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ON THE COVER:

Front Cover: Escherichia coli B resistance to Rifampin, p.6. Photo:

Back Cover: Students Minwoo Kim, Amber Ludke, and Brady Walker prepare streak plates to examine zone of inhibition.

Cover Design by Jianna Lin, Emily Ziperman, Zachary Pranske, and Joshua Baker

IN THIS ISSUE

STUDENT RESEARCH SPOTLIGHT

A Letter from the Editors

Jianna Lin, Jade Connor, Joshua Baker, Micheal Munson, Kaitlyn Peterson, Zachary Pranske, Grace Kohn, and Emily Ziperman

It is our pleasure to introduce to you *Scientia* 2017, Baylor's Undergraduate Research Journal in Science and Technology. *Scientia* is an interdisciplinary publication that aims to increase awareness of the wide-reaching nature of undergraduate research at Baylor and to provide a unique platform for undergraduate students at Baylor University to showcase their original research. To do this, *Scientia* publishes a collection of selected original research articles and abstracts that span the interdisciplinary sciences. As advocates of maximizing our education, we believe that the promotion of research here at Baylor provides students with quintessential and formative experiences that develop valuable characteristics such as intellectual curiosity, resilience, and, simply, strong interest in the pursuit of knowledge. To us, research is a hallmark of education, because it involves applying the information learned in classes to unanswered questions in hopes of advancing our knowledge of the world around us. For these reasons, we commit ourselves to reviewing, editing, and publishing the work initiated and collaborated on by Baylor undergraduates.

Scientia is a creation of the student organization Baylor Undergraduate Research in Science and Technology (BURST), whose mission statement is to increase awareness of undergraduate research on the Baylor campus, provide opportunities for undergraduates to optimize their research experiences, and educate undergraduates in the proper habits and techniques of research in scientific fields. In conjunction with BURST, we hope this array of student discovery will inspire an increasing number of students to partake in the many research opportunities present at Baylor.

Scientia encourages students in the STEM fields at Baylor to submit their research to this journal and work with *Scientia's* editorial board to learn more about the review and publication process, and potentially, receive a publication. The process of crafting *Scientia* includes a methodical review of submissions and collaboration between student researchers and editors of *Scientia's* Editorial Board. The Editorial Board is selected by BURST's Vice President of *Scientia*, Jianna Lin, with the understanding that they will work intensively towards the creation of the journal. Editors are closely involved in the selection of submissions for acceptance through careful review and meeting with authors to improve the professionality of the work. As undergraduate editors, we understand that undergraduate researchers are in the process of developing the skills required of professional research, and we strive to enhance these qualities in those who submit. We provide each author with personalized guidance and an opportunity to improve their ability to compose scientific literature. Following editor review of each accepted submission, *Scientia's* Professor Review Board, including Tamarah Adair, Ph.D., Patrick Farmer, Ph.D., Linda Olafsen, Ph.D., and Dennis Johnston, Ph.D, review the submissions. Authors then make further revisions based on comments from these professors. This overall process is funded by the College of Arts & Sciences, who work in conjunction with the editors and Baylor University's Office of Pre-Health Studies to print the journal. We are grateful to Dean Frank Mathis and Dean Elizabeth Vardaman for their continuous encouragement and thoughtful guidance.

Previous editions of *Scientia* included only independent projects of undergraduate students. However, we recognize that most work in laboratories is not completely motivated by the undergraduate, but instead, aimed to assist in the research efforts of graduate students and professors. Therefore, the research of most undergraduate students at Baylor is not eligible for publication within *Scientia* because these students are research assistants to principal investigators who plan on publishing their conclusions in national journals. To bridge this gap between the research we feature and the enormous amount and variety of undergraduate research that students partake in at Baylor, we have included a new section in *Scientia* this year, the Student Research Spotlight. Improving upon previous editions, this new edition of *Scientia* aims to highlight the work of undergraduates who assist in research at Baylor but are unable to release the data or specific intellectual content they work with in hope that the research conclusions drawn from the project may be published elsewhere by a professor or graduate student.

We hope that our efforts in creating *Scientia* 2017 excites the scientific community at Baylor to pursue further research experiences at Baylor and beyond, and that this journal effectively conveys the magnitude of undergraduate research here at Baylor so that you will be inspired to partake in this community.

Sincerely,

The *Scientia* Editorial Board

Effect of Thermal Stress on Rifampin Resistance in *Escherichia coli B*

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Abstract

This experiment sought to find a correlation, if any, between incubation temperature and resistance to the antibiotic Rifampin in *Escherichia coli*. One sample of *E. coli B* strain was obtained for this experiment. Cultures were first grown at 37°C, and then tested for Rifampin susceptibility before being split into groups corresponding to incubation temperature. The bacteria were then incubated at temperatures of 37°C, 39°C, and 42°C, and 37°C was used as a control. Three separate trials were conducted for each temperature and tested every seven days for changes in Rifampin susceptibility. The cultures were grown continuously in LB broth and transferred to fresh broth frequently to maintain optimal growth conditions. Rifampin susceptibility was measured using the disk diffusion method on sterile Mueller-Hinton (MH) agar plates. The diameters of inhibition were measured in millimeters. After measuring the zones of inhibition, statistically significant differences were found between the size of the zones of inhibition of the 37°C and 39°C groups on day 14 which correlate to an increase in Rifampin resistance in the 39°C group. However, on day 21, no statistically significant differences were present. Thus, we conclude that temperature did not have significant long-term effect on E. coli B resistance to Rifampin.

Introduction

Though it is commonly accepted that bacteria are present in virtually every aspect of our daily lives, a relatively small percentage of the population understand just how susceptible bacteria can be to mutations. For instance, the gram-negative bacterium *Escherichia coli* can be encouraged to undergo mutagenesis under stressful conditions such as elevated temperature.[1,2,3] Rifampin inhibits DNA-dependent RNA polymerase, limits protein synthesis, and consequently decreases the ability of the bacteria to grow. [4]

Resistance to Rifampin is a known consequence of point mutations to a specific gene, rpoB, and may occur spontaneously when *E. coli* is incubated at a higher temperature. [3] For these reasons, Rifampin was selected for use in this experiment to test antibiotic susceptibility in *E. coli.* Though genetic components were not investigated by this experiment, it is understood that any resistance encountered may be the result of heat induced mutagenesis of *E. coli* as detailed above. This experiment explores the hypothesis that *E. coli* resistance to Rifampin will increase over time as the bacteria is incubated at temperatures exceeding 37°C. Thus, three temperatures were selected based on their prevalence in natural environments. 37°C was used as a control, as it is standard physiological temperature of the average human body. The test group temperatures, 39°C and 42°C, are the temperatures of the mammalian body in other conditions found in nature, such as fevers.

Methods and Materials

Prior to testing, four incubators were calibrated and prepared. These included three bath incubators for tube cultures and one air incubator for agar plates. Each of the bath incubators were filled with approximately 5L of deionized water, set to the desired the temperature (37˚C, 39˚C, or 42˚C), and calibrated over a seven-day period. Each of the three temperatures tested were assigned three separate bacterial cultures. In total, there were nine test tubes and nine Mueller-Hinton (MH) agar plates per trial. Each were labeled alphanumerically with incubation temperature and an assigned letter for identification. Between trials, used test tubes were rinsed with deionized water, rinsed again with about 5mL (91%) Isopropyl Alcohol, and then allowed to air dry.

Because consistent temperature was required, a water bath kept at constant temperature was used. The bacteria were cultured in a broth solution in test tubes. Lysogeny broth (LB), a nutritionally rich medium, was used as a medium and maintained optimum growth conditions for the bacteria. A 200 mL solution of LB broth was made in a 500 mL beaker using 5g of prepared powder and 200 mL of deionized water. Once completely mixed, the solution was heated to boiling on a ring stand over a Bunsen burner. The broth solution was then allowed to cool to 37˚C (temperature measured using a laser thermometer to ensure no accidental contamination of broth).

Using a sterilized pipette, 5 mL of LB broth was transferred into each of the nine test tubes. Inoculation of the test tubes required a small beaker of 91% Isopropyl Alcohol and a Bunsen burner to maintain a sterile environment. Before and after each bacterial transfer, the inoculating loop was dipped into the alcohol, and then passed through the flame, allowing time to cool before the next use. Once prepared, the freshly inoculated test tubes were placed in their respective incubators
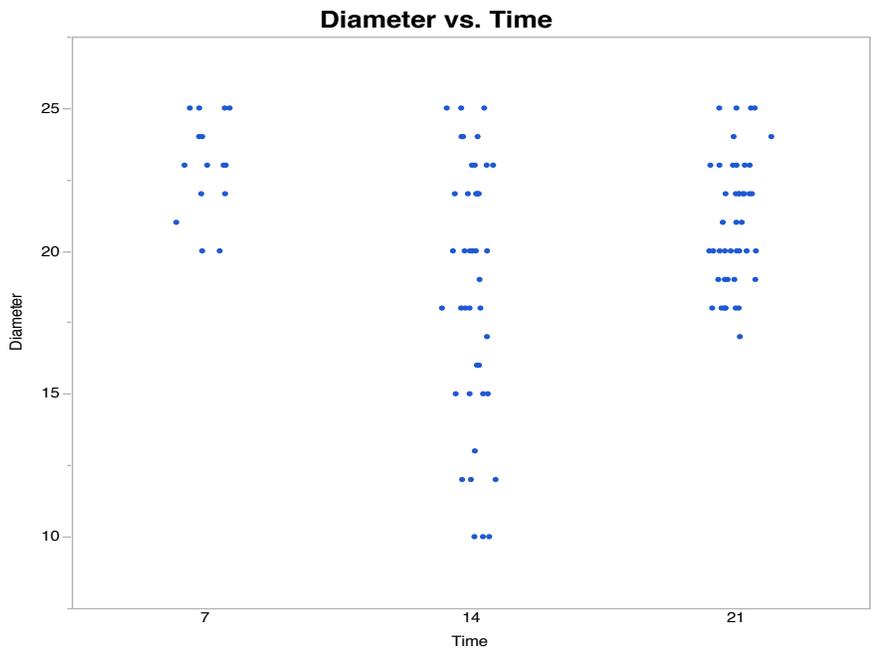
Figure 1. Diameter of Inhibition (mm) vs. Time (days)

