acid, m-coumaric acid, and p-coumaric acid solutions were used as the experimental variables. After one day of incubation at 37°C, the zone of inhibition was measured with an electronic caliper. Cinnamic acid and o-coumaric acid were the most effective compounds tested. p-Coumaric acid was the least successful compound tested. It had a statistically smaller zone of inhibition when compared to the other variables ( $p < 0.05$ ).

***Mikayla Elferis – See Emily DiPrima***

***Nicholas Gembs, Alexis Maikowski***

### **The Change in Land Area of Texas Wind-Tidal Flats from 1980-2016**

The coastline of Texas is home to many unique environmental biomes, one of which is the wind tidal flat. Recent events, such as hurricanes and apparent rising sea levels, are a danger to this distinct biome due to its proximity to the coast and low elevation. This project will determine the change in land area of wind tidal flats on the Texas coast to recognize any trends in biome area. In this experiment, MATLAB will be used to program and collect elevation data. Using the packages *M\_map*, *Intermap*, and *vterrain*, elevation points will be gathered along the Texas coast and barrier islands from 1980 - 2016. These points will be compared to the sea level at the time to determine which points are above or below sea level. It is predicted that due to the rise in sea levels over the past 40 years, land areas of wind tidal flats on the Texas coastline have decreased. Coastal erosion and strong waves create less sea-level landforms and a more drastic slope between low and high elevations. Due to unforeseen circumstances, we were unable to collect data for area change on Matlab. In the future, we expect to resume our experiment and complete our original procedure. Results were expected to illustrate a decrease in land area of the Texas barrier islands from 1980-2016, with more drastic effects in the tidal-flat biome due to its mid-level elevation. With these results, we can continue to connect habitat loss and declining populations of coastline species to rising sea levels and decreasing biome diversity.

***Theresa Haupt***

### **Outer Membrane Vesicle and Tube Formation in Francisella**

*Francisella novicida*, a laboratory strain of *Francisella tularensis*, produces outer membrane vesicles and tubes (OMVT) under specific media and growth conditions. OMVT have been associated with several known *Francisella* virulence factors, providing evidence for their role as a special secretion system during host cell invasion. A major focus of OMVT studies is elucidating the mechanisms underlying their production. Using a genetic screen, several hypo-vesiculating mutants were identified as genes of interest. Two of the strongest hypo-vesiculating genes, *FumA* (fumarate hydratase, an enzyme

involved in carbon metabolism) and *FTN\_1037* (unknown protein), were chosen to investigate their roles in OMVT production. This was explored by analyzing their sub-cellular localization in tube producing bacteria. The goal was to fuse these genes with green fluorescent protein (*gfp*) using overlap extension PCR, and track their localization, with respect to tube formation, using fluorescence microscopy. It is believed they may be located within a bulb that had been revealed from cryoelectron tomograph images near sites of OMVT production. The constructs were prepared in the *Francisella* expression vector - *PFNLTP6* and transformed into *E. coli* and *F. novicida*. Microscopy was used to verify that the *gfp*-tagged proteins are functional and to study their localization. This study will help acquire more knowledge about the role of *FumA* and *FTN\_1037* which would ultimately help in understanding the mechanisms that regulate OMVT production.

*Amy Held – See Elizabeth Demacopoulos*

*Emma Karadenes*

### **Matrix Metalloproteases as Inflammatory Factors in Vestibulodynia**

This study demonstrates an innovative approach for identifying specific inflammatory markers responsible for patients developing vulvodynia. By using vaginal rinse specimens (at the source of inflammation) it was reported by PI of the project and CO-Investigators that IL-8, with its ability to activate neutrophil granulocytes, emerged as an undoubted marker in vestibulodynia. MCSF (Macrophage Colony-Stimulating Factor), and GM-CFS (Granulocyte-Macrophage Colony-Stimulating Factor), may act together with IL-8, stimulating the production of macrophages and dendritic cells and taking part in inflammation and pain development. However, whole groups of cytokines and chemokines were downregulated in vestibulodynia patients. All the above suggests that vestibulodynia appears to be a result of non-classical cytokine-mediated inflammatory and pain syndrome, where IL-8 is the prominent marker on inflammation and pain syndrome. Many biochemical and inflammatory marker studies in vulvodynia patients, use blood and look at systemic inflammation, not at the local inflammatory response, as well as in vitro experiments. Also, taking into consideration that ILs, and IL-8 in particular, are mediating Matrix Metalloproteases (MMPs) to be released from neutrophils, MMPs are involved into vulvodynia symptoms with high probability. In addition, the correlation between the critical markers of inflammation and microbiome of the vagina in vulvodynia is not studied. Exploring levels of lactic acid producing bacteria (Lactobacilli), and Gardnerella, Streptococcus, Enterococcus, etc. as well as their correlations with MMPs production, was used to focus research on the direct mechanism causing neuropathic pain in vestibulodynia. MMPs are a family of enzymes which contribute to the degradation of the extracellular matrix and are involved in the regulation of leukocyte migration, inflammation, and wound healing. MMPs also appear to be the modulators of neuropathic pain, and more, play an important role in this process. Revealing the mechanisms and accurate characterization of biological & inflammatory substances participating in the development of this widespread and debilitating condition will help to discover targets for vulvodynia treatment. This research examines the role of MMP and the vaginal microbiome in the mechanism

responsible for vulvodynia (vestibulodynia). There is a connection between IL-8 and MMP-9 that was identified. IL-8 was significantly elevated and MMP-9 in vestibulodynia is significantly higher than in controls ( $p < 0.05$ ). The TIMP1 expression is also higher, however the p value is .06.

***Charlson Kim***

### **CNN-LSTM Based Automatic Diagnosis of Schizophrenia Using EEG Input**

Schizophrenia is a serious mental illness that interferes with a person's ability to think clearly, manage emotions, make decisions and relate to others. It is a complex, long-term medical illness and is estimated to affect a range from 0.25% to 0.64% of U.S. adults. While neuroimaging studies have provided compelling evidence of both structural and functional brain abnormalities in schizophrenia, electrophysiological studies have also reported findings such as shortened fronto-central distributions of electroencephalogram (EEG) microstates which aid in diagnosing this disease. The proposed method of diagnosis was the use of Convolutional Neural Networks (CNN) and Long Short Term Memory Networks (LSTM) to analyze Schizophrenic, EEG data as CNNs utilize convolutional filters to identify visual features and LSTMs incorporate memory to analyze time series data. FFT (Fast Fourier Transform) processed EEG data from Kaggle, CEONreprod, and Moscow State University was employed as the input training vectors and the models were built using Jupyter Notebook, Tensorflow, TF-Slim, and TFlern. The data was split into two groups: healthy and schizophrenic, while the architecture of the model consisted of 3 Time-Distributed Convolutional Layers, 2 LSTM layers and a series of Dropout, Batch Normalization, and Dense layers. The program utilized a variety of machine learning techniques such as xavier initialization for weight initialization and step decay, exponential decay, linear scaling, learning rate warmup, stateful/stateless for fine-tuning. The final method to evaluate the program's performance was a confusion matrix to test false negatives and false positives.

***Christine Kong (with Bhawan Sandhu, Lawrence HS)***

### **A Novel Nafion-free Proton Transport Membrane for the Proton Exchange Membrane Fuel Cell**

As an alternative energy source that does not produce greenhouse gases, Proton Exchange Membrane Fuel Cells (PEMFCs) provide a method of producing clean energy through the oxidation and reduction of hydrogen and oxygen gas, with H<sub>2</sub>O emitted as the only by-product. The electrons of the oxidized hydrogen ions travel through a wire to perform work, while the hydrogen ions (protons) migrate to the cathode through a membrane that is impermeable to electrons. Currently the most commonly used proton transport membranes are made of Nafion, a fluorinated ion conducting polymer. However, Nafion's limitations include its high cost, sensitivity to hydration, and its degradation at higher temperatures. This research has created a fuel cell membrane using inexpensive and widely available cellulose filter paper as a scaffold to support Resorcinol bis(diphenylphosphate) (RDP), an

oligomeric phosphate ester flame retardant which possesses high heat stability. The combination of RDP on cellulose filter papers, when tested on the fuel cell, enabled significant power output. To further enhance proton conduction, cellulose filters were treated with phosphoric acid, citric acid, and sulfuric acid, respectively, before the application of RDP, and then tested on a hydrogen fuel cell at temperatures ranging from 30°C to 90°C. Amplified power output was exhibited even at higher temperatures, as much as 300% more than RDP on an untreated cellulose membrane. Ion exchange was conducted on each type of treated membrane. Results suggest an easily fabricated yet novel approach for creating a new generation of cost-effective, thermally stable proton-conducting membranes for PEMFCs.

***Kimberly Liao***

**Identification of a Model Agnostic Disease Driver in Non-alcoholic Steatohepatitis; Implications for Drug Development**

Non-alcoholic steatohepatitis (NASH) is a disease characterized by excess lipid deposition, inflammation and scarring of the liver and is closely associated with obesity and diabetes. NASH, which begins as non-alcoholic fatty liver disease (NAFLD), can further progress to NASH with increasing levels of fibrosis, cirrhosis and even hepatocellular carcinoma (HCC). This disease is predicted to become the leading cause of liver transplants in the next five years, suggesting dire need for new treatment options. However, there currently are no FDA-approved drugs for NASH, and a number of therapeutics that has met success in the laboratory has fared poorly in clinical trials. Therefore, this study utilizes a model agnostic transcriptomic approach to identify a disease driver. A gene being relevant in multiply models suggest a greater likelihood of playing a role in human NASH as a disease driver. Adult mice were separated by three treatments: fast food diet (FFD), FFD + thioacetamide, and FFD + CCl<sub>4</sub> + glucose water; the 3 produced models each represent a stage of the NAFLD progression. Histopathological features were semi-quantitated on the basis of NAFLD activity score (NAS) and for fibrosis severity. Transcriptomic analysis was conducted through quantitative polymerase chain reaction (qPCR). Based on mRNA data, the majority experienced increased expression in the models representing NASH with fibrosis. However, the *gpat1* gene was sustained across all three models studied. The early detection and continued expression of *gpat1* and its strong correlation with NAS suggests functional significance in human NASH.

***Alexis Maikowski – See Nicholas Gembs***

***Izza Malik – See Candace Arneaud***

***Faizali Rahim, Funda Sahin***

**An Analysis of the Effects of Guar Gum and Carrageenan on *Escherichia coli***

Processed foods contain various chemicals that are added to prolong time for spoilage and to increase desirable flavoring. However, there are claims that processed foods containing guar gum and carrageenan put us at risk for many negative health effects. In this study, these two additives were used to find their effect on commensal gastrointestinal bacteria, such as *E. coli*. The purpose of this study was to determine the effect of different quantities of guar gum and carrageenan on *E. coli* and their IC<sub>50</sub>, which is the chemical ability to stop the biochemical functions of living things. It was hypothesized that as the concentration of the chemicals increase, the detrimental effect on *E. coli* will also increase. A killing curve method was used to undergo this experiment. It was found that *E. coli* growth was slowed as the chemical concentrations increased. The result of this project is that the chemicals tested do have an effect on the growth of the bacteria. Specifically, the light absorbance of the bacteria decreased as more chemicals were added. Since the light absorbance decreased, fewer bacteria were alive to disturb the path of the light, meaning that the chemicals are able to decrease the population of the bacteria. The spectrophotometer readings show that the net light absorbance for guar gum went from 1.14 at no chemicals to -0.09 at 250 microliters of guar gum. These effects can be similarly seen using the carrageenan, where the net light absorbance went from 1.18 without carrageenan to 0.37 with 250 microliters of carrageenan. These results support the idea that the chemicals have an effect on the growth of the bacteria.

***Funda Sahin – See Faizali Rahim***

***Joseph Strickland, Alexa Scotti***

**The Effect of Different Types of Coastal Defense Structures on Coastal Flooding**

Coastal areas are often densely populated due to socio-economic reasons or tourism. Coastal flooding may occur due to functional and structural failures of natural barriers or coastal defenses. Coastal flood defenses are the first lines to protect these low-lying areas against risks posed by flooding. Damage to these areas can range from loss of lives, physical damage to structures and infrastructures, and even environmental changes. The water level and wave height acting on coastal defenses are also thought to be affected by the rising sea level due to climate change, therefore, these structures must be able to last from deterioration. Areas unprotected by any coastal defenses have naturally suffered the most damage making it is necessary to perform an analysis assessing the performance of coastal flood defenses. The goal of this project was to test different coastal flood defenses, to determine which has the minimal water surge from rising water levels. These included coastal designs of different shapes, angles and the use of rocks. A wave tank was created with an inclined coastal slope. The different coastal defenses were placed on the shoreline and waves were generated at the opposite end of the tank. The amount of water that collected beyond the defense was recorded. Thus far data collection is still on-going.

