7th annual

CURES IN BIO SYMPOSIUM

Course Based Research Experiences in Biology

BIO 1V90

BIO 1406

BIO 4108

April 29, 2021

Foster 250

4:00-6:00

MENTORS

DR. MARTY HARVILL

DR. TAMARAH ADAIR

DR. MYEONGWOO LEE

Welcome to the CURES in BIO Symposium,

After a very different year with many challenges and adjustments, we are proud to present the culmination of many long hours of research. The Department of Biology has addressed the need and demand for research experiences for undergraduates by developing course-based projects. This symposium includes first year students as well as seniors. The projects are both field work, bench work and in silico experiments. There is something here for everyone!

Thank you for your interest and support,

Tamarah Adair
Marty Harvill
Myeongwoo Lee

Courses and Instructors Participating in CURES in BIO 2021

BIO 1V90: BIO 1V90: Laparoscopic 1 and 2 **Instructor: Marty Harvill, Ph.D.**

BIO 1406: Wetlands Biology **Instructor: Marty Harvill, Ph.D.**

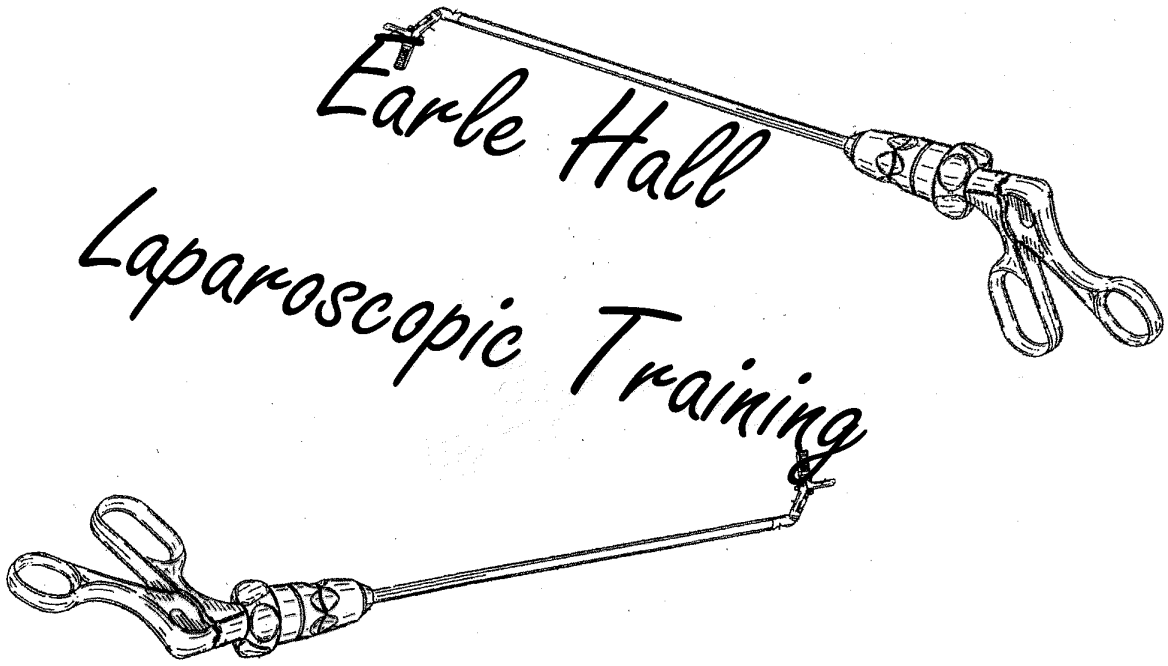
- Gabriel J Andino
- Annie Evelyn Arvidson
- Keree Dhiren Bhalodia
- Srikhar V Chilukuri
- Garrett Cooper Croley
- Duncan R Crosby
- Brandon Kyle Cunningham
- Abigail E Dotter
- Sowmya S Duddu
- Meredith N Ehlmann
- Benjamin Louis Fitch
- Jasmine Valentine Hartman Budnik
- Megan Nicole Hudson
- Alec T Kramer
- Madhumahita Maddukuri
- Emily K Massingill
- Leah Nicole McAleer
- Abhinav A Mehta
- Chloe I Meyer
- Jaycie Faith Moore
- Arvind Muruganantham
- Dylan John Riley
- Lydia Isabel Saucedo
- Bennett N Schackmuth
- Abel Reji Thomas
- Darren Wei