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Group	2	2	54824.40	1.9851	0.1430
Time	2	2	38480.53	1.3933	0.2532
Group*Time	4	4	182234.35	3.2992	0.0140*

Figure 2. Effect Tests from an Analysis of Variance (ANOVA) for Temperature Group, Time, and Group*Time Interaction (p-valuue).
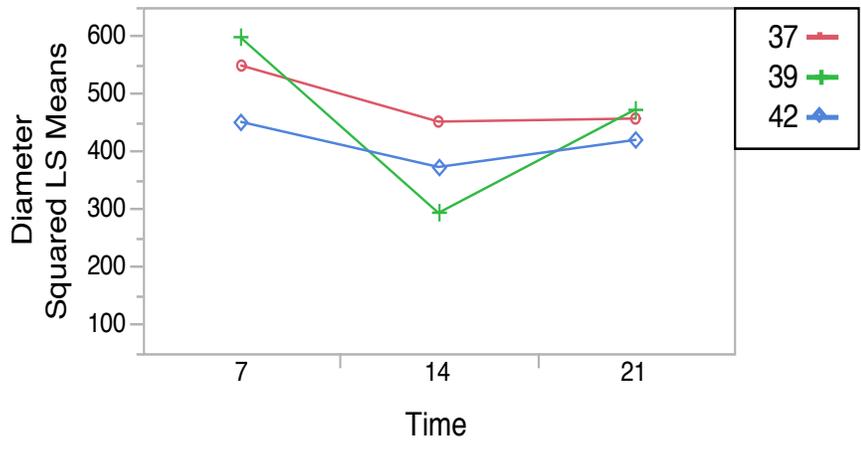
Figure 3. Diameter (mm) Squared vs. Time (days); lines represent different temperature

Level				Least Sq Mean
39,7	A			596.00000
37,7	A	B		548.60000
39,21	A	B		472.53333
37,21	A	B		456.73333
37,14	A	B		451.46667
42,7	A	B	C	450.80000
42,21	A	B	C	419.73333
42,14		B	C	372.80000

Figure 4. Output for Tukey HSD Difference Test. Levels not connected by a letter are statistically different from each other.
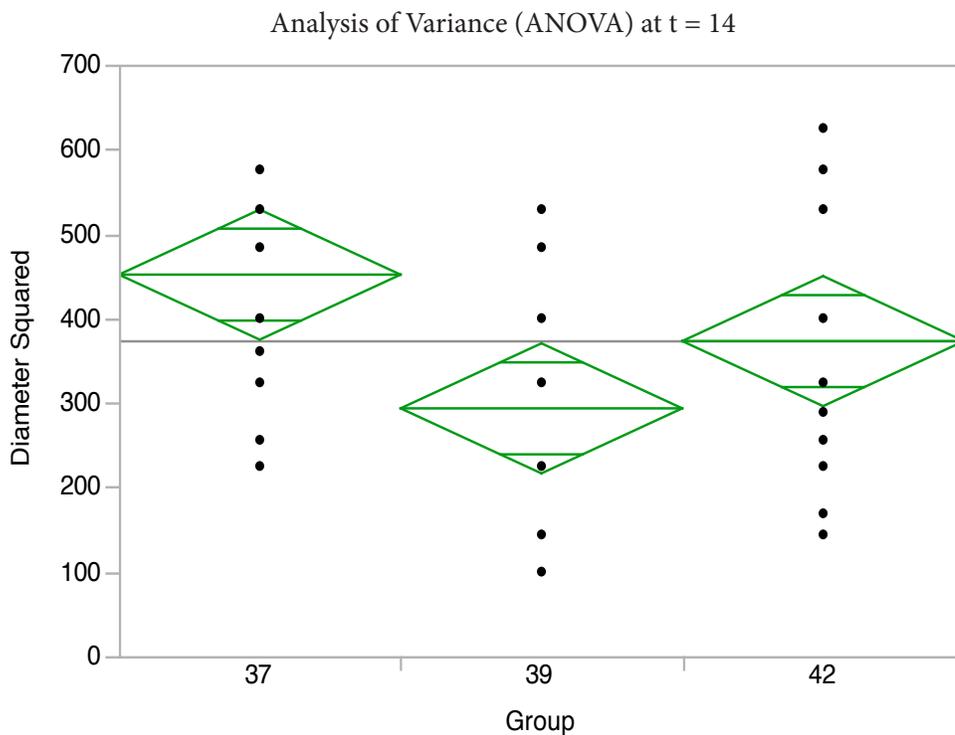
Figure 5. The x-axis is the date the measurements were taken, while the y-axis is the height in cm.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value	
37	39	158.2667	53.92324	27.2604	289.2729	0.0146*	
42	39	79.6000	53.92324	-51.4062	210.6062	0.3125	
37	42	78.6667	53.92324	-52.3396	209.6729	0.3208	

Figure 6. Output for Tukey HSD Difference Test. Levels not connected by a letter are statistically different from each other.

and allowed to grow for 46-49 hours. In this experiment, a 0.5 McFarland standard test was used to measure bacterial growth. Each culture was tested for Rifampin resistance once every seven days using the disk diffusion method. Sterile swabs were used to inoculate prepared sterile MH agar plates. To maintain sterility, the lid of the agar plate was gently lifted and held at an acute angle over

the agar, acting as a "shield" against possible air contaminants. The swab was then placed through the opening created by the lip of the agar plate and lid, and then gently placed onto the surface of the agar. Streak plates were prepared for each of the nine cultures using

MH agar.

Using flame sterilized forceps, five Rifampin discs were placed equidistant to each other on each inoculated MH agar plate. Each disc was gently pressed down to ensure full contact was made with the agar. To avoid contamination, the forceps used were sterilized

before and after the application of each disc. As detailed before, the lid covering the agar plate was lifted no higher than necessary and used to shield against possible air contaminants. This process was completed for each of the 9 test plates.

The lids of each of the plates were then secured with tape and the plates were placed, inverted, into the 37°C incubator and allowed to grow for 24 hours. The zones of inhibition were then measured and recorded for each of the test plates.

Results

Figure 1 is a plot of Diameter of Inhibition (mm) vs Time (days). As shown in this graph, the greatest range of values occur on day 14 and the least on day 7 (control). Additionally, it can be observed that day 14 is the only day in which true resistance is found (a diameter of >10mm). All results were analyzed using the JMP program by statistician Kristin Koch. In this figure showing the diameters of inhibition, each point is squared to satisfy an equality of variance assumption necessary for statistical analysis. Effect tests showed that while group and time did not individually have a statistically significant effect on the diameter, the interaction of both group and time did, as shown by the p-value of 0.0140 (Figure 2).

Figure 3 shows a downward trend in diameters of inhibition that could be indicative of growing resistance in the groups. Overall, the biggest increase in resistance occurred between day 7 and day 14 with a statistically significant difference appearing between the 39°C and 37°C groups (Figure 4). Another Analysis of Variance test (Figure 5) showed that on day 14, the lower range of data from group 39°C reached the threshold of resistance at a diameter of 10mm. There was a slight decrease in resistance across all groups on Day 21, and no group had a significantly different amount of decrease compared to other groups. While the average data for day 21 is still lower than that for day 7, the E coli grown in 39°C showed a significant loss of resistance. Day 21 had a greater range in diameter size than day 7, as seen on Figure 1, however the averages of the groups on day 21 are closer together.

A Tukey HSD Difference Test was used in order to pinpoint at what time and between which groups significant

difference exists (Figure 6). This test showed that there are no significant differences on day 7 between any of the groups (as indicated by the connection to the letter A in Figure 4). At day 14, there is a significant difference between group 39 degrees C and 37 degrees C, but group 42 degrees C is not significantly different from either of the two other groups. As seen in the ANOVA test Figure 5, the average of the 42 degrees C group lies between that of the other two groups. At day 21, no significant difference in inhibition zones was found between any groups.

Discussion

The results from this experiment show that there was no statistically significant correlation between the temperature of the environment across all temperatures tested. These results provided further information to the relationship between Rifampin resistance and thermal stress. On day 7 and 21, the three temperature groups show no statistically significant differences in their respective Rifampin susceptibilities. However, on day 14, statistical significance was found between the 37°C and the 39°C group. Between the two, the 39°C group had a lower average zone of inhibition, correlating to a higher Rifampin resistance. Though not tested, it is suspected that the 39°C group may have harbored the rpoB mutation. This particular mutation is linked to Rifampin resistance as it encodes for the RNA polymerase β subunit, the target of Rifampin.[2,4] As shown by Rodríguez-Verdugo, et al, in table 1 of their research article, there are at least 3 different loci on codon 572 where a single point mutation can increase the minimal inhibitory concentration to 25 μg/mL or even 800 μg/mL.[1]

Other studies conducted in this area found that this mutation is accompanied by an interesting trend. While generally beneficial in the presence of an antimicrobial, many resistance-inducing mutations are ultimately disadvantageous.[1] The rpoB mutation, however, appears to cause a marked advantage in thermal stress, low glucose environments in some E. coli strains.[1] The return of susceptibility noted between days 14 and 21 in the 39°C group suggest a decrease in overall fitness of resistant bacteria inconsistent with the rpoB mutation. This experiment did not account for nutritional variants and was therefore unable to confirm nor disprove the presence of the rpoB mutation which served as the inspiration for this enterprise.