*SShamtej Singh Rana*

### **Wildfire Prediction and Reduction for the West Coast of the USA Using a Neural Network Approach**

In the first ten months of 2019, on the west coast of the United States, more than 40,000 wildfires burned about 3.2 million acres of forest, costing over \$900 million in damages, in addition to 44 known deaths and 170,000 evacuations. In recent years, a surge in wildfire cases lead to the research of better methods of forecasting wildfire climate. In this study, a neural network was developed and climate data was input to a neural network to determine the current and future wildfire danger. A Feed Forward Neural Network (FFNN) for classification tasks was incrementally trained to make predictions of future fire weather. FFNN outputs were used to predict effective fire prevention solutions. The system was trained and tested using open source climate data from 2018-2019, and forest images from google.com. The FFNN uses temperature (°C), relative humidity (%), total precipitation (mm), wind speed/direction (mph), mean sea level pressure (kPa) and shortwave radiation (sfc). The classification network performs at an accuracy of 0.963, representative of high classification strength and dependability on Neural Network predictions.

*Ethan Sontarp*

### **Modeling Uranium Uptake in Fossilized Teeth and Bones: Potential for Long-Term Uranium Waste Storage**

Oxidized uranium (U) is soluble in groundwater and can be incorporated in or adsorbed to porous materials it encounters in the environment. In the early stages of fossilization, mammal teeth and bones provide this environment through bacterial decay and mineralization of the previously living tissue. The purpose of this study is to quantitatively model the uptake of uranium in porous biomaterials to 1) predict age of fossilization for samples whose origin is unknown, and 2) to understand the systematics of an exponential falloff uranium uptake in phosphates in order to improve the function of nuclear waste remediation tactics. Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) was utilized to determine isotopic ratios and ultimately calculate the isotopic age for a small elemental map spanning several of the hydroxyapatite-bearing biomaterials. Uranium concentrations were in the thousands of ppm for sections of dentine and under 100 ppm for sections of enamel. A model was devised based off the isotopic age equation to describe the uptake history of uranium in several fossilized biomaterials. Parameters for the model were described by an exponential fall off of uranium (U) uptake, with the initial U being zero and lead (Pb) only being produced as a product of decay. Simulated and measured data assured a good fit for the model's predictive property. Conjugate gradient technique was utilized to solve for local values of initial uptake, e-folding time, and predicted age, with the e-folding time for the bone sample being 1.3 Ma, and the tooth 0.9 Ma, respectively. These provide insight into the process of uranium uptake in porous biomaterials to further the knowledge of nuclear waste sequestration, as both porous materials had a rapid uptake history. Porous phosphates are worthy materials for the remediation of high concentrations of uranium waste and are

able to hold uranium for millions of years of time, even under destructive geological conditions.

### *Louis Viglietta*

#### **A Novel Method of Measuring the Kinetics of Iodide Catalyzed Hydrogen Peroxide Decomposition Using Oxygen Gas Concentration**

Hydrogen peroxide is a oxidant used both domestically and in industrial processes. In homes, it is commonly sold as an antiseptic or bleaching agent, whereas in industrial processes, it is more frequently used for bleaching. However, it is extremely unstable, spontaneously decomposing into water and oxygen gas. This process can be facilitated by both heterogeneous and homogeneous catalysts, including iodide ions and some transition metal ions. Hydrogen peroxide's sensitivity to such small amounts of common impurities affect its storage. It is often sold in dark plastic bottles to limit exposure to light but contact with metal and other compounds in industrial processes can cause premature decomposition. Thus, the purpose of this project was to further analyze the kinetics of catalytic hydrogen peroxide decomposition using a novel method involving the measurement of oxygen concentration. In each trial, 20.0 mL of hydrogen peroxide was added to a Nalgene water bottle in a water bath. Next, 1.000 mL of a potassium iodide (KI) catalyst was added into the reaction mixture and a Vernier oxygen sensor was used to cap the bottle. Oxygen percentages were measured over three minutes using Logger Pro, and then the process was repeated three times at each of five temperatures. Activation energy was calculated by creating an Arrhenius plot using the temperatures and calculated rate constants. It was hypothesized that as time proceeded, the oxygen concentration would increase but rate of oxygen production would decrease, as the reaction is first order with respect to hydrogen peroxide. Experimental data supported the hypothesis, and the activation energy was calculated to be 77.7 kJ/mol. This yields a percent error of 39%, indicating that oxygen gas monitoring may not be an extremely viable method of measuring hydrogen peroxide reaction kinetics.

### *Mariam Zahran*

#### **Identification of Disease-Driving Nodes in Acute Kidney Injury; TGF $\beta$ , An Acute Kidney Injury to Chronic Kidney Disease Driver**

Acute kidney injury (AKI) can be characterized by acute tubular necrosis (ATN) which is the inflammation and the death of tubules in the kidney due to decreased glomerular filtration. AKI is a sudden onset of kidney failure or kidney damage that occurs within a few hours or days. AKI is common among those who are hospitalized, especially in the intensive care unit. One in five hospitalized patients develop AKI and were associated with an increase in the likelihood of death. If AKI transition into chronic kidney disease (CKD) it can be much more dangerous and fatal. CKD is harmful because it causes kidney failure and can also harm many other body systems. In this study, banked renal tissue and H&E-stained renal sections induced with AKI were used to observe ATN and score them on a 0-

5 scale. The kidneys used were previously induced with AKI using folic acid, domoic acid, and mercury chloride. The one gene that was observed is TGF $\beta$  to observe the transition between AKI to CKD. A quantitative polymerase chain reaction (qPCR) was conducted to determine whether TGF $\beta$  is upregulated when AKI is induced and as the AKI becomes CKD. I observed that as the ATN score increases, meaning that AKI is transitioning to CKD, TGF $\beta$  is more greatly upregulated. The positive correlation found concludes that TGF $\beta$  is a gene that causes the transition from AKI to CKD causing a deadly condition. If TGF $\beta$  can be downregulated once AKI is found, then it will prevent the less harmful disease, AKI, from transitioning to CKD.

*Michael Zareif*

### **The Effect of Saturated and Unsaturated Fatty Acids on the Amount of Time Lye Soaps Take to Dissolve**

Soap is used on one's hands, face, and even body as it is the conventional tool people use to clean themselves because it is very effective at preventing unwanted germs or disease that can otherwise be on skin. Soap bars found in bathrooms always manage to rapidly dissolve, as they are used daily. Soaps are salts containing negatively charged fatty acids and positively charged ions. Throughout the 19th century, the discovery of many different fatty acids in neutral oil and fats led to a much better understanding of the soap making process. The purpose of this investigation was to determine which type of fatty acid will allow the greatest amount of soap production. It was hypothesized that saturated fatty acids will help increase the amount of soap produced, helping make soaps last longer because they often contain longer hydrocarbon chains which allows them to have stronger fatty acid properties such as stability. The desired fatty acid was added to sodium hydroxide and heated. Afterwards salt was added, and the solution was filtered through a funnel to separate the soap content. The soaps were massed to determine which had the greatest quantity. Thus far results show no difference between the saturated and unsaturated fatty acids and no difference within the types of fatty acids.

# **UNDERCLASSMEN**

*Defne Aktuna, Michael Chacon*

## **The Role of Aversive Conditioning in Scent Discrimination in the Green Crab (*Carcinus maenas*)**

In the Northwest Atlantic, green crabs have decimated shellfish and eelgrass populations since the 1800s which resulted in a decline in the fishing industry. Green crabs use their acute sense of smell to track or locate their next meal. They also have chemoreceptors on their antennae that enable them to identify chemicals in the water and sense their environment. Green crabs can be conditioned to go against their natural behavior by a reward, or penalty. The purpose of our project was to see if we could aversively condition green crabs to avoid a scent, and still recognize the conditioned scent once it was presented with other scents. During the baseline, each crab was introduced to four scents five times in a random order (bunker, shrimp, clam and bluefish). The crabs then transitioned to a conditioning phase where they were only presented with one scent, followed by the introduction of a pseudo-predator which was rapidly moved around the crab to disturb it. The final phase was post-conditioning, where the crabs were introduced each of the four scents again, in random order to see if they reacted aversively to the conditioned scent while having natural behaviors towards the other scents. The results showed that the crabs conditioned to clam had the best retention rate (90% aversive reaction) while those conditioned to shrimp had the worst retention rate (70% aversive reaction). The crabs were able to reverse their innate behavior by avoiding the fish and shellfish. They also displayed their ability to discriminate between scents and aversively condition to them as well.

*Victor Angielczyk, Daniel Baek*

## **Creating a Device for People with Limited Range of Motion to Put on a Jacket**

Many people who suffer from a limited range of motion have difficulty in their daily routines, especially the elderly or those with physical disabilities. For this population, a daily task such as getting dressed becomes difficult. Devices have been designed to improve daily activities of people with physical disabilities. Devices designed for the upper body aid a person in activities such as grooming, cooking, dressing, and extending one's reach. Patients with weak muscles can use these devices to provide them strength to a weak limb, thereby, making actions that require precision easier. The purpose of this project was to design a device to allow people to put on a jacket who are incapable. The population that this device focuses on are those with muscle issues and are unable to raise their arms up. The goal was to create a lightweight and easy-to-use device, to accomplish this, a mechanism was 3-D printed to be adjustable to accommodate various sleeve sizes. A magnetic apparatus was utilized to clamp to the sleeve that will pull it up so the person's arm can be inserted. The device will reduce frustration and help a person with limited range of motion to be able to put on a jacket while unaided, making them feel more independent.

***Daniel Baek – See Victor Angielczyk***

***Gabriella Barth, Marissa Mauro***

### **A Study of Drug Effects on Ladybugs**

Ladybugs, *Coccinellidae*, are a type of beetle that can be found all around the planet. Nicotine is a stimulant in small doses for humans but can be a pesticide for certain species of insects. According to one study, nicotine and tobacco act as a natural insecticide because of the toxicity of nicotine alkaloids. The purpose of this investigation was to determine the effect of nicotine as an insecticide on ladybugs, using data previously collected in the field the behaviors of the ladybugs' eating habits compared to other insects. It was originally hypothesized that the ladybugs would get addicted to the nicotine, however the experiment later uncovered that they were dying quickly after being exposed to the substance. For example, in one week our group went from having about 38 ladybugs to about 27 after introducing them to nicotine on food. Throughout the experiment we found that the ladybugs died at a rapid pace with the nicotine, especially as the doses and exposure increased. These observations may be used to develop effective future pesticides.

***Brandon Berkoff, Daniel Shoemaker***

### **The Effect of Airfoil Shape on the Aerodynamics of an Airplane**

This study was done so that an airfoil design could be found that will make an aircraft more aerodynamic. If an aircraft is more aerodynamic, then it is safer and requires less fuel. Fuel is very expensive for aircraft so any fuel saved will add up and make air travel cheaper. Aircrafts that are more aerodynamic use less fuel, and therefore produce less pollution. To find an airfoil design that is more aerodynamic, 5 different airfoil designs were 3D printed and a small-scale wind tunnel was made. Vapors were pumped from dry ice through the wind tunnel so the airflow around the airfoils could be visualized. All the airfoils were tested at 3 speeds and at 3 different angles. It was found that the airfoil that was thin and had a teardrop design was most aerodynamic, airfoils that have a sharp front are not aerodynamic and that the teardrop design that was thicker wasn't aerodynamic. These results are significant because it shows what kinds of airfoils are aerodynamic and best to use on an aircraft. The hypothesis was that the teardrop design would be the most aerodynamic. The results supported the hypothesis.

***Ben Bloom, Lorenzo Cristiano***

### **The Effect of Sound Frequencies on Ant Behavior**

As more land is urbanized, there is less room for ants and other insects to live and they start moving into people's homes and apartments causing structural damage and costing homeowners thousands of dollars in damage. They are vectors that carry pathogens. The increase of ant populations living inside homes is a threat to personal health and safety.

Some of these diseases include *E. coli*, *Shigella*, *Salmonella*, and *Staphylococcus*. As a result, companies make traps that contain poisonous chemicals such as borax, cyfluthrin, and fipronil that are harmful to young children. This increases the need for safer methods to deter ants. Our methodology is to purchase harvester ants from Carolina.com along with a cage to hold the ants in and sand for the ant's comfort. We then used a JBL Flip 4 speaker to test frequencies on the ants by putting the speaker in the cage. We then left ants in our controlled environment without any frequencies playing to collect data for our control. After that we left the ants with the frequencies playing ranging from 23,000-25,000 Hz for 5 minutes each at intervals of 250 Hz. We then recorded any unusual behavior while the ants were with the speaker. From 23,000 to 24,000 Hz the speed and erratic behavior of the ants had increased very quickly, while from the 24,500-25,000 Hz it had slowly increased but then it had plateaued. These qualitative data show that frequencies from 23,000-25,000 affect how ants socialize, and it may affect where they colonize. This is important to help switch over to a safer method to deter ants because it lets people use these high frequencies to deter ants instead of toxic chemicals.

***Calvin Bode, Gavin Primis***

### **The Effect of Home Remedies on the Growth of *E. Coli***

It has been said that different household items can be used as cures or relievers of illnesses such as honey for a sore throat. The purpose of this experiment is to investigate how other not so well-known household products such as apple cider vinegar, cinnamon, ginger, garlic, turmeric, marshmallow root, peppermint oil, and mint affect bacterial growth when compared to a control (water) plate. Another reason this experiment was performed was to prove that there is a less expensive and more accessible alternative to antibiotics. In order to demonstrate how well the lesser known household remedies work, they were tested against *E. coli* on a plate by saturating a paper disk with each specific substance and then compared them to a control plate with water by measuring the zone of inhibition using a caliber. At the end of the experiment, there was no strong evidence that any of the remedies had a huge effect. However, apple cider vinegar, which has an average zone of inhibition of 15.75mm and garlic, which had a zone of inhibition of 11mm, worked the best out of all of them. The ones that proved least effective were mint which had a zone of inhibition of 6.5mm and marshmallow root which had a zone of inhibition of 7mm. Although some remedies worked better than others, each household remedy made a noticeable visual difference when comparing them to the water control plate. The purpose of this study was to obtain information that would help people in the future with a sickness involving bacteria look for a more natural remedy that works, rather than using antibiotics.

***Samantha Borre, Grace Kim, Madeline Pettit, Angela Won***

### **Color Preference of Painted Ladies as Caterpillars and Butterflies**

The Painted Lady (*Vanessa cardui*) is one of the most common butterfly species in the world and can be found in all parts of the United States, Mexico, and most of Canada.

Caterpillars have the unique ability to see colors using their skin. An experiment launched by a team in Communications Biology demonstrated that caterpillars can activate genes that oversee controlling vision in their skin and head. The purpose of this experiment was to identify if Painted Ladies can see colors by observing whether they choose the color blue or green, and if their choices stayed the same as adult butterflies. The main source of food for caterpillars is plant leaves, so if Painted Ladies are placed in a maze with two different colored paths, then it is expected that the caterpillars will take the green route rather than the blue route. After constructing the maze, food was then placed on each of the routes so their color choice would be unbiased. As a result of six trials (three trials for caterpillars and three trials for butterflies), it was determined that twelve caterpillars and seven butterflies preferred green. This is important as it may help farmers or gardeners protect their growing crops from being infested by unwanted pests.

***Jayson Bromberg, Eric Huang***

### **The Effect of Regeneration on Addiction Retention in *Dugesia dorotocephala***

*Dugesia dorotocephala*, also known as brown planarians, are a type of flatworm with an unusually complex nervous system for its size. As a result of this, they are often used by scientists in behavioral and drug studies to simulate our own nervous system. Planarians also have the ability to completely regenerate from virtually any injury; this includes their nervous system. In order to test the limits of this, we investigated if planarians could retain an addiction after regeneration. To do this, one group of planarians were subjected to an ethanol solution and one to a nicotine solution. The planarians' stress-induced seizure-like movements (pSLM) in one of the drugs were recorded. Each planarian was then decapitated and moved to another petri dish with artificial pond water (APW) until it regenerated completely. Each planarian was then placed back into its original drug and the pSLMs were recorded. The number of pSLMs before and after regeneration were compared in order to determine if there was a significant difference between the two data sets. Although most of the research is ongoing, the current data gathered shows a significant difference between the pSLMs before and after regeneration in the nicotine trials.

***Christopher Buscemi, Matthew Tobias***

### **Testing the Effect of Carbon Dioxide and pH on Aquatic Snails.**

The intention of the research is to learn how simulated global warming effects will affect behavior, survival, and environment of Aquatic Snails. Global warming was simulated by adding carbon dioxide into the snails' habitat. The pH was measured after the addition of carbon dioxide to determine how increased CO<sub>2</sub> could affect the acidity of the water. After observing the snails in the experimental group and control group, the data was recorded and compared the additional carbon dioxide was the deadly factor when exposed to the snail population. The pH was found to be to be insignificant in any behavioral pattern or survival of the snails. After increasing and decreasing the pH, the snails died so that shows it was not the pH but it was the change in carbon dioxide. These results show how the

melting of glaciers causes more carbon dioxide in the ocean environment and that may be especially harmful to multiple species living there. The hypothesis was not supported by the data. There were not many behavioral changes. The snails did not move closer to the top of the tank as predicted.

***Matthew Campisi, James DiBenedetto, Kevin Henris***

### **The Effect of Heat and Cold Shock on The Behavior of Ghost Shrimp**

The objective of the study was to determine the effect of sudden changes in temperature on the behavior of aquatic life like ghost shrimp. The study began by setting up three tanks of the same dimensions six inches in length and width and a foot in height, filling each tank with the same amount of water and ghost shrimp. The tanks were surrounded by graph paper with boxes measuring 1 cm x 1 cm. The hypothesis stated that if Ghost Shrimp are shocked with cold temperatures, then their movement will increase because rapid movement leads to increased heat energy produced in the organism. If Ghost Shrimp are shocked with hot temperatures, then their movement will increase because they will attempt to escape the rising temperature as a natural response. Each tank was divided into three separate groups (hot, cold, and room temperature). The number of boxes moved along the X, Y, and Z axis was counted from the graph paper and recorded for the 3 shrimp in the standard water temperature of 20 °C for 10 minutes. Researchers proceeded to run the experiment again, this time with tanks at 30 °C and another at 5 °C. It was discovered that at 30 °C the shrimp were much more active than they were before, moving twice as much the control run. In the tank at 5 °C the shrimp went into shock and were not moving at all to conserve warmth. In the control group, the relative same amount of movement remained the same. The hypothesis was not supported by the data. In the heat shock tank, the shrimp moved more than in the control experiment. In the cold shock tank, the shrimp went into shock and stopped all movement. This data could be used for further research from scientists about the potential effects of global warming on the behavior of aquatic animals.

***Jasmine Carpio, Meiya Lin***

### **The Effect of Dog Saliva on the Growth of *E. Coli***

Saliva is a type of fluid in the mouth used to break down food, but it also plays a large role in many other functions as well. Saliva contains a biologically active substance called Lysozyme which enhances healing by subduing infections. Additionally, IgG, IgM, and IgA antibodies found in saliva can identify foreign substances and promote the killing of bacteria. The antibacterial properties of saliva were tested by plating *E. coli* with saliva and measuring the zone of inhibition after a period of two days. The purpose of this is to provide evidence for the use of saliva against *E. coli* found in feces. If the *E. Coli* is exposed to saliva of a Rhodesian Ridgeback, then there will be an increase in the Zone of Inhibition but, if *E. coli* is exposed to only water, there would not be an increase in the Zone of Inhibition. This is because dog saliva contains Lysozyme which breaks chemical bonds and attacks bacteria and the water does not have the same antimicrobial properties as saliva.

In a tested experiment, a Zone of Inhibition appeared around the filter disk that contains saliva at a diameter of ten millimeters. During the tested experiment, the control that contained distilled water resulted in a Zone of inhibition of zero millimeters in diameter. This data supports the hypothesis as it provided evidence to the claim that dog saliva does contain antimicrobial properties. The study of saliva against the bacteria, *E. coli*, can support that saliva can help better understand behavioral adaptations like maternal licking.

***Michael Chacon – See Defne Aktuna***

***Annika Chang, Katerina Efthymiou***

### **The Effect of Vitamin D on the Gene Expression of *dat-1* in *Caenorhabditis elegans* Modeling Parkinson's Disease**

As average life expectancy increases, Parkinson's disease (PD) is becoming more prevalent among the elderly population affecting about 5% of people over the age of 85. PD is characterized by the formation of Lewy bodies, abnormal aggregates of protein, and the loss of dopamine neurons in the brain. SLC6A3 gene, an ortholog to the *dat-1* gene in *C. elegans*, aids in the production of proteins called dopamine transporters or DAT that resorb synaptic dopamine. The purpose of this investigation was to determine the effect of vitamin D on the expression of the *dat-1* gene in *C. elegans*. It was hypothesized that higher concentrations of vitamin D would increase the expression of the *dat-1* gene as the active form of vitamin D is seen as a neuroprotectant because it maintains calcium levels in nerve cells. It also affects neurotrophic factors, like the nerve growth factor (NGF) which is responsible for neuron differentiation. The experimental groups were exposed to vitamin D varying in different concentrations and the control had no vitamin D. The Qiagen RNA easy RNA extraction kit was used to extract RNA from the *C. elegans* and RT-PCR was performed to amplify the *dat-1* gene. Gel electrophoresis was used to determine the gene expression in each group. Thus far results have been inconclusive as the gel electrophoresis proved unsuccessful. However, we anticipate to collect data that was in line with the hypothesis that higher concentrations of vitamin D, like 50 000 IU, would result in an increase in the expression of *dat-1* gene compared to lower concentrations like 1, 000 IU due to the neuroglial effects of vitamin D discussed in our hypothesis.

***Kevin Chen***

### **Experimental Determination of Sinkhorn Limits**

A stochastic matrix describes the transitions of a Markov chain. A Markov Chain is a probability model whose transitions are independent from how it arrived at its current state. The maximum likelihood estimation of a stochastic matrix can be found by alternately scaling the rows and columns, whose elements converge to a limit. The purpose of this project was to develop conjectures about the sinkhorn limit of a matrix, and from those conjectures, attempt to develop a formula for the exact value of the limit. Utilizing the functionality offered by Mathematica, a short program was written to scale a matrix's rows

and columns repeatedly, following the Sinkhorn-Knopp algorithm. Analysis was completed using methods unique to Mathematica, such as the RootApproximate and MinimalPolynomial functions. The project successfully found a formula for the limit of a 2x2 matrix with only computer experimentation which was confirmed by previous investigations. The polynomial generated by the MinimalPolynomial function when used on an element of the output matrix, had a power specific to the size of the matrix. A 2x2 matrix produced a quadratic polynomial, a 3x3 matrix produced a degree 6 polynomial, and a 4x4 produced a degree 12 polynomial. In addition, the coefficients of the 3x3 case polynomial were notably similar to the elements of the 7<sup>th</sup> layer of Pascal's Triangle.

***Nathan Cheung***

### **The Loss of Ampicillin Resistance due to the SOS Response**

The SOS response is a mechanism that is triggered in bacteria in response to the damaging of its DNA. When the mechanism is activated, the process to repair the DNA begins, this prompts low fidelity DNA polymerase to begin to repair the DNA. Low fidelity DNA polymerase unlike high fidelity DNA polymerase, which is used to replicate DNA, is extremely prone to errors which leads to hypermutation. While high fidelity DNA polymerase is more accurate and more efficient the upside to low fidelity DNA polymerase is that it can still replicate DNA past damaged bases. The purpose of this study to determine whether hypermutation could be utilized to remove ampicillin resistance in bacteria as a path to further understand antibiotic resistance and its possible removal. Data was to be collected by exposing multiple cultures of *E.coli* resistant bacteria to ultraviolet light, to induce the SOS response. Comparisons of turbidity were to then be made of the culture at 24, 48, and 72 hours to cultures not exposed to the UV light, after the addition of ampicillin. It was hypothesized that when the SOS response was prompted the bacteria would begin to hypermutate increasing the chance of the removal of the resistance gene and would cause a larger decrease in turbidity. A statistically significant decrease in the turbidity after the addition of the ampicillin compared to the turbidity before would point to a successful removing of the mutation, which would support the hypothesis.

***Lindsey Chung, Abigail Pappachen***

### **The Effects of PETase Derivatives on Phytoplankton Populations**

Every year, around 8 million metric tons of plastics enter the ocean. The presence of plastics in water is killing marine life and destroying ecosystems. The most common type of plastic water bottles is made of polyethylene terephthalate, also known as PET. This material can take hundreds of years to degrade naturally. Recently, a PETase enzyme was discovered, in *Ideonella sakaiensis* bacteria, that can biodegrade PET (polyethylene terephthalate). Phytoplankton are autotrophic, which provide oxygen as well as nutrients for other oceanic organisms. They are producers and the foundation of oceanic ecosystems. In areas crowded with plastics, phytoplankton cannot receive sunlight for photosynthesis. The purpose of our experiment was to see if PETase derivatives affect phytoplankton

populations which determines if PETase is safe to use on oceanic plastics. Since PETase degradation of PET results in terephthalic acid, it was used as the derivative in this experiment. Erlenmeyer flasks, with a 4.5% concentration of phytoplankton, were cultured for 5 days, then the number of cells was recorded on a spectrophotometer at a wavelength of 443  $\mu\text{m}$  for a 14-day period. Various concentrations of terephthalic acid were added to each beaker respectively (2.5ml, 5 mL, 7.5 mL, and 10 mL). We hypothesized that there would be a negative effect on phytoplankton because previous studies have shown benzoic acid, which is bound to a PETase derivative, had decreased phytoplankton populations. Therefore, terephthalic acid, a product of PET degradation, should also decrease phytoplankton populations. We found this to be true for the various terephthalic acid concentrations, and anything above 5.0ml of terephthalic acid had no further effect as the graph plateaued. Hence, using PETase to degrade PET in oceanic ecosystems is more harmful than beneficial to a marine environment.