Improvements to the study can be made with respect to the choice of tools and techniques used to obtain more accurate results. A larger number of samples used in a future study would likely lead to statistical significance when comparing the effect of the group on diameter of inhibition. Access to an autoclave or shaking incubator would allow for more uniform samples and lower systemic error. In addition, access to E. coli genotyping technology would be necessary for further analysis of the samples and detection of possible mutations. Extending the length of the trials would increase conclusiveness of the data. Additionally, possible fluctuations in incubation temperature caused by limitations of the tools used are also a considerable source of error.

Overall, the results of this experiment, and those which inspired it, can have significant implications on bacteria in relatively high-temperature environments such as fevers in mammals or improperly processed water sources. Spontaneous development of antimicrobial resistance may become a focal point for research in the near future, considering the relatively recent increase in the prevalence of antibiotic resistant bacteria and the increasing public interest in this field.

Acknowledgements

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Usage of Complementary and Alternative Medicine in Pediatric

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Abstract

Due to the rising cost of healthcare, alternative medicine usage has increased in children. Despite the proliferation of research involving the usage of complementary and alternative medicine (CAM), few studies have explored the usage of essential oils, a specific CAM treatment typically used to relieve symptoms associated with dermatological etiologies. However, essential oil usage is high in the general population. We hypothesize that essential oils are the most commonly used form of CAM by pediatric patients between the ages of two and seven. To test this, we collected 201 surveys of a simple random sample of American families in the Baylor Scott & White Hillcrest Pediatric Clinic. The survey consisted of questionnaires inspired by similar studies and the input of doctors at the clinic. Data was analyzed using a univariate analysis, bivariate analysis, and a linear discriminant analysis. Results showed that essential oil usage in the 2-7 year age range was not the most common form of CAM. Instead, nutritional supplements such as vitamins were found to be the most common form of CAM therapy amidst the entire sample population.

Introduction

Complementary and Alternative medicine (CAM) is broadly defined as products that are marketed as increasing health, but are not prescribed by a doctor. The usage of CAM in pediatric patients is steadily increasing.[1,2] This is due to a variety of reasons, including increasing cost of conventional medical care, increasing educational level of the parents[2], increasing distrust of the medical community in general, and increasing usage by parents and other family members.[3] The population that uses such alternate methods primarily consists of well-educated and financially stable adults of good health.[2,8.] Even though CAM usage is increasing, there is very little evidence supporting its efficacy over conventional medicine. One of the main problems with the increasing usage of CAM medicine is that patients are not communicating their usage to their doctors.[1, 4, 5] There is both a knowledge and communication gap between healthcare professionals and their patients regarding these CAM treatments. This could be due to a lack of information about efficacy, safety, and drug interactions of CAM therapies.[7, 8,9] Due to the lack of research that supports the use of alternative medicines in the pediatric demographic, the usage of alternative medicine is controversial. However, despite this, the usage of CAM in pediatric patents has increased. To increase knowledge of pediatric CAM use, our study aims to determine the type of CAM most used by pediatric patients. We hypothesize that of pediatric patients between the ages of two and seven, essential oils will be the most common type of CAM used.

Methods and Materials

To test our hypothesis, we constructed a survey and administered it to a simple random sample of patients of the Baylor Scott & White Hillcrest Pediatric Clinic. The survey included questions regarding demographics, types of alternative medicine used, effectiveness of treatment, communication of treatment to the doctor, and source of information. Parents of the patients completed the survey during in-person interviews while they were in the clinic for appointments. Demographic control variables included average age and gender. Other variables addressed by survey items included types of alternative medicine usage, whether or not they found that treatment to be effective, whether they had communicated it to their doctor, and where they had learned about it were asked in a dichotomous format with "yes" being coded as 1 and "no" as 0. The questions that asked whether they had communicated the usage of CAM to their doctor and whether they found the CAM to be effective were given additional response options to more accurately depict the verbal feedback received from the patients. The full sample consisted of 201 surveys (1 survey per family) and 444 children.

Using descriptive statistics, we ran univariate and bivariate analyses of the data. This data was used to calculate the percent usage of certain CAM therapies to give the practicing doctors an estimate of what types of CAM are being used by patients at the clinic. Furthermore, a linear discriminant analysis (LDA), a form of inferential statistical test, was used to investigate the correlation between age and CAM usage. Results showed that there is a positive correlation between age of child and probability of CAM usage from ages zero to eighteen of pediatric patients at the Baylor Scott & White Hillcrest Pediatric Clinic.

Among patients in the 2-7 years-age range, an Adjusted
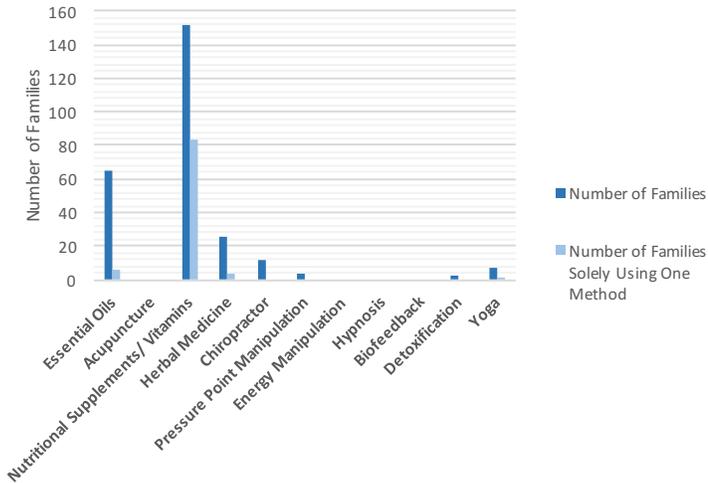
Figure 1: Nutritional supplements were by far the most common CAM used in the general population.
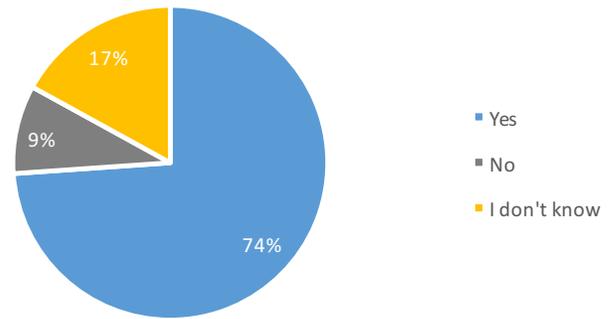
Figure 2: A survey asking whether patients found CAM usage to be an effective means of treatment.
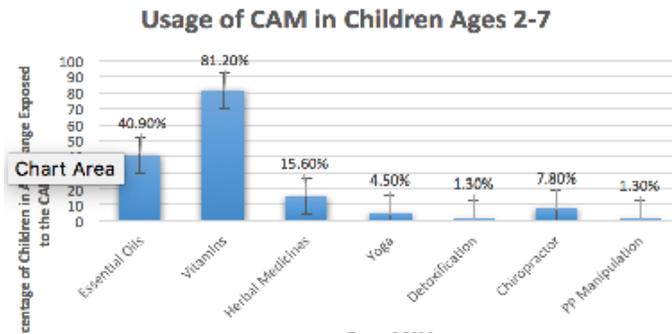
Figure 3: Although vitamin usage was the highest in the 2-7 range at 81.2%, essential oil usage was the second at 40.9%.
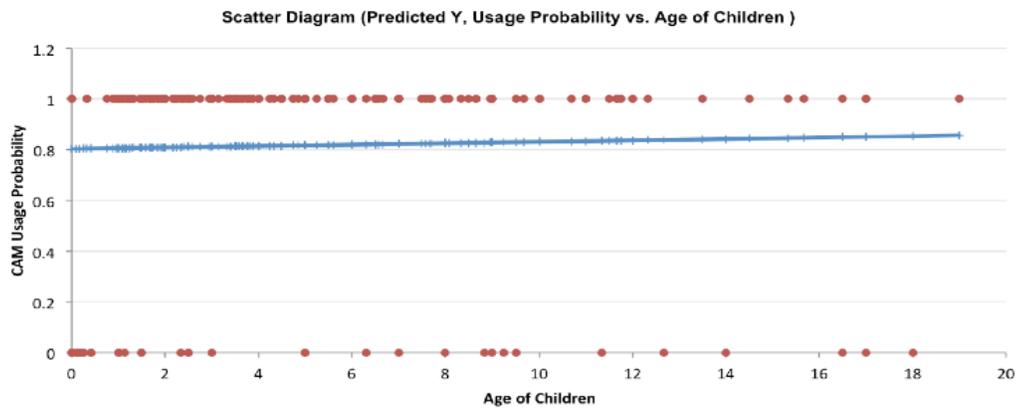
Figure 4: As the age of the child increases, the probability of CAM usage also increases. The blue line is the inferential statistic and can be used as a predictor of CAM usage based on age.