***Richard Clements, Jack Giovannini***

### **Ant Movement and Behavior in Response to Specific Sound Frequencies**

As more land is urbanized, there is less room for ants and other insects to live. Because of this, they start moving into people's homes and apartments causing structural damage and costing homeowners thousands of dollars in damage. These ants are vectors that carry pathogens to other species, and the increase of ant populations living inside homes is a threat to personal health and safety. Some of these diseases include E. coli, Shigella, Salmonella, and Staphylococcus. As a result, companies make traps that contain poisonous chemicals such as borax, cyfluthrin, and fipronil that are harmful to young children. This increases the need for safer methods to deter ants. The methodology process in our experiment is to purchase harvester ants, along with a cage to hold the ants in, and sand for the ant's comfort. After setting up the environment for the ants, a JBL Flip 4 speaker is used to test frequencies on the ants by putting the speaker in the cage. Then the ants were left in the controlled environment without any frequencies playing to collect data for our control. After that, the ants were left with the frequencies playing ranging from 20,000-22,500 Hz for 5 minutes each at intervals of 250 Hz. After the time of frequency was over, notes would be taken on the ants behavior, noting several elements such as the speed of ants, amount of food the ants ate (if there was food in the environment), and the ants location in the container. From 20,000 to 21,500 Hz the speed and erratic behavior of the ants had increased very quickly, while from the 21,500-22,500 Hz it had slowly increased but then it had plateaued. These qualitative data show that frequencies from 20,000-21,000 affect how ants socialize, and it may affect where they colonize. This is important to help switch over to a safer method to deter ants because it lets people use these high frequencies to deter ants instead of toxic chemicals.

***Alyssa Collado, Jane Maloney***

### **Impact of Radio Frequency Waves on the Regeneration of Planaria**

In the modern 21<sup>st</sup> century the use of smartphones is common among adolescents as it has become an essential part of life since it is a way people stay connected. These mobile cellular devices emit radio frequency radiation (RF) through the transmission of signals. This form of radiation can produce heat that is absorbed through materials containing water, which is threatening to humans because the body is made up of 70% water. Radio frequency radiation can have damaging effects to the human body especially regarding the brain and tissue closest to where the phone is utilized. Due to the scientific controversy over the health risks associated with cell phone affects on humans, further studies need to be done. The purpose of this project is to study how RF waves affects planarian regeneration as a result of tissue damage. Planarian are known for their extraordinary regenerative capacity and are easily maintained. We hypothesized that planarians exposed to RF waves will regenerate at an abnormal and slower rate, and the longer the exposure the greater the effects. Planaria were divided into three groups: a long length phone call, a short length phone call and a group without any RF exposure from a cell phone. A parabolic reflector was used to emit radio frequency waves from the antenna of a cell phone onto the planaria. Planaria were cut in half and eye regeneration rates was observed under the microscope. The research achieved in this experiment could bridge knowledge gaps on health issues related to the effects of smartphone usage on human brain tissue. This era of technology is new and cell phones have been prominent in our society for only a short amount of time, therefore, their effects on the human neurological system is limited.

***Kristen Collura, Grace Papazoglou***

### **The Effect of Ethanol on the Scent Choice of Fruit Flies (*Drosophila melanogaster*)**

As the population of fruit flies increases, many people want to understand ways to repel them. Fruit flies contaminate food consumed by people and ruin crops through the transfer of harmful bacteria. Ethanol is determined to be a key odorant/scent for the fruit flies, but it is imperative to study this hypothesis in order to understand more about the substances that attract and repel *Drosophila melanogaster*. The purpose of this experiment was to determine if, and how, ethanol affects the scent choice of fruit flies between apple cider vinegar and banana. Using a fly choice chamber that was created specifically for this experiment, the amount of time it took for the flies to make their decision, and which scent was chosen, were recorded. After multiple trials, it was determined what scent they were drawn to the most, and then ethanol was added to the least chosen scent. The flies were then put in the chamber again to discover if ethanol would attract the flies to the least chosen scent. It was hypothesized that ethanol would impact their choice and the flies would be drawn to the ethanol. Results indicate that ethanol is a key odorant for the flies due to the data that demonstrates their change in decision. In the first round of trials without the ethanol, the scent chosen the least was apple cider vinegar. Out of the 30 trials, 22 flies chose banana and 8 flies chose apple cider vinegar. After the addition of ethanol to the apple cider vinegar, the banana scent was chosen the least, therefore indicating that ethanol

impacted their decision. Out of the 30 trials with ethanol, 10 flies chose banana and 20 flies chose apple cider vinegar and ethanol. These conclusions may be used to develop effective ways to repel fruit flies in the future.

***Joseph Cramer***

### **Multiple Sclerosis Progression Based on Past Patient Records**

Multiple Sclerosis (MS) is a degenerative auto-immune disease that affects millions of people around the world. MS is a disease that attacks the myelin sheath around a nerve cell's axon causing inflammation and damage. This sheath is essential for the transportation of electrical impulses around the body if damage messages will be altered. In this investigation, the Sylvia Lawry Centre for Multiple Sclerosis Research database (SLCMSR) was used to collect data. This database includes thousands of past patients' records providing a look into how a patient progressed with the disease. Four types of data were analyzed to predict how the multiple sclerosis will take course in a patient's body. These included age of onset, disease duration, baseline EDSS, and attacks during the last 12 months. This data showed how frequently a patient had an episode, how long the episode lasted for, and how damaging their MS when it first presented itself. This purpose of this investigation was to determine if you can predict a newly diagnosed patients progression based on previous patient records. This can have important implications for Multiple Sclerosis Patients' disease progression in the future and possible treatments options.

***Gavin Cressy***

### **The Effect of Isolated Neurological Agents on Huntington's Disease in *C. elegans***

Neurodegenerative disorders occur when neurons in the brain and spinal cord begin to deteriorate. This initially impairs balance, movement, memory, and speech, but can lead to paralysis and even threaten one's life. Damage to axons, responsible for transmitting neural impulses between cells, can cause a decline in physical and cognitive function. Huntington's Disease (HD) is a neurodegenerative disorder caused by a CAG trinucleotide repeat, which results in the production of defective protein that can block axonal impulses. To study a potential treatment for HD, *Caenorhabditis elegans* (*C. elegans*) was used as a model organism. *C. elegans* possesses the LIN-14 gene, associated with the prevention of axonal degeneration. A wild-type strain of *C. elegans* was used. Worms were exposed to 0.03 M caffeine, allantoin, and omega-3 solutions, as these compounds exhibit positive properties associated with brain health. *C. elegans* were then observed using a thrashing assay under a microscope once a day for three consecutive days where each s-movement was recorded in 30 seconds. It was hypothesized that worms exposed to neuroprotective substances would increase the number of thrashes per minute and that worms that lacked exposure would decline in the number of thrashes per minute over the three-day interval. However, based on data collected, there was no significant statistical difference found between the number of thrashes made by wild-type worms that were exposed to

neuroprotective substances and those that lacked exposure. Therefore, there seems to be no significant effect of isolated neurological agents on phenotypic response in *C. Elegans*.

***Lorenzo Cristiano – See Ben Bloom***

***Justin Davitashvilli, Heetaek Ra***

**The Effect of Alpha Pinene on a Student's Cognitive Ability to Memorize and Perform Well on an Assessment**

Alpha pinene is an organic compound of the terpene class that is found in many essential oils such as peppermint, rosemary, lavender, basil, and cinnamon. Previous studies prove that alpha pinene helps with anxiety and short-term memory within in the hippocampus of the brain. The purpose of the experiment was to determine if there was a correlation between different essential oil scents and a student's ability to memorize and perform well on a vocabulary word assessment. Fifty students were randomly selected students and separated into two classrooms, one classroom with a specific scent and the other not containing a specific scent. Using a 15-word vocab list, the students were given the task to memorize and later recall in a certain time frame. We recorded the data via google survey. Our hypothesis was when students were exposed to the alpha-pinene scent in an isolated area, it will help benefit the cognitive ability to memorize vocabulary words because the familiar odor will help to trigger a recollection of specific odors correlating with the memory of the given vocabulary words. We were anticipating collecting data which showed that students that were exposed to the scents of rosemary, peppermint and lavender received scores that were 5 points or higher than the students that were not exposed to any scents. We anticipated that the students exposed to the scent would finish the test faster and also memorize the words better.

***Krish Dayal, Sally Ma (Siyang)***

**The Relationship Between Areas with High Particulate Matter and Age on the Incidence of Annual Deaths Caused by Air Pollution**

The fast industrialization experienced by many countries has led to a greater concern for environmental pollution. Air pollution particles result in serious health effects, as the pollutants can cause respiratory illness along with other negative health issues such as cancer. In the United States, the EPA currently regulates particles in two size ranges, PM10 and PM2.5, referring to particulate matter size less than 10 mm and less than 2.5 mm respectively. Understanding key factors influencing human exposure will help to develop successful control strategies and reduce health impacts of particulate matter. The purpose of this study was to investigate global associations between areas with high particulate matter and the incidence of respiratory illness and lung disease based on the population's age. As people age their immune system becomes weakened making them more susceptible to air pollution and the associated adverse health effects. We hypothesize that cities with higher pollution would positively correlate to an increased incidence of annual respiratory-

related deaths in its aging populations. Data was collected from the 2018 World Health Organization Ambient Air Pollution Air Quality database, the Index Mundi and the Breathelife2030 website. Results show there is no correlation between respiratory deaths and areas with higher particulate matter associated with age. Due to limited data sets further studies needs to be done.

***Jessica DeYulio, Steven Homenides***

### **The Effect of Octopamine on The Memory of *Drosophila melanogaster***

Alzheimer's Disease is one of the most prevalent forms of dementia which affects an estimated 5.2 million Americans. Patients affected by Alzheimer's Disease endure severe cognitive problems that impair both their working memory and long-term declarative memory (general knowledge and personal memories); and there is a rapid cognitive decline which leads to a premature death. *Drosophila melanogaster*, the fruit fly, is considered a model organism for studying human disorders due to its genetic similarities and short life span. The objective of this project is to study if octopamine (an epinephrine-like neurohormone in invertebrates) has any ability to improve the memory of Alzheimer's-induced fruit flies. Previous research has suggested stress hormones improve cognitive ability of Alzheimer's Disease in humans. The memory of the fruit flies was determined by the number of flies that were able to make it to the opposite side of a phototaxis chamber. The flies were placed in the dark side of the chamber, then were exposed to bright light. The number for both wild type and Alzheimer's-induced flies, that flew to the bright side were recorded in a 30-second time span. These groups of flies were further separated into groups exposed to octopamine and those who were not. Our hypothesis was partially supported that the octopamine improved the memory of the Alzheimer's-induced fruit flies. The T-test showed the P-value between the Alzheimer's-induced flies with and without octopamine was statistically significant ( $P= 0.0194$ ), but there was no difference between the wild-type flies with and without octopamine.

***James DiBenedetto – See Matthew Campisi***

***Sophia DiMauro***

### **Creation of A Game That Will Help With ADHD**

The objective of this project was to create a well-developed, working game which aided people with ADHD. The game focuses on their symptoms, which includes having trouble with being patient, having low frustration tolerance, and having trouble dealing with failure. The game was developed using Scratch. The results are that the game is well developed with no errors and works the way it is supposed to. I cannot say this game supported my hypothesis because I was not able to test anyone, however I believe that if I continue to develop my game it was positively impact a person with ADHD. However, this

development was very significant because it got be closer to my goal of creating an app that can be downloaded by anyone who needs help.

***Jordan DiPrima, Melina Nicou***

### **The Effects of Aromatherapy on Cognitive Function in *Drosophila* with Alzheimer's Disease**

Alzheimer's Disease (AD) is a neurological disorder that leads to the progressive decline in memory and cognitive function. The causative agent of Alzheimer's Disease is the deposition of Amyloid-beta Protein (A $\beta$ ) causing plaque and neurofibrillary tangles in the brain. A $\beta$  proteins have been shown to have a role in inducing oxidative stress and inflammation in the brain, which appear in the pathogenesis of Alzheimer's disease. Nerve cells in the brain communicate by releasing specific chemicals called, neurotransmitters. Acetylcholine (AChE) is a neurotransmitter associated with memory that Alzheimer's patients have insufficient quantities of. Since essential oils have been shown to reduce oxidative stress, the purpose of this study was to determine if essential oils can be used as a potential remedy to improve cognitive impairment for Alzheimer's induced fruit flies. As fruit flies are a model organism for neurocognitive disorders. The RING assay was performed, on flies treated with the essential oil, *Mentha piperita*, the essential oil, *Rosmarinus officinalis*, and untreated flies were used as a control. A cotton swab of each essential oil was placed in the fly habitat for 1 hour before the assay was performed. Results were video recorded and the data collected for three seconds after the last tap of the assay was viewed, it was hypothesized that *Rosmarinus officinalis* would have the greatest effect because the carnosic acid found in *Rosmarinus officinalis* is shown to be protective from oxidative stress. Our results show that there was a difference between untreated wild type and the untreated AD flies ( $p=0.0000$ ). There was a difference between untreated wild type and *Rosmarinus officinalis* wild type flies ( $p=0.0002$ ). There was also a difference between untreated AD flies and treated Alzheimer's flies with both *Rosmarinus officinalis* and *Mentha piperita* ( $p=0.0000$  for both). The results suggest the use of *Mentha piperita* is a more effective essential oil to improve cognitive function, and a better treatment method for AD patients over the use of *Rosmarinus officinalis*.

***Ryan Dituro, Christian Dreyer, Bryan Yuk***

### **Environmental Factors and the Evolution of Elephants**

Evolution is when a species changes over time due to environmental factors. This project's purpose was to try and understand more about evolution and to find the missing links between evolution and the environmental factors a species is exposed to. Elephants were chosen for this project because the changes elephants underwent throughout their evolutionary history were easier to observe. For example, when the woolly mammoth evolved into an elephant, it was because the climate became hotter, and over time, the woolly mammoths with less hair were more fit to survive which increased their numbers. This project consisted of research on many different types of elephants, and then a program

was made that can show patterns in evolution. For example, the user may put factors that influence evolution into the program such as climate and the presence of predators. Then the program will show the user an elephant that has gone through evolution with these factors. The goal for the program is to have at least a 50% success rate and hopefully a pattern will be revealed.

***Christian Dreyer – See Ryan Dituro***

***Lola Duff, Tiana Geter***

### **The Relationship Between Ant Behavior and a Magnetic Attraction**

Ants evolved from the Vespoidea wasp ancestors in the Cretaceous period. Ants usually live in large colonies, nesting underground. To get around in their environment, they use magnetic pulses to locate which direction to go in like a built-in compass. The effect of magnetic pulses was tested during this experiment, specifically, how magnetic fields impact an ant's movement and behavior. The ants were allowed to move around in a tube while different numbers of magnets were placed on either side resulting in magnetic attraction through the tube. When using more magnets to increase the strength of the magnetic field, it took longer for the ants to know which way to travel. When using 0-3 magnets, the ants had little to no reaction, however, when using 4 magnets, the ants would hesitate and not travel in any specific direction. This data shows the relationship between magnetic fields and how they impact an ant's mobility. Knowing why ants are attracted to magnetic fields can lead to further studies of adaptation in certain regions of the world where the magnetic force is exceedingly strong.

***Katerina Efthymiou – See Annika Chang***

***Julianna Gembs, Ashley Lewis, Marnie Ziporkin***

### **The Effect of Different Land to Water Ratios on Fiddler Crab Carapace Color**

The species of fiddler crabs, *Uca pugilator*, are known to have a change in coloration of their carapace. The fiddler crabs change color as a response to stress, temperature changes, and their environment. The colors that the crabs can change to range on a scale from 1-7 (blue/green), 8-9 (tan), 10-12 (black/green), and 13-18 (yellow/brown). The purpose of this experiment was to observe if changing the environmental percentage of water and land would affect the fiddler crab's carapace color. It was hypothesized that if there was more land than water in the tank, the fiddler crabs would change to a darker shade of its original color. This is because there would be more factors on the land that could affect the crab's internal functions, such as larger temperature changes and differences in the amount of sunlight, causing the crabs to become more stressed and irritated. To obtain data, two tanks with different ratios of sand to water to setup. One of the tanks had a 40:60 ratio of sand to water while the other tank had a 60:40 ratio of sand to water. Through observing the crabs daily, it was determined that the average color of the crabs in the 40:60 tank was 9

on the scale, and in the 60:40 tank the crabs' average color was 17. This means that the 40:60 tank crabs were lighter and had more of a purple tint, while the crabs in the 60:40 tank were darker and browner. There were many limitations to this study, including lifespan, limited data, and other variables in the tank. These may have influenced the overall data and hindered the reliability of the results. The importance of this research was to learn about how the environment impacts an organisms' behavioral instincts and what kind of variables can change an organisms' daily life.

*Tiana Geter – See Lola Duff*

*Jack Giovannini – See Richard Clements*

*Mikayla Girimonte, Sydney Kalmaer*

### **The Effect of Caffeine on the Behavior of Ladybugs**

More than one third of adults living in the U.S. do not get enough sleep. Most of those adults turn to caffeine to keep themselves awake and give them more energy. They tend to drink soda or take caffeine pills. The extreme amount of caffeine in these products helps to reduce fatigue, but prolonged use of caffeine as a coping mechanism for lack of sleep can lead to addiction. The purpose of this experiment was to determine if and how caffeine pills, when consumed by ladybugs, affects behavior. Behavior and activity were determined by separating the ladybugs, close observation, controlled food sources, and extensive notetaking. The ladybugs were fed either raisins that were soaked in a solution of 200mg of caffeine pills to 500 mL of water or a 100% water solution. The ladybugs were separated into groups of 20 and put into separate containers. It was hypothesized that the ladybugs consuming the caffeine raisins would display different behaviors, for example how much they were flying, in comparison to ladybugs that were fed a normal diet. Results indicated that caffeine pills have a major (negative) effect on the behaviors of ladybugs. The results were not ideal. Overall, this experiment has helped me to learn how I should be more careful with what I use to keep off bugs because the bugs could be dying. Additionally, this experiment could be used to further identify the impact of stimulants on other living organisms.

*Elena Gnilitskaya*

### **The Effect of Synthetic Microfibers on Locomotion in Planarians**

Over recent years the demand for cheap and fashionable clothing has massively increased. As a result of this, fashion companies use synthetic fabrics such as Nylon, Polyester, and Spandex. When these fabrics are washed, microfibers are released from them and are released into plumbing systems, and consequently the ocean. These microfibers are considered microplastics and can release harmful leachates into the water when exposed to UV radiation. Planarians are a type of freshwater non-parasitic flatworm. Their nervous

system is very similar to that of human beings. This quality makes them a good model organism for toxicology. This study was created to observe the effects that microplastics in an organism's environment have on its ability to move around and react to stimuli. Firstly, Nylon, Polyester, Polyester and Spandex blend, and Nylon and Spandex blend fabrics were torn into threads and weighed out to 2 grams of fibers each. The fibers were then left to sit in 100mL of artificial pond water. The data was collected using a line crossing assay. A circular piece of graph paper was placed beneath a petri dish where the planarians were placed in the artificial pond water and microfiber solution. The number of lines crossed by the planarian was counted and put into data tables. The results of this experiment were supposed to show how leachates from microfibers would affect the ability of planarians to move around. Future studies that could be based on this one could include how the presence of microfibers affects development and the effect on the reproductive ability of organisms.

***Sanjit Gunasekaran***

### **Designing a Device That Assists One-Handed Guitar Players**

Annually, more than 50,000 people lose limbs. Consequently, many people who want to learn how to play the guitar are left unable to do so. Using an Arduino, servo motors, and foot activated switches held together with a wood frame, a device that replicates the effect of a guitarist's strumming hand was created. To test the effectiveness of the device, test subjects would be taught how to play a simple passage on guitar, and then taught how to play the same passage 48 hours later. After both instances, the subjects would be asked to rate the difficulty of the passage on a scale from 1 to 10 (1 being easy, 10 being difficult). Due to the Covid-19 outbreak and the resulting quarantine, I was unable to gather data and complete building the device, however all electronic components are assembled. In conclusion, while this is a crude prototype, this concept can potentially be developed further into a marketable product. This prototype is important because it allows a group of people who were unable to do a task a way around their disability.

***Avi Gupta, Daphne Koutosukos***

### **Effects of Inorganic Water Pollutants on Respiration in *Lemna minor***

Recently, both water pollution and floods has devastated many plants including the crop, rice. For the purpose of this study *Lemna minor*, duckweed, will be used due its similar growing environment to rice. Copper pollutes the water mostly through mining, farming and manufacturing and lead mostly through anthropogenic sources and naturally through rocks, plants and volcanic dust. In addition, when duckweed is exposed to heavy metals such as copper, the amount of chlorophyll and growth decrease, and silvering occurs from bioaccumulation. Lead becomes very toxic to people, as it increases oxidative stress creating reproductive and central nervous system issues. Our research is important, as it showed how inorganic compounds impact specific parts of the plant. It also tests how the bioaccumulation of metals from the water, as metals in the water are known to increase

hardness and toxicity. In addition, the respiration rates of the plant will also be measured, as it is an important life function. Data was collected with a carbon dioxide probe in parts per thousand (PPT). Each trial was conducted over a 24-hour period. It was predicted that a combination of the two metals would harm the plant differently compared to the result of the two metals separately. If the ratio includes more lead, the effect would be more apparent and toxic than a solution with a greater ratio of copper, because lead is more toxic to plants than copper. Our results thus far concluded that the CuCl 0.005% solution was the most harmful to duckweed. Comparison between the control and experimental groups showed that the mean CO<sub>2</sub> concentration decreased 0.3233 PPT. For the PbNO<sub>3</sub> tests, 0.005%, the mean the CO<sub>2</sub> concentration increased 1.2653 PPT compared to the control. Due to time restraints the 0.015% concentrations and the mixture of the two metals was not finished.

***Brianna Han***

### **Using RNAi to Model Duchenne Muscular Dystrophy in *C. elegans***

Duchenne Muscular Dystrophy (DMD) is a genetic disorder, whose symptoms include progressive degeneration and weakness in muscles. It is caused by a mutation in the dystrophin gene, resulting in a lack of dystrophin protein production. Dystrophin forms a complex at the muscle membrane with numerous proteins, called the dystrophin-associated protein complex (DAPC), which provides mechanical stability. Loss of DAPCs leads to muscle necrosis, which is the primary cause of muscle degeneration. *Caenorhabditis elegans* are model organisms that can potentially be used to model DMD, which can be done by utilizing the process of RNA interference (RNAi). RNAi targets and degrades mRNA, inhibiting the synthesis of a specific protein. A novel recombinant DNA plasmid will be engineered by digesting pL4440, extracting DNA from *C. elegans*, amplifying and purifying *dys-1* from the DNA, then finally ligating *dys-1* to pL4440. Gel electrophoresis will be conducted to check the success of each step. *E. coli* will then be transformed with this plasmid. *C. elegans* will then be grown on plates seeded with the transformed *E. coli*, and observing their movement on the plate as well as the structure of their muscles using phalloidin staining will determine if the *C. elegans* successfully model DMD. If successful, this technique could contribute to studies aimed at developing a cure or relief of some genetic disorders. Research can be done on DMD without needing to obtain specifically genetically modified *C. elegans*. In addition, other genetic disorders could be modelled and tested using the same technique.

***Emily Hartman***

### **Effect of Distractions on Reaction Response**

A growing issue is the use of technology while driving leading to distracted driving, specifically texting while driving. This issue has increased as technology is now a key component of one's life and indirectly the way everyone stays connected. More than 9 people are killed in the United States everyday due to a car accident caused by texting and driving. It takes on average 4.6 seconds for a driver to send or read a message while driving.

That time is equivalent to driving a football field blindly while driving at an average speed of 55 mph. The goal of this project is to bring an awareness on how technology influences a person's reaction time to texting while driving. High school students played an online reaction rate game. Their texting speed with no distractions or game playing was measured to account for the various texting speeds people may have, this was subtracted from them playing the game with no distractions to normalize the data. The distraction was to send a specified text prior to the game ending. The average reaction rate was recorded and compared between the two games. Thus far the results showed that the student's reaction time was increased when texting while playing the online game. The average reaction rate with no distraction was 0.2564 seconds, while the average reaction rate with a distraction increased to 1.9102 seconds. This supports distracted driving can impair a person's reaction rate to respond to a stimulus.