Wald confidence interval was used to determine which CAM treatments were most common.

Results

Results showed that nutritional supplements/vitamins were by far the most used type of alternative medicine in the Hillcrest clinic (Figure 1). 41.3% of all patients surveyed reported using only nutritional supplements/vitamins as their CAM treatment (Figure 1). A significance test also determined that the usage in vitamins and minerals was significantly larger in comparison to that of essential oils (Figure 3). This is due to a few factors, including doctor recommendation (15.2%) and parent belief that there is a nutritional deficit in their children (20.5%).

We also found that of the patients that use CAM, 73.9% have found the treatment to be effective (Figure 2), which is larger than any other type of CAM among that age group. Additionally, results showed that the most used CAM treatment in the two through seven-age range were nutritional supplements such as vitamins as 81.20% of patients in the two to seven-age range reported usage of them.

An inferential statistical model, linear discriminant analysis, was utilized to investigate the correlation between age and usage of CAM. Based on this model, we found that as age increased, the probability of CAM usage also marginally increased (Figure 4).

Discussion

Out of all families surveyed, 32.9% of families use some type of CAM other than nutritional supplements and vitamins. This is much higher than the national average, which is 19.7%.[8] In addition, we found that 44% of parents had various other reasons for using CAM on their children. These reasons ranged from not knowing why they were using CAM treatments to wanting to improve their general health. Although these estimators serve only a preliminary purpose, these results may provide some insights for further studies concerning comparable CAM usage in a regional setting.

Acknowledgments

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Duration of UV-B Radiation Exposure and Phenotype Differences in *Brassica rapa* Plants

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Abstract

UV-B radiation significantly influences plant growth, development, phenotype, and reproductive success by acting as a mutagenic agent. Previous studies on various plant species have revealed a number of physiological effects of UV-B radiation such as reduced biomass, epidermal formation, changes in the ability of crop plants to compete with weeds, decreases in the percentage of pollen germination, and changes in cuticular wax composition. These phenotypic alterations are thought to be caused primarily by DNA damage, direct photosynthetic damage, induced membrane changes, protein destruction, hormone inactivation, and signal transduction by means of a UV-B photoreceptor. This study aims to determine the effects of UV-B radiation exposure on mortality, biomass, and height in *Brassica rapa*. An experimental group of 48 *Brassica rapa* seeds were subjected to 21 days of continuous UV-B radiation and standard fluorescent light from the day they were placed into soil. A control group of 48 *Brassica rapa* plants we subjected to 21 days of continuous fluorescent light starting the day they were placed into soil. The number of plants, leaves, and plant height were measured in 7 day intervals. Plants in both treatment groups were then uprooted and heated for 3 days, starting on day 21. Plant biomass was measured on day 24 when the plants were dry. Results demonstrated that UV-B radiation causes increased mortality and decreased shoot height and biomass in *Brassica rapa*.

Introduction

Solar radiation is pivotal to life on Earth. Without it, photosynthesis would be impossible for plants grown for agriculture. Although plants are dependent on light for growth, providing plants with excessive amounts of light radiation may not enhance growth and survival. Studies have shown that UV radiation, a component of solar radiation, acts as a mutagenic agent in plants with significant negative effects on plant growth, development, phenotype, and reproductive success.[1,2] UV radiation is divided into three classes: UV-A (315 to 400 nm), UV-B (280 to 315 nm), and UV-C (100 to 280 nm). Earth's ozone layer removes UV-C wavelengths from sunlight before it reaches the earth's surface, it is the UV-B and UV-A regions of the UV spectrum that plants are most commonly exposed to.[2] The current depletion of the ozone layer as a result of chlorofluorocarbon contamination in the stratosphere exposes plants to increasing levels of UV radiation, and thus poses a substantial threat to the existence of plants and therefore, humans.[2]

Although the specific effects of UV-B radiation vary among plant species, negative effects are more commonly found. For instance, UV-B radiation has been found to damage photosystem II in plants, thereby reducing their photosynthetic productivity.[3] This decrease in productivity results in a variety of phenotypic changes, such as shorter plant height and decreased growth rate in plant species such as the Pinaceae.[4] In addition, UV-C radiation has been known to reactivate the maize Mutator transposable element.[5] This damage reduces rates of pollination in addition to preventing transcription.[6]

Differing light on Square-Root of Height of *Brassica rapa* plants
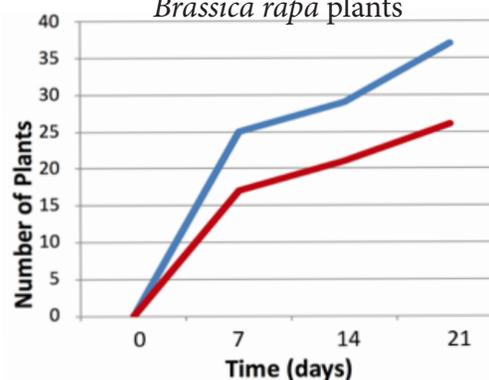
Figure 1. Number of *Brassica rapa* plants upon exposure to

		Fluorescent light only	Fluorescent light and UV-B Radiation
Number of Plants	Day 7	25.0	17.0
	Day 14	29.0	21.0
	Day 21	37.0	26.0
Height (cm)	Day 7	6.68	4.54
	Day 14	11.3	8.50
	Day 21	15.8	13.04

Table 1. Effect of UV-B radiation on *Brassica rapa* physiology

Effect of UV-B Radiation on Square-Root of Height of Brassica rapa plants
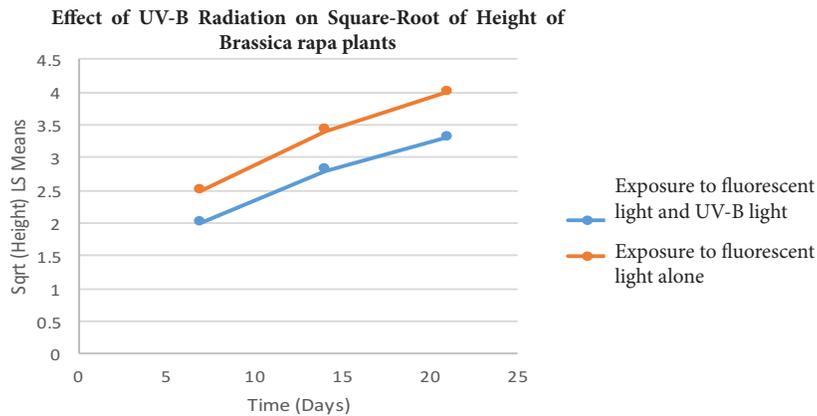

Figure 2. Changes in mean square root of height of *Brassica rapa* plants upon exposure to white fluorescent light (—) and UV-B light (—) for different time intervals.

Furthermore, UV radiation has been shown to induce DNA lesions such as the *6,4 pyrimidine*-pyrimidones dimer (CPD), diverse rare DNA photoproducts, and DNA-protein crosslinks in various species of plants. [7]

Experiments that have increased UV-B levels to stimulate conditions that would exist as a result of a reduction in the ozone layer have found many physiological responses to UV-B radiation in plants including reduced biomass, decreases in the percentage of pollen germination, changes in the ability of crop plants to compete with weeds, epidermal deformation, changes in circular wax composition, and increased flavonoid levels. [9, 11] These changes are thought to have resulted from a number of effects of UV-B radiation, including DNA damage, direct photosynthetic damage, membrane changes, signal transduction via a UV-B photoreceptor, protein destruction, and hormone inactivation.[9]

However, little research on the specific effects of UV radiation on *Brassica rapa* has been done. Determination of these effects on *Brassica rapa* is valuable because of the plant's wide use in modern research as a model organism. *Brassica rapa* are commonly used in research due to their fast germination and development. Therefore, results of this study provide researchers with the knowledge and ability to alter the growth of their model as they wish. Specifically, determination of the correlation between length of exposure to UV radiation and variations of phenotypic traits of a specific plant species would allow for human manipulation of the plant species for desired traits, and essentially, would thereby enhance the ability of the researcher or scientist to use UV radiation and the mutations it produces as a tool to control plant growth and phenotypes.

Methods
Controls and Variables

This experiment included one control group and one experimental group, both of which consisted of 48 plant seeds. The two groups differed only by the type of light they were exposed to. The control group was exposed to four 122 cm diameter, 40 Watt fluorescent light bulbs, while the experimental group was exposed to two 122 cm diameter, 40 Watt fluorescent light bulbs and two 122 cm diameter, 40 Watt UV-B bulbs.

Site Selection

The study was conducted indoors in a laboratory in Waco, Texas in an environment with an average constant temperature of approximately 20º C. This indoor site was selected to allow for maximum control and consistency in plant exposure to light, heat, pressure and water. Plants were grown directly in plastic bins of dimensions 40.6 cm in length, 20.3 cm in width, and 20.3 cm in height. A total of 12 plastic bins were used, each of which housed 6 evenly spaced *Brassica rapa* seeds.

Plant Species Selection

Brassica rapa was chosen as the model organism for this experiment because of their fast seed development and germination. A tall variation of *Brassica rapa* was chosen because greater potential height allowed for greater variation in plant height and growth rate, which were dependent variables. The plants were supplied by Carolina Biological Supply company.

Soil Selection

Just Natural Organic potting mix was used as soil. All plants were exclusively exposed to this soil environment throughout the duration of the experiment. Each group was comprised of six containers, each of which was filled with 10.6 cm of potting soil. A total of two pounds of soil was used.