***James Haupt, Matthew Pace***

### **The Effects of Antibiotics and Silver Nanoparticles on the Regeneration of Planaria**

Many metals have been used in the past to treat wounds and infections. For example, metals like silver. The use of silver goes back to 4000 B.C.E. and was used in the in the form of silver nitrate. They used the silver nitrate for burns, ulcerations, and infected wounds. The development of antibiotics, like levofloxacin and azithromycin caused the use of these metals to decline. We have now seen a resurgence of these metal due to nanotechnology. Silver is one type of nanoparticle used for wound-healing. Pathogenic bacteria inhibit the healing process. These types of bacteria are protected by a biofilm, which induces and exacerbates the inflammatory phase of the healing process. Silver nanoparticles work by releasing silver ions that cripple the “chemical lung”. The chemical lung is used in bacteria to metabolize oxygen. This process suffocates any bacteria resulting in its death within 6 minutes, while leaving surrounding tissue unharmed. The purpose of this project was to test the usage of silver nanoparticles on the healing rate of planaria. Injured planaria were placed in four environments, artificial pond water (control), 30% silver nanoparticles, 25% ampicillin, and 25% kanamycin solutions. After cutting them, data was collected to determine how long it took for eyespots to develop. It was hypothesized that the planaria would regenerate quicker with silver nanoparticles because the particles release ions that suffocate pathogenic bacteria by crippling the “chemical lung”. The results showed that 90% of the planaria regenerated in the silver nanoparticle solution, 30% in the ampicillin solution, 20% in the kanamycin solution, and 0% in the control within a 48-hour period. This supported that silver nanoparticles helped regenerate planaria the fastest.

***Kevin Henris – See Matthew Campisi***

*Annabelle Hohne, Amy Liu*

### **The Effects of Different Catalysts on the Oxidation of Oxygen**

With greater levels of pollution and a fluctuating climate, there is an increased demand for alternative, clean energy sources. For this reason, the photoelectrolysis of water as part of the production of chemical fuels is being studied in order to optimize this process. Therefore, researching the most efficient catalyst for the photoelectrolysis of water would contribute to this search for clean energy. The research presented herein focuses on the effects of different ratios of manganese, iron, and copper nitrates on the oxidation of oxygen. It was hypothesized that the solutions with the most manganese nitrate would produce the most oxygen because they have high catalytic activity. These nitrates were combined in predetermined ratios to create the catalysts. Ten  $\mu\text{L}$  of each ratio of nitrates were spotted on 63 different places on a glass electrode. The glass electrode was heated in a jewelry kiln for 6 hours at 500 °C to convert the nitrates to oxides. A current was run through the electrode submerged in degassed NaOH to produce oxygen. A photo of the electrode was taken under UV light so bright green spots appeared which indicated oxygen presence. The photo was uploaded to ImageJ software to quantify the relative amount of oxygen present compared to the reference oxide ratios. We expected to see the most oxygen in the spots with the most manganese nitrate, however, we don't expect the brightness to be as bright as the reference solutions. We also expected to see some excess oxygen in different areas of the electrode which may result from disrupting the NaOH solution too much.

*Steven Homenides – See Jessica DeYulio*

*Ashley Hsu, Zeynep Tasoglu, Maryum Waqar*

### **Identifying differences in zones of inhibitions of bactericides against *S. epidermidis* and *E. coli* K-12**

The proliferation of antibiotic resistance is a critical issue the 21<sup>st</sup> century is facing. Primarily due to the misuse of antibiotics, resistance ultimately leads to superbugs, in which a bacterial strain is immune to a specific antibiotic. Based on other studies, silver nanoparticles (AgNPs) are confirmed to be highly toxic to a wide range of micro-organisms by inhibiting DNA replication, decreasing the probability of potential mutations carrying a resistant gene (Morones et. al, 2005). Thymol most effectively inhibits growth by inducing the permeabilization and depolarizing of the membrane (Meeran, et.al., 2017). Kanamycin, an aminoglycoside, inhibits protein synthesis whereas lysozyme possesses specific hydrolytic activity against the peptidoglycan layers of both gram-positive and negative bacteria (Dzhavakhiya et. al, 2007). The purpose of this project was to test alternatives in treating bacterial strains by measuring zones of inhibitions. Sterile discs were dipped into solutions of AgNPs, lysozyme, and thymol, and placed on streaked LB plates for five generations, with four trials, incubated at 37°C. *E. coli* K-12, a gram-negative bacterium, and *S. epidermidis*, a gram-positive bacterium was used. It was

hypothesized that AgNPs would be most successful in combatting resistance due to its known toxicity (Morones et. al, 2005). Additionally, Kanamycin was thought to have an effect as well due to it being designed specifically against bacterial infections by inhibiting protein synthesis. Lysozyme was the least effective and kanamycin was the most potent bactericide for both strains. Also, thymol was more effective than AgNPs and lysozyme. Overall, *E. coli K-12* showed the most resistance.

***Eric Huang – See Jayson Bromberg***

***Robin Hwang***

### **An Effective Approach to Generating a Renewable Source of Energy Using Thermoelectric Peltier Tiles**

Electronic devices have become an integral part of our lives by making our lives more comfortable and convenient. It is typical to use conventional energy resource-harvesting methods for electricity to power these common electronic gadgets. People tend use the chemical energy from batteries or get a supply of electricity through wall outlets from power lines. Thermoelectric generators (TEG) are devices that convert temperature differences into usable electricity. These devices get energy from the ambient surrounding environment and can eliminate the need for batteries or require less battery replacements. The purpose of this experiment was to use Peltier tiles inside fabric to generate electrical power utilizing the body heat of the individual and the outside environment to create a temperature gradient. The Peltier phenomenon can be useful when it is necessary to transfer heat from one medium to another on a small scale. This is known as a Peltier heat flux, and since it does not require any moving parts, it is a desirable source of electricity. The larger the temperature difference, the more electrical current that is produced, and the more power that is generated. This project will investigate the resistance when multiple tiles are wired in a series, incorporating the thermal energy to convert to electricity in a fabric matrix, and examine how much of a Peltier heat flux would be required to generate enough electricity to power an electronic device. It was hypothesized that when there are more thermoelectric tiles wired together in a series, there would be a greater constant flow of energy towards a final electrical port with minimal amounts of resistance. Thus far experimentation is still on-going.

***Kylie Iannuzzi, Brennan Thomann***

### **The Effects of Homosalate, Octinoxate, and Oxybenzone on the Regeneration of *Dugesia dorotocephala***

Water related tourism is one of the most rapidly growing activities in the world. Many people use sunscreen to prevent long term damage from high amounts of UV radiation. However, chemicals in the most popular sunscreens have been shown to have adverse effects on oceanic life. Three of the main chemicals used in these sunscreens are oxybenzone, octinoxate, and homosalate. One important model organism are planarians.

Planarians were chosen because of their ability to regenerate at different rates depending on water toxicity. The purpose of this project is to research the toxicity of these three chemicals so we can better understand their effects on freshwater ecosystems. For the control group, planarians were cut and the amount of time it took for them to regenerate (have eyespots) was recorded. For the experimental group, three solutions were made, one for each of the chemicals tested, with the concentration of each solution varying due to their different solubilities. Then planarians per solution were cut and regeneration times were recorded. It was hypothesized that if a planarian is exposed to a concentration of oxybenzone, octinoxate, or homosalate then it will take longer for the planarian to regenerate completely. The reason for this would be the chemicals would interfere with their hormone production taking them longer to fully regenerate. This is a result of the actions of the chemicals interrupting the signals used in regeneration. Results found that both the homosalate and octinoxate increased regeneration times. The control group took an average of 4.9 days to regenerate, while the homosalate group averaged 5.2 days and the octinoxate, 5.0 days. As a result of time constraints, we were not able to complete our trials using oxybenzone. In the future, this research could be expanded with different chemicals or different organisms to help create more eco-friendly sunscreens.

*Michael Jang*

### **Wastewater Cleaning Device: Surface Chemistry**

Heavy metals have high densities and can easily bioaccumulate in the human body, causing a variety of problems. For example, mercury and lead can affect the brain of infants and young children damaging their cognitive abilities. Even though research has been done in this area to help others who do not receive adequate water, further research must be done to create better solutions to this problem. The purpose of my project was to create a device can improve the situation with heavy metal pollution in water. My device was able to measure concentrations of heavy metals using a spectrophotometer and extracted heavy metals in water using electrodes. By using a portable spectrophotometer, the device is able to efficiently clean sources of water by targeting areas with higher concentrations. To test the capabilities of the measuring and extracting parts of my device, the spectrophotometer was tested with different solutions of copper sulfate against the school spectrophotometer. The electrodes were put in a copper sulfate solution connected to a battery to allow it to extract heavy metals, with this modified copper sulfate solution it was measured by the school spectrophotometer to calculate the amount of copper sulfate extracted by the electrodes. Making the spectrophotometer more sensitive required the usage of a tube coated with a reflective surface to increase the path length of the makeshift cuvette. This was done by electroplating a copper tube with a silver solution allowing the insides to take the characteristics of a mirror. Using these components, the full device will be built through an Arduino to control when the electrode is used and to run the spectrophotometer. If a device is made to measure heavy metals with an enhanced path length, then the device will be able to measure more accurate measurements of heavy metal concentrations because the increased path length will increase the amount of particles encountered by the light increasing the sensitivity of the device. My data was supposed to include a measurement of data from a school spectrometer compared to the data from my spectrometer to measure

the accuracy of my spectrometer. I was also going to measure the effectiveness of my electrodes by measuring the change in concentration of the heavy metal solution before and after the extraction. Finally, I was going to build my device and test its capability to do all these features including the Arduino features all together.

***Sydney Kalmaer – See Mikayla Girimonte***

***Gina Kim, Flora Lin, Amber Syed***

### **Biodegradable Non-toxic Feminine Hygiene Products for Underprivileged Women**

A significant issue in society is the taboo placed on talking about menstruation and proper hygiene. Numerous underprivileged women lack sanitary resources to properly care for themselves. Our goal was to design a biodegradable sanitary napkin that can be catered to women of all socioeconomic backgrounds and be reusable and cost efficient. The construction of this product consisted of, muslin fabric on the top and bottom layer of the biodegradable pad. Cotton pads were used in the replaceable and removable layer of the pad alongside cotton fluff. Cellulose gels were mixed in and embedded into the cotton fluff, creating an innovative heterogenous mixture. Multiples of this pad were produced to test effectiveness. Previous research determined cellulose had been a key factor in our experimentation in determining the best material(s) to use in pads since it had better absorbency than both rayon and cotton and was environmentally friendly. Our pad design was compared to a commercial pad design by testing maximum absorbency. The goal of these observations was to determine if our product was more efficient than commercial pads. Our finished pad design combined cellulose and cotton fluff embedded within cotton pads for our inner layer. We used cheesecloth to hold the inner layer of the pad together along with muslin fabric for the washable and reusable covering. We tested our pad against a commercial pad by dropping artificial blood until max absorbency was obtained, determining which pad was able to absorb the most fluid. Thus far, both our pad and the commercial pad held the same amount of blood.

***Grace Kim – See Samantha Borre***

***Daphne Koutosukos – See Avi Gupta***

***Yashica Kumar, Eshani Mukherjee***

### **The Effects of E-cigarette Liquid Chemicals on *Drosophila melanogaster***

Secondhand smoke is the combination of the smoke that comes from the flaming end of a cigarette and the smoke that is inhaled by the smoker. Specifically, electronic cigarettes are battery-operated technology that transport vapors to smokers in aerosol form. In some e-cigarette flavor pods, a solution consisting of propylene glycol, water, vegetable glycerin, and vitamin e acetate has been identified. The propylene glycol is a petroleum byproduct

and serves as a base of e-liquid which aids in the production of vapor. Vegetable glycerin is a colorless, thick organic compound that acts as a filter for nicotine and serves as a base for flavor concentrates. Vitamin e acetate has been used to thicken the fluid in the e-cigarette and may be the cause for damaged lungs of patients. To investigate the impact e-cigarette chemicals, wild type fruit flies were used because 75% of the genes that cause disease in humans are also found in these species. The purpose of this study was to determine if e-cigarette liquid chemicals such as nicotine, propylene glycol, vegetable glycerin, and vitamin e acetate have an impact on the vertical moving speed of *Drosophila melanogaster*. More information about this topic will bring more awareness to the harms it causes. Data was collected by placing fruit flies in a molasses feeding tube with 0.1 ml of each separate substance. Twenty-four hours later the flies were transferred to polystyrene vials marked at 6.5 cm in height. A stopwatch was set to see when the first fly would pass the 6.5 cm mark. It was hypothesized that the fruit flies exposed to nicotine will have a fast climbing speed because of the classification of nicotine as chemical stimulant. The flies exposed to vitamin e acetate would have a slower climb time because the chemical would have damaged its respiration functionality and therefore its energy production. It is predicted that flies exposed to propylene glycol would have a slower climbing speed as well because propylene glycol impacts the kidney function in humans, therefore the olog, nephrocyte, a cell in a fruit fly, would be injured. Vegetable glycerin will not affect the climb speed because it generally not harmful when it is consumed in its correct dosage. Based on our findings there was no statistical difference between e-cigarette chemicals and the crawling reaction time of the *Drosophila*.

***Matthew Lee, George Li***

### **Using Deep Learning in Radiology to Detect Glioblastoma**

Radiology has become an important part of modern medical care. It can create two-dimensional and three-dimensional representations of tissue as well as cross-section images of the body using x-rays, computerized tomography (CT), magnetic resonance imaging (MRI), fluoroscopy, and angiography. Deep learning can be applied to radiology to minimize human error and potentially save lives. Deep learning is a form of machine learning that mimics the human brain using artificial networks to learn independently from unstructured data. It can accomplish tasks that are impossible for orthodox computer programs and do so with minimal chance of error. The goal of the experiment was to develop a deep learning algorithm that can detect and diagnose diseases found in medical images. Due to advances in machine learning, we hypothesized that it was possible to apply a deep learning algorithm to radiology that can detect and diagnose diseases found in radiology images. Data for learning and testing sets were obtained and the algorithm was coded in Python using sci-kit learn and dicom. The algorithm examined the learning set of data for up to a week, and it was tested with the testing set after its learning period. The accuracy of the algorithm was then recorded and tested again until it was able to diagnose the disease with maximum accuracy. Further testing is currently ongoing.

*Aspen Levine, Nick Vazquez*

### **The Effect of Thermal Energy on the Agnostic Behavior of Different Species of Termites**

Agnostic behavior is any type of social behavior relating to fighting or aggressiveness, which includes threats and submission. It is often due to limited resources including food, shelter, and mates. Studies have shown that certain colonies of the *C. formosanus* subterranean termite were extremely agnostic, toward colonies of different species, while other species have not shown this behavior at all. Thermal gradients have also been shown to promote foraging in habitats with high moisture for two species of desert subterranean termites. Termites are devastating pest to homes. The purpose of our project was to determine if heat induces agnostic behavior in New York vs Carolina termites. By studying the social interactions of different species of termites in varied thermal environments, we can better understand their survival ability in a changing climate. For our procedure, twenty-five termites were placed in each of two moist chambers. One chamber had a heat lamp placed above. The behavior and movement of the termites were recorded. Thus far results show that the addition of heat increases Carolina termite's submissive behavior, as more termites were visible at the bottom of the chamber exposed to heat. Further testing needs to be done on the interaction between the different species.

*Sarah Levine*

### **Application of a Temperature-Induced PZT Piezoelectric Response to an RC Discharge Circuit**

Synthetic biology is a field that encompasses the construction of circuitry to replicate the processes observed in organisms. Such applications of this field include implants and artificial copies of human components for research and medical aid. It has allowed researchers to understand the behavior of different cells in detail, however, synthetic tests replicate the functions themselves without factoring in the contextualization of the environment that dictates the function, thus leading to failure in practical models. The focus of this experiment is the piezoelectric effect, which occurs when an applied physical stress (i.e; shear, compression bending) causes a dipolar formation, resulting in an electromagnetic emission. The reverse can occur if a certain voltage is applied to the material, causing physical deformation. The impact of temperature on piezoelectric materials is crucial to the application of piezoelectrics to the synthetic biological field, as its ability to both absorb ambient vibrations from the environment and charged signals from the cell itself would enable current circuits to adapt to various stimuli. For this experiment, a PZT ceramic will be applied to an RC discharge circuit to determine energy both energy efficiency and thus its ability to accurately represent temperature-induced cellular functions (see figure 1). An EK-Tm4c123gx1 launchpad will be utilized as the base of the circuit, with a 10mm diameter PZT disc connected to the launchpad XL interface via soldered wires. The surface area of the disc will be coated with a thin sheet of copper to maximize absorption of energy from a heat source that radiates a desired temperature from 10°C-60°C. Each temperature of heat will account for three tests with the circuit. To

calculate what occurs in the circuit: a series of calculations is mapped out: Degrees Celsius to Joules,  $E=h(c/Y)$  to determine wavelength,  $C=v \times Y$  for frequency, Joules to volts, Capacitive resistance:  $X= 1/2\pi fc$ , Impedance:  $z= \text{sqrt}(R^2+(-X)^2)$ , Piezoelectric mechanical stress. The data appears in a quadratic formation, reaching its peak at the 40°C mark, coinciding with the optimal temperature of the human body.

*Ashley Lewis – See Julianna Gembs*

*George Li – See Matthew Lee*

*Karen Li*

### **Diagnosis of Eosinophilic Esophagitis in Correlation with an Autoimmune Condition**

Eosinophilic Esophagitis (EoE) is a chronic allergic, inflammatory disease of the esophagus in which eosinophils, a type of white blood cells usually seen with allergic reactions that cause inflammation and damage to the esophagus. Since it is a relatively new condition, scientists do not know its exact cause, however it has been proven that people with other allergic diseases have a greater risk of developing EoE. The symptoms include abdominal pain, dysphasia, vomiting, chest pain, poor growth, and impaction, varying from case to case. It is similar to some autoimmune conditions, such as Crohn's disease, and allergic diseases involve the immune system. The purpose of this project is to determine whether a relationship exists between the diagnosis of an autoimmune disease and EoE. Little is known about the cause, so understanding a connection would help the diagnosis of cases and lead to further advances in research for the cause of EoE. Deidentified patient data was taken from a multicenter, nationwide database, Cerner Health Facts. Data such as age, gender, medical history, and time/age of diagnosis' was extracted. Excel and python were used to analyze the data. Patients with EoE and an autoimmune disease were compared against patients without an autoimmune disease. It was hypothesized that there would be a correlation between autoimmune diseases and diagnosis of EoE. EoE can be consider a malfunction of a part of the immune system, which can also be cited as the cause of other autoimmune diseases. Therefore, a relationship could be present. Results showed that there was a higher autoimmune diagnosis percentage out of the EoE patient pool versus the general population, including the EoE patients (19.84 and 14.26 percent respectively). Out of the patients with both EoE and an autoimmune condition, 50.3% were diagnosed with their autoimmune condition before EoE and an average of 50.0% of patients with each specific autoimmune disease were diagnosed with their autoimmune condition before EoE. There was an average of 654 days between diagnosis', however there was no correlation between the time between diagnosis' and the specific autoimmune diseases.

*Flora Lin – See Gina Kim*

*Meiya Lin – See Jasmine Carpio*

*Amy Liu – See Annabelle Hohne*

*Sally Ma (Siyang) – See Krish Dayal*

*Jane Maloney – See Alyssa Collado*

*Marissa Mauro – See Gabriella Barth*

*Eshani Mukherjee – See Yashica Kumar*

*Alasdair Newman, Bryan Youn*

#### **Isolating Pollutants from Water Sources**

Every year, 8 million tons of plastics and other pollutants such as liquid heavy metals and rubber have polluted bodies of water such as oceans, streams, rivers, and lakes. The goal of this experiment was to build a boat like machine that goes into these bodies of water and filters out an abundant type of those pollutants. Without addressing this problem, these pollutants may end up entering human bodies. If these pollutants are consumed by humans, then they can carry cancer causing elements, and can potentially cause hormonal defects. To collect these pollutants, a net was used to collect plastic pollutants with a filter inside the net to chemically or physically collect smaller and liquid metals. One example was by using steel wool with a negative charge. This was used because copper ions are a positive charge and will be attracted to the negatively charged steel wool filter. It was discovered that adding 300mL of water to 10mL of powdered copper sulfate results in the best visibility of copper which allows for optimum efficiency in removing the copper from the water. This resulted in being able to see the positive results of collecting copper. Seeing that the net can collect plastics, the plastics can then be removed from the bodies of water which is the primary goal. Using the right amount of copper sulfate and water, we were able to extract the copper from the water. And because we collected the plastic with the net, we are able collect and remove plastics and metals from the water. The importance of this work being done is to ensure the safety of humans and organisms of all kinds, as most plastics and metals are harmful to organisms if they are consumed.

*Evan Ni*

**An Analysis of the Correlation Between Stage 1-2 Hypertension and the Risk of Developing Early Onset Alzheimer's Disease**

Alzheimer's disease (AD) is the 6<sup>th</sup> leading cause of death in the United States. Presently, there is no cure for AD, only treatments that can slow its progression. Therefore, it is imperative to further investigate the risks of AD to identify possible methods of reducing the risk of developing AD. The purpose of this investigation is to determine the correlation between stage 1-2 hypertension and the development of AD. Using the database provided by NACC, the systolic blood pressure was compared to the development of AD and the effects of stage 1-2 hypertension on the development of AD was determined. It was hypothesized that Stage 1-2 hypertension will not have a strong correlation with the development of AD, as previous research isolated only severe hypertension as a risk, and only a combination of cardiovascular diseases with hypertension will increase the risk of developing AD. Based on the comparison between cognitively normal patients and patients whose presumptive cause of cognitive disorder is AD, the data thus far suggests that there is no significant correlation between Stage 1-2 hypertension and AD development.

*Melina Nicou – See Jordan DiPrima*

*Matthew Pace – See James Haupt*

*Grace Papazoglou – See Kristen Collura*

*Abigail Pappachen – See Lindsey Chung*

*Thehan Perera, Robert Petruzzi*

**A Study of the Behavior of a Fiddler Crab (*Minuca pugnax*)**

Fiddler crabs are an interesting species that live in Marshes, Beaches, and Mud flats. The way they assess their surroundings makes it imperative to study their behavior as it may bring data to improve Machine learning. This investigation's purpose was to determine whether fiddler crabs learn from experience, and to find out the extent to which they process information about their environment. The reactions that two fiddler crabs had to perceived threats (objects) were collected. The control group had various objects swung at them while in a fishbowl, while the experimental group had the same objects swung. Both groups shared the same two crabs, and the data collected from them was categorized into the control and experimental. When not used, the crabs were in a 10-gallon tank with land and water halves. It was hypothesized that if the fiddler crabs experience the scenario repeatedly, they will get accustomed to it and no longer perceive the occurrence as a threat. For example, the crabs may first be cautious of an unfamiliar bird sitting near their burrow, but If this became a frequent occurrence, then the crab may ignore

it. Based on the results, the crabs during the experimental trial became increasingly accustomed to the objects swung at them, retreating from the threat and then ignoring it completely. The controlled trial showed that the crabs would flinch when a different object was swung toward them. However, the T-test showed little difference between the groups, possibly due to lack of data.

***Robert Petruzzi – See Thehan Perera***

***Madeline Pettit – See Samantha Borre***

***Harry Poulouse***

**Epigallocatechin gallate as a synergistic agent to inhibit the growth of *Serratia marcescens***

The increase in the amount of antibiotic resistant superbugs has sparked the need for an effective solution. Antibiotic resistance has risen to dangerously high levels in all parts of the world. According to the CDC, antibiotic resistance causes around 2 million infections and around 23,000 deaths per year in the U.S alone. New resistance mechanisms have been emerging and spreading globally, threatening our ability to treat common diseases. Diseases such as pneumonia, tuberculosis, blood poisoning, gonorrhoea, and foodborne diseases have become significantly harder to treat. These diseases are all caused by bacteria that have recently become resistant to commonly used antibiotics. However, recent research has suggested a new method of solving this problem. Epigallocatechin (EGCG), a catechin found in green tea, has recently been used to fight against different species of bacteria in both synergistic and independent methods. The purpose of this project was to see the effects of EGCG as a synergistic and independent agent to inhibit the growth of *Serratia marcescens*. EGCG effectiveness was tested on strains of *Serratia marcescens* treated with 100 µl of ampicillin, kanamycin, gentamicin, or tobramycin combined with varying amounts of EGCG. Cell counts after 48 hours of incubation were measured and analyzed. Results show that there is an indirect relationship between the amount of EGCG used and living cells remaining after incubation and that EGCG facilitates the effects of the antibiotics. Results may support the use of the polyphenol in a clinical setting to treat *S. marcescens* and other antibiotic resistant bacteria.