Light Sources

A total of two 122 cm, 40 Watt F40 T12 UV-B lamps and four 122 cm, 40 Watt fluorescent bulbs were used in the experiment as the only sources of light for the plants. Two light bulbs were placed into each of three light holders, which hung a distance of 45.7 cm above the soil surface. Light holders above both groups were arranged symmetrically to ensure that each plant was equidistant from the light source and thus received an equal exposure to light. The fluorescent and UV-B bulbs above plants in the experimental group were placed in an alternating fashion to maintain equal light exposure across all plants. All lights remained on throughout the entire duration of the experiment.

Experimental Design

All plants were exposed to their respective light sources continuously for 21 days. Each bin was given approximately 300 mL of water every other day. On days 7, 14 and 21, both qualitative and quantitative observations and measurements of the number of plants, leaf size, number of leaves, and plant height of each group were recorded. On the 21st day, the plants were uprooted and observations and measurements of their roots recorded. The plants were subsequently placed under a 25 Watt incandescent heat lamp and dried over a duration of 3 full days. On the 24th day, plant biomass was measured using an analytical balance.

Results

Of the 48 seeds planted in the control group, 33 germinated above soil, whereas 24 of the 48 plant seeds planted in the experimental group germinated above soil. Table 1 displays the number of plants alive (defined as having germinated above soil) in both the control and experimental group on days 7, 14 and 21, along with the average mean plant height, average mean biomass, and average mean number of leaves per plant for day 7, 14, and 21.

An analysis of variance (ANOVA) of mean plant height over time for the two treatment groups showed a significant difference in height between treatment groups (p<0.0001). The results of Dunnett's test, a multiple comparison procedure used to compare each of a number of treatments with a single control, showed the control group had an overall significantly higher mean height than the experimental group (p<0.0001). Square root of height was taken to satisfy an assumption of equal variance for Dunnett's test. A T-test revealed that plants in the control had a higher height on every day of measurement (7, 14 and 21).

Plants in the control group had an average higher biomass than those in the experimental group, as seen in Figure 3. Statistical analysis of plant biomass was not possible, so the difference in plant biomass was not proven either significant nor insignificant. However, the values for the masses of the
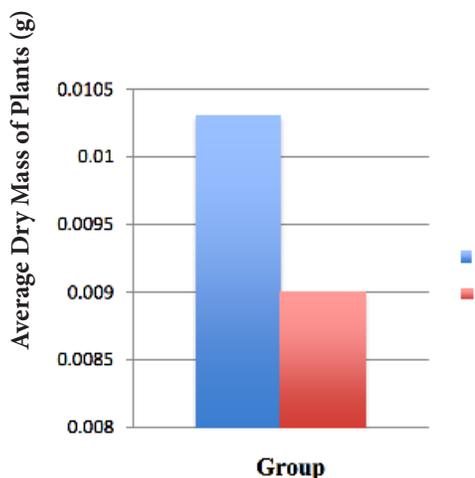
average plant in the control and experimental groups seem to differ greatly (Figure 3).

Discussion

Table 1 shows that exposure to UV-B radiation increases plant mortality, as defined as the number of plants that germinated above soil and subsequently died, and decreases shoot height and biomass of *Brassica rapa*. Figure 1 shows that exposure to UV-B radiation increased *Brassica rapa* mortality throughout its development during the duration of the experiment, as the number of living plants in the control group was greater than that of the experimental group on every day measurements were taken. This suggests that the effects of UV-B radiation on *Brassica rapa* mortality rate were consistent throughout plant growth and development for the entire duration of the experiment. Therefore, UV-B radiation affects *Brassica rapa* at more than one stage in its lifespan, and potentially affects all stages of *Brassica rapa* growth and development (Figure 1). The significantly higher mortality rates during early development and germination caused by UV-B radiation have also been found in studies on the Pinaceae species. [4]

Plants in the control group had significantly greater height than those in the experimental group (Table 1, Figure 2). A student's T test showed that plants in the control group were consistently shorter than those in the experimental group from the first day of height measurement (day 7) to the last day of height measurement (day 21). Thus, we conclude that UV-B radiation stunts Brassica rapa growth throughout the first 21 days of their life span. It is probable that UV-B radiation affects *Brassica rapa* shoot height and therefore growth and development throughout its entire life span. However, further experimentation that observes the plants throughout their life span is required to make such a conclusion and provide additional insight to UV-B radiation's effects on *Brassica rapa* during the end of its lifespan. Additionally, Figure 1 and Figure 2 also show that UV-B radiation's effects on *Brassica rapa* mortality rate and height were invariable and consistent throughout the first 21 days of growth. UV-B radiation consistently led to an increase in *Brassica rapa* mortality rate and a decrease in *Brassica rapa* shoot height. The significantly shorter mean stem height in plants exposed to UV-B radiation has also been seen in the *Pinaceae* species.[4]

UV-B radiation exposure also led to lower mean biomass in Brassica rapa plants as seen in Figure 3. This is consistent with results in Figure 2, which show that UV-B radiation exposure led to a decrease in plant height. Since height and biomass are positively correlated, a shorter height should result in a lower biomass, as seen in results displayed in Figure 3. Studies of *Pisum sativum* have also found a 30 percent decrease in biomass in groups exposed to UV-B radiation. [7]

Results of this study may be explained by previous studies on *Emiliania huxleyi* plants, which found that UV-B radiation causes mutation in photosystem II and induces 3 stomatal closure by inhibiting K+ accumulation by guard cells, limiting adaxial stomata opening and thereby limiting CO_2 uptake and photosynthetic productivity.[13,16]

Figure 3. Average biomass of a *Brassica rapa* plant upon exposure to white fluorescent light (—) and UV-B light (—) after 21

Decreased photosynthetic productivity limits sugar and energy for meristematic cell division during primary growth, ultimately result ing in increased plant mortality during germination, shorter shoots, and smaller biomass. Potential sources of variation in this experiment include displacement of seeds due to water flow during watering. The displacement of the seeds could have caused them to aggregate together or become pressed to the sides of the container. This could have prevented germination and early plant growth of the displaced seeds.

Conclusions

This study has illustrated UV-B radiation's potential to cause significant decrease in Earth's carrying capacity by increasing plant mortality rate and decreasing plant photosynthetic productivity. Future analysis of the effects of UV-B radiation on other phenotypes and characteristics of *Brassica rapa* would provide a better understanding of the holistic effects of UV-B radiation on *Brassica rapa*. The increasing levels of UV radiation reaching the Earth's surface due to depletion of Earth's ozone layer as a result of Carbon emissions emphasizes the importance of understanding the effects of greater levels of UV radiation on organisms.

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Potential Sources of Antibiotics Against ESKAPE Pathogens Within the Soil Bacterial Flora

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ESKAPE pathogens are responsible for a wide range of nosocomial infections. The pathogenicity of ESKAPE pathogens and the growing threat of their antibiotic resistance have increased a demand for new antibiotics. Since the 1940s, humans have benefited from substances naturally produced and collected from in situ bacteria. Pharmaceutical companies have altered natural products by adding functional groups to extend the effects and minimize dosage. We are replicating the original protocols to isolate and identify novel substances to fight ESKAPE pathogens. Organisms were isolated from soil samples from both Tacoma, Washington and Waco, Texas. These colonies were tested against ESKAPE pathogens for evidence that pathogen growth was suppressed. Seven isolated colonies from the Tacoma sample and 8 isolates from the Waco sample displayed zones of inhibition, indicating that these isolates had greater potential for producing effective antibiotic substances than others based on patch plate results. Retesting this spring revealed only 1 of the 7 organisms from Tacoma and all 8 isolates from Waco continued to produce zones of inhibition; gram staining and various media tests were performed on these organisms in effort to identify their characteristics. Diluted samples of each isolate were mixed with Taq polymerase in PCR tubes, and each sample was treated with 27F and 1492R primers to extract the desired nucleotide sequence. The thermo-cycled samples were sent for DNA analysis. One was identified as *Serratia marcescens*, and ID of the other isolates and their subsequent antibacterial secretions could lead to the discovery of new antibacterial compounds and products.

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An Examination of Alcohol, Depression, and Quality of Marriage as Predictors of Family Functioning in a Sample of U.S. Veterans

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Since the return of veterans serving in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF), the integration of veterans back into civilian life has been a concern to the health of the military community. Notable aspects of this integration include healthy marital and family functioning. The topics of many recent studies have focused on the adverse effects that Post-Traumatic Stress Disorder (PTSD) has on marital and family functioning.[1,2] However, few studies have addressed the effects that alcohol use and depression have on the same variables. A family study, characteristic of the present study, examining alcohol abuse and depression is of importance because past research has indicated that PTSD rarely occurs without the company of alcohol abuse and depression, factors that negatively impact home life. The current study examined the comorbid effects of alcohol and depression as well as the quality of marriage of these veterans on family functioning. This was done using a hierarchical linear regression of the responses from a web-based survey completed by 75 veterans with children between the ages of zero and eighteen. After examining demographic predictors such as gender, ethnicity, number of years served in the military, and number of children, we found that variance in family functioning of veterans transitioning back into civilian life is uniquely explained by a model that includes alcohol use and depression. A second model, which included the Quality of Marriage Index (QMI), better explained variance in family functioning relative to the model of comorbid alcohol use and depression alone. In the final model applied, depression and quality of marriage were significant factors in predicting family functioning. Considering that family functioning is a powerful influence on overall health and mental health the findings from the present study indicate that treatment of depression as well as an emphasis on a healthy relationship between intimate partners postdeployment may be advantageous for improving family functioning.