***Gavin Primis – See Calvin Bode***

***Heetaek Ra – See Justin Davitashvilli***

*Daniel Realmuto*

### **Microplastics in Long Island Freshwater Environments**

Humanity has in the last 50 years been using many different types of plastics. Unfortunately, plastic is not biodegradable, and has become a major pollutant. While it is not biodegradable, it does break down into smaller pieces, normally by UV radiation. Microplastics are commonly found in seawater and is relatively easy for organic lifeforms to ingest and if there is an increased presence of microplastics, fish and other organisms' health will deteriorate. The purpose of this project was to determine how common, and what types of micro and macro plastics are found in freshwater systems. Steve, J. published her methods on how to collect these particles and used them to determine how common micro plastics are found in Jamaica Bay. The project was done in Blydenburgh Park instead of saltwater environments as there is a shortage of micro plastic studies done on freshwater ecosystems. If the park can determine the abundance of microplastics, the park can determine who serious the problem is. It is hypothesized that if sampling occurs at freshwater parks, then more than half of the samples will contain at least one microplastic, because human interaction and excessive use of plastic most likely contaminated the freshwater parks as there are major roadways that rainwater runoff flow from. It will not be extremely common like in marine environments, because there are overall less plastics, some microplastics will drop to the bottom due to buoyancy, and there are no currents to bring plastics to the surface. Surface water samples were taken 75 cm from the shore. The samples were taken from the start of the creek from New Millpond at Blydenburgh Park. Two cup jars were used to take the samples. The water was then partly poured through using a 100-micrometer metal mesh in order to reduce the amount of water in the jar. The remaining water was poured onto a petri dish and observed under a dissecting microscope. The amount of microplastics was then recorded by color and type.

*Marlee Reiter, Kiera Spahn*

### **Identifying the Ideal Concentration of Nickel Nitrate, Iron Nitrate and Ammonium Nitrate to Produce Oxygen in the Water Oxidation Half Reaction**

Fossil fuels are not sustainable as population and need for natural oil continues to grow. However, solar energy, theoretically, has the potential to fulfill the energy demands of the world, if the technology was available. Photoelectrochemical water splitting with sunlight has shown potential for production of renewable hydrogen. The HARPOON program aims to find optimized photocatalysts for the oxygen evolving reaction in the splitting of water. Various metal oxides have demonstrated promise in catalyzing the exceedingly slow oxidation half reaction of water into oxygen. Mixed oxides of iron, nickel and ammonium in 15 different ratios were prepared. ImageJ was used to evaluate and interpret the data. If we were able to figure out which combination produced the most oxygen, then we would have run a new plate, with new ratios of metal nitrates, revolving around this spot. It would have been focused on more narrowly, with smaller variations, while using the same methodology as before. For example, if the brightest spot in ImageJ had a ratio of 50:25:25

of its metals, then we would make a new plate with different concentrations, similar to this one in order to then see the optimal concentration ratio around this one.

***Alexa Scotti – See Joseph Strickland (Senior)***

***Daniel Shoemaker – See Brandon Berkoff***

***Kiera Spahn – See Marlee Reiter***

***Shreya Sriram, Asmaa Zahra***

**The Dose-Dependent Effect of Rhamnolipid Molecules and Amoxicillin on  
*Escherichia coli* and *Staphylococcus epidermidis***

A growing problem is that over time bacteria develop a resistance to antibiotics and become less effective. This resistance is then passed on to the future generations making the bacteria difficult to combat. Hence, there is a need for alternative remedies in fighting bacterial infections when current antibiotic treatments fail. Amoxicillin is a penicillin antibiotic which prevents bacteria from forming cell walls, it is used to treat infections caused by *E. coli*, *staphylococcus*, *streptococcus*, *H. influenzae*, and *H. pylori*. The purpose of this experiment was to observe the synergistic effect of rhamnolipids and amoxicillin in a dose-dependent manner for both gram-negative and gram-positive bacteria to bring new insight on reducing bacterial mortality and effectively treat infections. A rhamnolipid solution and amoxicillin solutions were serially diluted. Blank disks were dipped into the respective solutions and plated on respective *E. coli* and *S. Epidermis* plates. Afterwards, the zone of inhibition will be measured to determine the best antibiotic to biosurfactant ratio most effective at killing both gram-positive and gram-negative bacteria.

***Rohan Surana***

**An Analysis of the Relationship Between Cyclogenesis Latitude and Sea Surface  
Temperature (SST) Anomalies**

Because cyclones can cause large scale destruction to human infrastructure, it is necessary to develop models that can effectively predict their occurrences. Though current research points at a poleward migration of yearly average cyclogenesis latitude in the Pacific region, developed trendlines of the shift cannot accurately predict seasonal cyclogenesis variability. In this investigation, I attempted to develop a new method that could predict yearly variability in cyclogenesis latitude during the cyclone off-season (months between consecutive cyclone seasons) using sea surface temperature (SST). The goal was to create a model that would achieve a balance between climatic prediction and immediate prediction. In such a scenario, both the level of accuracy and time span prior to storm occurrence are satisfactory enough to minimize physical damage. Additionally, the amount of weather data to analyze would be minimized by decreasing the time span to the off-

season. To perform correlations between SSTs and cyclogenesis latitude, average latitudes of positive SST anomalies (regions of above average temperature) during the cyclone off-season (months between consecutive cyclone seasons) were calculated through the development of a Python algorithm. This algorithm could extract pixel coordinates from SST images by identifying color values that correspond to positive SST anomalies. This analysis was performed solely in the Northeast Pacific region. Moderate to strong non-linear relationships were found to exist, more apparent when averages were weighted in favor of larger positive anomalies.

*Amber Syed – See Gina Kim*

*Zeynep Tasoglu – See Ashley Hsu*

*Brennan Thomann – See Kylie Iannuzzi*

*Matthew Tobias – See Christopher Buscemi*

*Kevin Tuzinowski*

**Identifying Differential Expression of Canonical Wnt/ $\beta$ -catenin Pathway Related Genes in *Mus musculus*.**

Alzheimer's disease (AD) is the most common neurodegenerative disease worldwide (Beyer, 2012). It starts with short-term memory loss, worsens over time, and then results in total loss of cognition. As many as 5.3 million people in the United States are affected by AD, and this number is expected to drastically rise in the next decade (Snider, 2002). Currently, AD patients have no clear therapeutic option, except for some symptomatic relief. Thus, it is imperative that there be new model approaches to combating this disease. The canonical Wnt/ $\beta$ -catenin pathway is a highly conserved signaling cascade that plays a vital role during embryogenesis (Garcia, 2018). The means by which signaling occurs through the canonical Wnt/ $\beta$ -catenin pathway is done by Wnt ligands. Wnt ligands are precursor proteins used in the formation of the central nervous system (CNS), they play a critical role in synaptogenesis, axonal extension, and growth cone guidance. The hypothesis was that genes related to synaptogenesis and axonal extension would be expressed less than that of growth cone guidance related genes. Differential expression is a method of comparing a variety of genes and their rate of transcription. Certain genes that have been transcribed more may be responsible for the phenotype that induces robust axonal regeneration.

*Nick Vazquez – See Aspen Levine*

***Jordan Walsh***

**Human Activity Recognition using Wi-Fi Channel State Information (CSI)**

Channel State Information (CSI) describes the properties of a channel (i.e., the instantaneous amplitude and phase of a signal) in a wireless communications link. Transmitted Wi-Fi signals can travel through humans and objects, although there is an observed phase offset and decrease in amplitude at the receiver. The purpose of this project was to utilize collected CSI data to distinguish between three cases: (1) the absence of human activity within a room, (2) a stationary human standing in the middle of a room, and (3) a human continuously walking throughout a room. Whereas presently used detection methods, cameras and motion detectors, require specialized equipment to be installed, this CSI-based approach utilized existing Wi-Fi infrastructure already present in homes, schools, and public areas. Data was collected for one hour for each case, with CSI data over each antenna-to-antenna connection and subcarrier in a 3 x 3 MIMO Wi-Fi connection being logged every second. A linear support-vector machine (SVM) model in Matlab performed with 97.3% accuracy in a binary classification between case 1 (no activity) and case 2 (standing). When values from case 3 (walking) were introduced in a tertiary classification, the accuracy of the linear SVM decreased to 80.0%. This is likely because the distinguishing feature of the walking data was its amplitude and phase variance over time, which cannot be fully observed instantaneously. In the future, to improve accuracy in this tertiary classification, the variance of CSI values over a certain time period could be used by the classification model.

***Maryum Waqar – See Ashley Hsu***

***Angela Won – See Samantha Borre***

***David Yang***

**The Longitudinal Effects of Polypropylene Microplastics on Common Duckweed  
(*Lemna minor*)**

Microplastics have demonstrated ubiquity, resistance to abrasion and relative pervasiveness, absorption of toxic chemicals, and have been noted for their entry and bioaccumulation in multiple aquatic organisms. *Lemna minor* is a small, fast growing aquatic plant that is easily tested and cultivated, absorbs pollutants such as heavy metals, and studies have shown microplastic adhesion to its roots. Due to duckweed's similarity in uptake to rice, contamination of microplastics in a multitude of organisms, and the obscurity of the effects of microplastics on humans; it is imperative that duckweed be tested in order to identify the possible implications of microplastics on macrophyte growth, uptake, and human health. Usage of a variety of biochemical and physiological tests ranging from frond growth, to nutrient and oxidative stress testing, have been used to observe the resulting changes in uptake and hindrance of plant growth caused by

microplastics. It has been shown that polypropylene microplastics have some diminishing effects on the uptake ability of *Lemna minor* and that microplastics may cause stress within duckweed, causing reactive immediate general benefits like ciliated growth that are more punishing long term in areas such as chlorophyll and peroxidase levels. This study has shown that prevalence of microplastic usage may result in contamination of major human food sources that could be magnified by microplastic's pollutant capacity. Furthermore, this study raises alarm to the implications and necessity to change excessive uses of plastics with long environmental lifespans and their effects on common macrophyte crops such as rice.

***Bryan Youn – See Alasdair Newman***

***Bryan Yuk – See Ryan Dituro***

***Asmaa Zahra – See Shreya Sriram***

***Tryphena Zareif***

**The Effects of Nonsteroidal Anti-inflammatory Drugs on Neurological Inflammation in *Drosophila melanogaster***

The world relies heavily on many industrial, medical, and technological applications to advance. These processes could have negative effects on human health and the environment by distributing heavy metal pollutants into the environment. These harmful compounds leak into food and water supplies, can be ingested by humans, and cause neurological inflammation. Since fruit flies are physiologically similar to the human, they are often used in neurobiological studies. The purpose of this experiment was to observe the effects of heavy metal pollutants on fruit flies. It was hypothesized as fruit flies were administered nonsteroidal anti-inflammatory drugs (NSAIDs), such as Cyclobenzaprine and Ibuprofen, then exposed to heavy metal pollutants, their cognitive ability would be increased when administered Ibuprofen due to its small molecular size which allows it to be more readily absorbed. To carry out this study, two experimental food groups of Cyclobenzaprine and Ibuprofen were created along with a control group. Each food vile contained a heavy metal concentration of 0.002% based on previous LD-50 assays and 0.125g dosage of NSAID concentration. The mature flies were tested using a Ring Assay to see how far they could fly vertically in three seconds.

***Chapin Zerner***

**Inner Ear Synaptic Changes in *Porichthys notatus* Supporting Seasonally Enhanced Acoustic Communication**

*Porichthys notatus*, commonly known as the plainfin midshipman fish, is a vocal fish found across the west coast of North America. Plainfin midshipman exhibit extreme

seasonally dependent environmental alterations. Winter months are spent ~100m beneath the surface of the water; reproductively active summers occur in intertidal zones [1]. The role of dopamine (DA) has been extensively studied in mammalian subjects, namely rodents [2]. However, dopaminergic processes have previously remained understudied in ancient teleost fish. Type I Male midshipman rely on vocal signaling in the form of low frequency hums (100 Hz) to court gravid females during reproductively active summer seasons. Females thusly rely upon response to auditory stimuli and require significant neuroanatomical changes to compensate for vast changes in water depth. Conducted experimentation was hypothesized to show quantity and contact area of darkened hair cell membrane ribbons to increase in gravid summer females. Experimentation revealed quantity of darkened area membranes to show no significant difference between seasons. Moreover, summer females were expected to demonstrate increased levels of dopaminergic processes. In actuality, the opposite was true, indicated by an increase in count, volume, and proximity of DA terminals to regenerative hair cells in winter females. From this, DA was shown to act as an inhibitory neurotransmitter. Due to its homologous brain structure to that of high-functioning mammals such as humans, the malleability of dopaminergic processes of *Porichthys notatus* have far-reaching potential well beyond that of the midshipman itself.

***Jeffery Zhou***

### **Experimental Analysis on 3 Different Types of Solar Panels**

The purpose of this study was to try to gather data about the solar panels to see which one of them, the monocrystalline, polycrystalline or thin film cells, would be the most efficient in certain conditions. The study was done in the vicinity of my home, where I constantly went outside in the same spot, to try to get the solar panels into the sun and measured the voltage of each of those solar panels in certain times in the day, with a multimeter. I also measured whether it was sunny or cloudy or rainy or etc. The results that were obtained were that the thin film cells were the most efficient compared to the monocrystalline and polycrystalline silicon solar cells. The hypothesis was not supported by the data and was incorrect according to the data gathered.

***Marnie Ziporkin – See Julianna Gembs***

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