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Isolation of *Arthrobacter* Bacteriophage for Characterization and Genome Analysis

Alec Ingros, Alex Munoz, Andrea Springman, Caroline Addison, Chrissy Sessa, Christina Gaw, Cori Hughes, Daniel Zeter, Emily Johnson, Haley Everroad, Jake Hanna, Joshua Baker, Julia Hawes, Madison Powell, Micheal Munson, Natalie Widdows, Navya Katragadda, Niharika Koda, Niru Ancha, Noah Patton, Pranav Kapoor, Roshni Jaffery, Stu Mair, Thomas Eckenrode, and Tamarah Adair, Ph.D.
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Bacteriophages, viruses that target bacteria, are components of a variety of medical treatments for diseases such as Acute Bacterial Diarrhea, Cystic Fibrosis, and urinary tract infections.[1] Their importance has only increased with the growing occ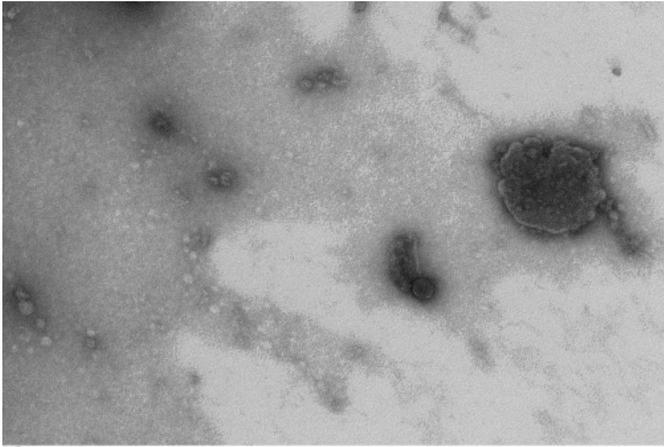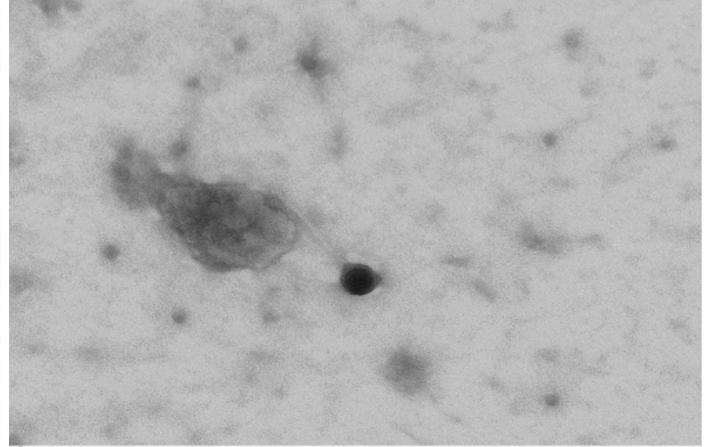urrence of antibiotic resistant bacteria.[2] In addition, the bacteriophage population is vast, numbering around $1x10^{31}$ phage particles within the biosphere.[3] This experiment aimed to increase the understanding of phage genomics, particularly by discovering new bacteriophages, in hope that they may contribute to further discoveries. The study was performed as part of the SEA-PHAGES (Science Education Alliance - Phage Hunters Advancing Genomics and Evolutionary Science) program, hosted by the Howard Hughes Medical Institute in conjunction with HHMI Professor Graham Hatfull at the University of Pittsburgh. Isolation, purification, and amplification procedures were performed to isolate phages from multiple environmental samples using the host *Arthrobacter sp.* A total of eighty-two environmental samples were collected from various locations throughout the country including California, Pennsylvania, New Mexico, and Texas. Soil extracts were filtered using a 0.2 μm filter and the lysate was enriched with the host bacterium, *Arthrobacter sp. ATCC 21022*. A series of plaque assays were performed and each positive plaque was passaged three times for purification. A total of twenty-five positive plates were identified and seven unique bacteriophages were isolated, purified and amplified until maximum concentrations were obtained. The concentration of the purified phage lysates was determined using serial dilutions and spot testing. Concentrated phage solutions were used to analyze the phage using electron microscopy. DNA was then extracted from phage lysates with a minimum titer of 107 pfu/mL. Nine mL of lysate was mixed with DNA and RNA nucleases to degrade contaminating host nucleic acids. Next, the coat protein of the viruses and the enzymes were denatured by the addition of the DNA binding resin, which contains guanidinium thiocyanate. After the DNA was uncoated and bound to silica resin, the DNA was column purified and eluted into Tris-buffer. The DNA concentration was determined by nanodrop and confirmed by agarose gel analysis (Figure 1). Four DNA samples were sent to the Pittsburgh Bacteriophage Institute to be sequenced using Illumina Sequencing. These phages, Lore (Figure 2), Shrooms (Figure 3), Nubia (Figure 4), and Caterpillar (Figure 5), are now part of the genomic database at phagesdb.org. Using computational programs, the genomes of these samples will be analyzed to identify genes, regulatory elements, and other genomic features.

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

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2016 URSA Winners Abstracts

Psychology and Neuroscience

Baylor Student Sleep Architecture: Why Baylor Students Need the Recommended 8 Hours
Madison Krueger; Mentor: Michael Scullin, Ph.D.

Despite the National Sleep Foundation's recommendation to sleep 8 hours/night, many college students do not prioritize sleep (choosing social or other activities at night) or believe that they cannot fall asleep if they go to bed earlier. It is no surprise then that more than 50% of Baylor students sleep fewer than 7 hours/night on average, which is detrimental to both cognitive performance and mental health. We hypothesized that Baylor students might show improved sleep in a quiet, sound-attenuated laboratory environment without distractions (phone, television, computer). We objectively recorded sleep architecture in forty Baylor Students for up to three nights (n=25) using polysomnography, which includes electroencephalography, electrooculography, and electromyography. Polysomnography data illustrate that sleep is not a single entity but rather cycles of stages: Stage one and two sleep are the lightest stages whereas REM and slow wave sleep are the deepest stages that are most vital to cognitive and mental health. Contrary to common belief that one cannot fall asleepbefore midnight, we turned out the lights at 10:30 PM, and students took an average of 20 minutes to fall asleep. Furthermore, in our controlled sleep laboratory environment, students on average slept for greater than 8 hours. We further identified that REM duration was slightly elevated in Baylor students, which may be due to chronic sleep restriction prior to participating. Therefore, Baylor students need at least 8 hours of sleep and can achieve this recommendation by going to bed earlier in a dark and quiet environment devoid of typical technological distractors.

A Randomized, Double-blind, Placebo Controlled Study of Oral Aniracetam in C57BL/6J Mice without Pre-Existing Cognitive Impairments
Taylor Jefferson, Conner Reynolds; Ashvini Pandian, and Meagan Volquardsen; Mentor: Joaquin Lugo, Ph.D.

The piracetam analog, aniracetam, has recently received attention for its cognition enhancing potential with minimal reported side effects. Prvious studies report the drug to be effective in both human and non-human models with pre-existing cognitive dysfunction, but few studies have evaluated its efficacy in healthy subjects. A previous study performed in our laboratory found no cognitive enhancing effects of oral aniracetam administration 1-hour prior to behavioral testing in naïve C57BL/6J mice. The current study aims to further evaluate this drug by administration 30 minutes prior to testing in order to optimize any cognitive enhancing effects. In this randomized, double-blind, placebo-controlled study, all naïve C57BL/6J mice were tested in tasks of delayed fear conditioning, novel object recognition, rotarod, open field, elevated plus maze, and marble burying. Across all tasks, animals in the treatment group failed to show enhanced learning when compared to controls. These results provide further support evidence suggesting that aniracetam conveys no therapeutic benefit to subjects without pre-existing cognitive dysfunction.

Psychological Correlates of Polysomnography-Defined Sleep Quality
Sanna Lokhandwala, Stacy Nguyen, Cole Rowley, and Hannah Ballard; Mentor: Michael Scullin, Ph.D.

Sleep is a biological drive that promotes mental and physical health. Whereas many people say they can function on four to six hours of sleep, the Centers for Disease Control and Prevention recommend seven to nine hours per night. Relevant to students, sleep quantity and quality are implicated in learning and memory, and sleep deprivation tends to impair attention and behavioral performance. We used the gold standard in sleep measurement—polysomnography—to investigate the correlation between sleep and an individual's mood and memory. Participants (N=32) ages 18-25 spent two consecutive nights in a controlled, sleep laboratory, during which we continuously monitored their sleep using polysomnography (PSG), which includes electroencephalography (EEG), electrooculography (eye movements), electromyography (muscle tone), and respiratory patterns. Thus, we were able to identify the different stages of sleep implicated in good sleep quality: Rapid Eye Movement (REM) and slow wave sleep (SWS). In addition, participants completed questionnaires on each night that incorporated a Depression Scale and a Rumination Scale to quantify their emotional state as well as two prospective memory questionnaires to quantify their difficulty completing delayed intentions (e.g., medication adherence). We hypothesize that greater sleep quality (e.g., increased SWS and REM) will be positively associated with better mood and prospective memory. A correlation between these factors would indicate that the type of sleep one obtains is as important as the total duration to determining emotional and cognitive health.

Severity of TBI in Post War Veterans and its Effects on Cortical Thickness
Zachery Sloan and Joel Reid; Mentor: Sarah Dolan, Ph.D.

Traumatic brain injury (TBI) is a condition that affects returning war Veterans. TBIs are thought to result from damage to axons induced by the force of an impact or blast wave, which causes axonal demyelination and neuron loss. In the cerebral cortex, neural loss can be observed as a thinning of the cortical mantle; thus, locally reduced cortical thickness can theoretically indicate a region of cortex affected by TBI. However, it is not known whether the severity of a TBI affects cortical thickness years after the TBI was incurred. To address this question, we studied cortical thickness in a veteran cohort ranging in age from 18-60. We hypothesized that there would be a measurable reduction in cortical thickness related to TBI severity. TBI severity was determined by the Vasterling TBI Assessment. Additionally, a high-resolution T1-weighted scan was acquired for calculation of regional cortical thickness. Once the scans were completed, a piece of software called Freesurfer segmented the white and gray matter. To account for any mistakes Freesurfer may have made, we hand corrected boundaries of both gray and white matter. Cortical thickness was calculated as the distance between the gray and white matter surfaces. At each point, cortical thickness was correlated against TBI severity across participants. In secondary analyses, cortical thickness was averaged across points within each gyral structure and correlated against TBI severity. Implications of observed relationships between TBI severity and cortical thickness will be discussed further.

Environmental Science

Microplastic Ingestion in Grunt (*Orthopristis chrysoptera*) Along the Texas Gulf Coast
Savannah Tarpey, Jessica Purtell, and Colleen Peters; Mentor: Susan Bratton, Ph.D.

Plastic microparticles, ranging between 50 and 5000 μm, reside within marine, freshwater, and deep ocean environments. While substantial literature has quantified the ingestion of macroplastics by marine vertebrates, relatively few studies have focused on the ingestion of microplastics and artificial polymers, such as polyester and nylon threads. This study documents microplastic ingestion by grunt (Orthopristis chrysoptera) from the inshore coastal waters, between Galveston and Freeport, Texas. A total of 122 grunt were collected from four sample locations, averaging 17.31 cm in length and 77.94 g in weight. Of the 122 grunt collected, 35 (29%) stomachs contained ingested microplastics. Neither fish length (p=.586, cc=0.050) nor weight (p=.899, cc=-0.012) was correlated to microplastic ingestion. Fish collected from Surfside Jetty had the highest frequency of microplastic ingestion (61%) and mean number of particles per fish (1.65), followed by Freeport Channel (24% and 1.33), 91st Street (20% and 1.25) and San Luis Pass (14% and 1.00). A total of 50 microplastic items were collected from the grunt stomachs and 98% were in the form of threads, with blue the predominantly collected color (46.8%). Additionally, there was one microplastic bead recovered from a grunt collected from Freeport Channel. There were no macroplastic items or additional microplastic forms collected from sample stomachs. While this study confirms the ingestion of microplastics by grunt, it is probable that species, feeding method, location, and levels of local anthropogenic disturbance influence the frequency of microplastic ingestion.

Geology

A Geological Comparison of the Oil Shale, Natural Gas, and Nahcolite Resources of the Piceance Basin and their Associated Extraction Methods
Hayden Ross; Mentor: Wayne Hamilton, Ph.D.

The Piceance Basin of the Green River Formation in northwestern Colorado contains an abundant accumulation of natural gas, oil shale, and nahcolite. This basin contains the single largest accumulation of oil shale deposits in the world with an estimated in-place value of 1.5 trillion barrels. Natural gas is currently being produced from the basin out of tight sands and coal seams using modern methods of hydraulic fracturing. The Piceance Basin also contains the second largest deposit of nahcolite in the world. Such a large energy potential is contained within the basin, and newer techniques of extraction will be needed to utilize its full potential. A high percentage of federal land covering the basin, combined with energy intensive extraction methods have made production only viable during higher oil and gas prices. Environmental impacts with current production methods have also hindered extraction in this area. This research will attempt to give the most viable extraction method for each resource based on depth, cost, environmental impact, and areas where the resource is most abundant. Various publications were collected and compiled in the attempt to better understand this complex and mineral-rich basin. The most efficient extraction methods were

chosen using the compare and contrast diagram made after gathering all data. After comparing and contrasting the different production methods for each resource based on the criteria, the results indicate that in-situ methods need to be used for oil shale and nahcolite production. Current methods of hydraulic fracturing have proven to be economic and environmentally safe to use for natural gas. Although the in-situ methods of recovery have proven to have a high success rate of both oil shale and nahcolite, they have a high-energy intake making it uncompetitive against modern methods of obtaining crude. Natural gas production in the basin has spiked in recent years as more efficient methods of hydraulic fracturing have been developed. A huge resource is contained within the basin, but better methods of extraction for oil shale and nahcolite will need to be developed to get the full potential out of the basin while also satisfying strict environmental policies.

Physics

Calculating the Gain of Silicon Photomultipliers
Nathaniel Chaverin; Mentor: Jay Dittmann, Ph.D.

The Compact Muon Solenoid (CMS), one of several large particle detectors at CERN's Large Hadron Collider in Geneva, Switzerland, records the energy of products of proton collisions using scintillating material, which emits light when struck by energetic particles. The light is then passed to a set of devices which translate the analog light signal to a digital electronic signal. While the current Endcap Calorimeter uses Hybrid Photodiodes (HPDs) to accomplish this, following its upgrade in 2017 it will use Silicon Photomultipliers (SiPMs). A major milestone for the project was a highly successful testbeam run at CERN in August 2015. The testbeam run served as a full integration test of the electronics, allowing a study of the response of the preproduction electronics to the true detector light profile. We present the results of the gain testing and conclude that SiPMs offer high-quality and consistent energy readout.

Chaos and Nonlinear Behavior in Inelastic Gravitational Billiards
Martin Martinez Jr.; Mentor: Jeffry Olafsen, Ph.D.

Billiards are simple systems used to investigate Hamiltonian dynamics in physics. When real billiards are examined experimentally, the energy dissipated in each collision must be replaced by an external stimulus to maintain the dynamics. We focus on a specific system of a driven billiard using a wedge shaped boundary to examine billiard using a wedge shaped boundary to examine nonlinear and chaotic behavior. Mathematical models such as the logistic map are simple low dimensional systems that exhibit nonlinear and chaotic behavior as a single parameter is varied. This logistic map can then be used to identify a very specific mathematical parameter known as the Lyapunov exponent, which helps in identifying chaos more clearly. In the current experiment, the dynamics of a particle free to move near a horizontally shaken vertical boundary will be examined for the presence of chaos. The goal of the research is to extract a Lyapunov exponent between any two trajectories in the system nonlinear and chaotic behavior. Mathematical models such as the logistic map are simple low dimensional systems that exhibit nonlinear and chaotic behavior as a single parameter is varied. This logistic map can then be used to identify a very specific mathematical parameter known as the Lyapunov exponent, which helps in identifying chaos more clearly. In the current experiment, the dynamics of a particle free to move near a horizontally shaken vertical boundary will be examined for the presence of chaos. The goal of the research is to extract a Lyapunov exponent between any two trajectories in the system.

Chemistry and Biochemistry

SEWing DNA Threads: A Model of DNA Unwinding
Katie Dodge, Carly Thaxton, and Danae Olaso; Mentor: Michael Trakselis, Ph.D.

Hexameric helicases are the proteins responsible for unwinding duplex DNA into single-stranded templates for replication. From archaea to humans these proteins are known as the minichromosome maintenance (MCM) family of proteins. It is widely accepted that the mechanism of unwinding includes encircling one strand by the hexameric helicase, while the other strand is excluded from the central channel. There is evidence to suggest that the excluded strand plays an important role during unwinding by interacting with the outer surface of the helicase. This new model is called the Steric Exclusion and Wrapping (SEW). By making alanine substitutions at positively charged residues on the external surface of the archaeal Sulfolobus solfataricus (Sso) MCM, we have determined important contacts between the excluded DNA strand and the helicase enzyme that further validate the SEW model. The excluded strand interaction is implicated in the control of the kinetics of unwinding and maintaining the single-stranded product for use by other replication proteins. Exterior alanine mutant SsoMCM recombinant proteins were

to assess the importance of each of the mutated residues to the electrostatic surface interactions with the excluded DNA strand. These assays showed generally lowered DNA unwinding rates but had unaltered ATPase activities that were stimulated in the presence of DNA. This data identifies possible single-stranded DNA binding sites during SsoMCM unwinding and validates the SEW model as a mechanism of helicase unwinding.

Thiosemicarbazone Compounds as Inhibitors of Cruzain as Potential Treatment for Chagas Disease
Chioma Ikedionwu and Prashant Appikatla Mentor: Mary Lynn Trawick, Ph.D.

Chagas' disease or American trypanosomiasis is a parasitic disease caused by Trypanosoma cruzi, which is transmitted by an insect vector or by a blood transfusion. The parasite requires cruzain, a cysteine protease, throughout its life cycle for multiple functions including evasion of the body's immune response and the This study aims to find novel inhibitors for cruzain, a validated target for Chagas, and to understand their mechanism of action, as well as, to create potential therapeutic treatments. Current drug treatments, including nifurtimox and benznidazole, are not very effective and have serious side effects. Consequently there is an urgent need for new treatment agents. This study investigates thiosemicarbazone compounds, synthesized in a collaborative project by the Pinney group at Baylor University, since they have been shown to be effective against cathepsin-L enzymes, which are homologous to cruzain. Fluorescence plate enzyme assays that measured the cleavage of the fluorescent product, 7-amino-methylcoumarin (AMC), from the cruzain substrate Z-FR-AMC allowed us to measure the enzymatic activity. Advanced kinetics, including progress curves, reversibility studies, and IC50 assays based on differing incubation times provided methods to evaluate the effectiveness and the mode of action of these compounds as inhibitors. Data from these analyses suggest that the inhibitors with low IC50 values are tight binding and time-dependent. Further investigation of these compounds is necessary to develop them into potential treatments for Chagas' disease.

Biology

Determining the Correlation between agr Polymorphisms and S. aureus Sensitivity to Blue Light Inactivation
Sarah Yuen; Mentor: Tamarah Adair, Ph.D.

Staphylococcus aureus is a Gram-positive pathogen responsible for minor skin infections, deep tissue infections, and even death. Antibiotic resistance of strains such as Methicillin-Resistant Staphylococcus aureus (MRSA) leads to an increased difficulty in treating "staph" infections caused by this bacterium. Due to the increasing resistance of staph strains to antibiotics, it is important to investigate and develop alternative modes of treatment for bacterial infections. Photodynamic therapy using 470 nm blue light has been identified as a viable alternative to antibiotic treatment, however significant differences in the sensitivity of strains to blue light have been found. This project investigated the role of a genetic component, the Accessory Gene Regulator (agr), found to be down regulated in *S. aureus* isolates exposed to blue light. While no correlation was found between *S. aureus* strains and the various agr types with their sensitivity to blue light, there is a statistical difference between the response of differing isolates which requires further investigation.

High Throughput Behavioral Analysis of Zebrafish Larvae Using Python Code and iPhone Recordings
Austin MacDonald Mentor: Joaquin Lugo, Ph.D., Crystal Usenko Ph.D., Erika Abel, Ph.D.

There is increasing evidence that zebrafish larvae can be used to investigate the effects of seizures on brain development. However, current methods are often expensive, and require specific operating systems and video software combinations to run correctly. Video software to quantify behavioral disruptions in zebrafish is a powerful way to collect large amounts of data. In addition, the software allows for many replicates and an unbiased analysis of behavior. Our study utilizes a high throughput freeware video analysis software created with Python. The software is flexible across operating systems (runnable directly from the Terminal, Command Prompt, and Linux), is open source, usable with any type of video file extension, and produces accurate unbiased quantification of the behavior. In this study, we developed the use of this software for assessing zebrafish activity using 10 to 20 minute long segments of iPhone 6 video recordings of swimming behavior. Controls were compared to 15 nM pentylenetetrazol (PTZ), which is a known convulsant, and 30mM tricaine (an anesthetic). PTZ exposure increased the overall movement per second compared to the control group, while exposure to tricaine significantly decreased activity (p value < 0.01). This Python Software has a wide variety of uses due to it being open source and the ease of experiment specific modifications that comes with that. During the process, the code was annotated for simplicity. Statistical analysis was conducted using Python libraries matplotlib and SciPy.stats. This method and software can be applied to analyze other recording platforms and

2016 URSA Winners Abstracts

Determinants of Variation in Left Myocardial Strain in the Dallas Heart Study
Grant Hallbauer; Mentor: Marty Harvill, Ph.D.

Myocardial strain measurement is a sensitive and non-invasive method to measure myocardial deformation that has been used previously to identify subtle subclinical abnormalities in systolic function. Furthermore, recent studies have identified impaired myocardial strain as a significant predictor of adverse cardiovascular events, even among asymptomatic healthy individuals with normal ejection fraction. For the present study we randomly selected 340 participants from the Dallas Heart Study Cohort who had a complete cardiac MRI imaging at baseline. . Global longitudinal strain (GLS) was measured using the TomTec Feature Tracking analysis software. On unadjusted analysis, higher strain (greater impairment in systolic function) seen in tertile 3 participants was associated with a greater burden of cardiovascular risk factors such as hypertension (tertile 3 vs tertile 1: 64.0% vs. 58.4%) and diabetes (22.1% vs. 20.4%) as compared with tertile 1 participants. Furthermore, higher strain was also associated with higher left ventricular mass, greater VAT, lower SAT, and greater concentricity. Left ventricular concentricity and visceral adiposity were independently associated with greater subclinical systolic impairment. In contrast, higher levels of subcutaneous fat were associated with a lesser degree of systolic impairment. These findings highlight the contributions of impaired strain towards the risk of adverse cardiovascular events among individuals with abnormal adipose distribution and increased concentricity.

Student Research Spotlight

A Survey of Undergraduate Research at Baylor University, Waco, Texas

Andrew Yancey--Sophomore Biochemistry major

I had the privilege to begin working in Dr. Pinney's research lab beginning the first semester of my sophomore year. In the lab I work with Ricardo Francis, a graduate student here at Baylor University. The main focus of the research entails the synthesis of benzophenone-based Cathepsin L inhibitors in order to slow the rate of metastasis of cancer cells. As an undergraduate student in the laboratory, I currently help Ricardo run reactions that are essential in achieving his goal of synthesizing reagents needed for more complex reactions. In doing so, I have had the. This mainly entails synthesizing reagents needed for more complex reactions. In doing so, I have had the opportunity to gain much experience performing many laboratory techniques such as setting up reactions, running Thin-Layer Chromatography (TLC), performing extractions, running column chromatography, and running Nuclear Magnetic Resonance Spectroscopy (NMR). When I first entered the research lab last semester, Ricardo was faced with the task of teaching me everything I needed to know considering I did not have any upper-level laboratory experience. As time has progressed, I have slowly become more comfortable and independent when performing tasks in the lab. Although performing techniques in the lab is fun, it is the theory behind those techniques that fascinates and motivates me. This research experience led me to greater confidence in applying the knowledge I already have to real-world experiences. At the same time, working in a research lab has taught me that I can never stop learning, making it that much more fun. Overall, I have thoroughly enjoyed having the opportunity to work in the research lab as an undergraduate student.

Rusty Wilson--Sophomore Psychology major

As a research assistant in Dr. Jo-Ann Tsang's social psychology laboratory, I administer studies designed by graduate students to participants on a weekly basis. The primary focus of this research lab is to study gratitude and the effect of various variables on attitudes and impressions. I began working under Dr. Tsang last spring, and since then, I have learned a lot about academia. For instance, I have seen and been a part of the processes of carrying out research studies. Before I was a research assistant, my impression of research was people in lab coats carrying out difficult quantitative tests with chemical reactions or microbiology. Through working under Dr. Tsang, I have realized that research has many different avenues and is very varied. The great breadth of interests that research spans across makes finding a professor who has a similar research interests not as daunting as it may seem at first. All in all, experiencing research was a positive and transformative experience for me.

Tanner Hood--Junior Neuroscience major

Since the beginning of my academic career at Baylor in 2014, I have been fortunate enough to be involved with multiple research proojects in the STEM fields. From studying C. Elegans as an infection model with the Department of Biology to investigating traumatic brain injury and PTSD with the U.S. Department of Veterans Affairs, my experiences in the sciences are relatively diverse. However, the most transformative project I have had the honor to be part of is not within the scope of STEM. With generous support from the College of Arts & Sciences, particularly the excellent Dean Elizabeth Vardaman, I launched an exhaustive investigation into undergraduate research experiences of Baylor students. Sampling students on awareness, interest and quality of experiences, I am most proud to have stimulated conversations of improvement at the highest levels of Baylor governance. By managing a study that I both designed and implemented, I could see the true heart and soul of research – curiosity. When thinking of research, it is easy to picture white coats and pipets. While this an essential element to scientific inquiry, it is important to remember that we are all researchers. We are all curious and we all seek truth. Ask that hard question, and you never know where it may lead you.

Aparna Sarode--Senior Biochemistry major

During my time at Baylor, I have conducted research in Dr. Abel and Dr. Usenko's Zebrafish Laboratory. My freshman year, Dr. Usenko was my Introductory Biology professor, and I heard a lot about her research during class and office hours. So, I had mentioned to her that I was interested in involving myself in her research, which resulted in an invitation to her lab the beginning of my sophomore year. My research project investigated the relative toxicity of organophosphate flame retardants in embryonic zebrafish. I really enjoyed my research experience and learned a lot through the guidance of my mentors. One of the most prominent values that I learned through my experience is the importance of teamwork in the research group. When working in a group, it is important to be accountable and fulfill the tasks assigned to you, even if it may be small responsibilities such as feeding fish or cleaning dirty tanks. Furthermore, I gained an appreciation for the dedication and time commitment necessary to conduct research. In the end, I learned that research is a lot of hard work, but that hard work is rewarded with a very gratifying experience.

Zachary Prankse--Freshman Neuroscience major

During my second semester at Baylor, I began working under Dr. Michael Scullin in Baylor's Sleep, Neuroscience, and Cognition (SNaC) Lab. Our research focuses mainly on sleep patterns and how they affect cognitive abilities, memory, and aging. As a research assistant, my responsibilities include running participants through cognitive learning and memory tests to administer polysomnography (PSG) tests, which track brain waves, blood oxygen levels, and eye movements in sleeping participants. Before I began working in Dr. Scullin's laboratory, I imagined most labs to be bright and noisy, so I was surprised to learn that our overnight participants stay in rooms that are just as nice as hotels! This made it very clear to me that research comes in many different forms, and labs are designed to meet the needs of both the researchers and participants. Additionally, since Dr. Scullin currently has only one graduate student working in the lab, I was given the opportunity to play key roles in Dr. Scullin's research projects. From my time spent in the SNaC lab, I can confidently say that I am looking forward to gaining more knowledge and experience.

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