BIO 1406: SEA-PHAGES **Instructor: Tamarah Adair, Ph.D.**

- Sriram Avernini
- Grip Gilbert
- Nicole Wire
- Emily Young

BIO 4108: Cell and Developmental Biology **Instructor: Myeongwoo Lee, Ph.D.**

- Angela Leung



Lillian Saterbak, Eden Sauley, and Ben Fitch
1V90 Laproscopy/Harvill

The Effect of Physiological Stimulation on Laparoscopic Procedure Efficiency

Laparoscopy surgery is a minimally invasive surgical procedure that utilizes specialized techniques to perform various surgical tasks. Compared to open surgery, laparoscopy surgery reduces pain, recovery time, and scarring experienced by the patient. Many factors affect the efficiency and success of surgery. This study is interested in the effect of physiological stimulation on laparoscopic procedure efficiency . The study hypothesized that physiological stress will increase surgical efficiency to a point, shown in a negative correlation between the level of physiological stress and both the rate and error, but once that point is reached efficiency will begin a rapid decline with the level of stress showing a positive correlation with rate and error. Physiological stress found in a hospital environment was simulated through the completion of the FitnessGram Pacer Test. Stress levels were measured via heart rate, blood pressure, and oxygen saturation. These vital measurements were recorded before the stress test, immediately after the completion of the stress test, and after the completion of five trials of the FLS box exercise. The time elapsed and number of errors was recorded for each individual as participants completed ten trials of the FLS box exercise. The data collected was compared with control - no physiological stress - and statistical significance was found for the effect of physiological stress on the performance rate, but there was no significance found for the effect of physiological stress on the number of errors made. There was a negative correlation between physiological stress and the performance time recorded in the experimental trials

Grant Shrable, Ishan Pandey, and Ali Yousuf
1V90 Laproscopy/Harvill

Effects of Mobile Videogames on Laparoscopic Efficiency

The usage of smartphones in the workplace has increased with the rise of technology. Many professions, including those in healthcare can benefit from the implementation of smartphones in the workplace. There is no current research on this aspect of the healthcare field. Our study hopes to use the results to justify an increase in smartphone usage for surgeons prior to their procedures. This study examined the correlation between videogame usage and hand eye coordination among students in a laparoscopic surgery lab. An online survey was administered to 25 college students that are proficient in a laparoscopic pegboard exercise. The survey assessed level of perceived hand eye coordination as well as typical smartphone and technology usage among the students. A correlation analysis was conducted on the data. There was no significant association between those who had prior videogame experience compared to those who do not in reduction of pegboard exercise times. However, we saw significance in a reduction of pegboard exercise times for all students through the use of the game prior to the exercise.

Sarah A. Bentzin, Luke S. Jones, and Miranda J. Lutterbei
1V90 Laproscopy/Harvill

The Effects of Muscular Fatigue on Laparoscopic Performance

Previous research has demonstrated that muscular fatigue has a significant negative impact on concentration, fine motor control, and voluntary muscular force output. This study sought to investigate the impact of cumulative muscular fatigue on participants,Äô performance on a laparoscopy Peg Board task. The primary hypothesis was that participants would display impaired performance, observable through increased times, after completing multiple bouts of hand exercises to failure in the hours preceding the Peg Board task. The data was analyzed using two paired T-tests (alpha = .05), and a p-value of <0.0001 was obtained, indicating that the results were statistically significant in support of the alternative hypothesis that the average times of the “after” group (post-hand-exercises) were less than the average times of the “before” group (control). These results have positive implications for the surgical field as a whole. The data indicates that the performance of a fine motor task, even a perceivably strenuous one, may actually lead to short-term improvements in fine motor skills and surgical dexterity. Future studies may seek to investigate the degree of impact that muscular hand fatigue has on precision and more cognitively demanding motor tasks, in addition to the threshold at which muscular fatigue begins to negatively affect performance.

Rachel Brody, Samantha Davis, and Alagu Subramanian
1V90 Laproscopy/Harvill

The Effect of Varying Level Intensities of Acute Aerobic Exercise on Laparoscopic Proficiency

An average day for a surgeon includes multiple walks into the operating room preparing to intervene in the face of death; a responsibility that warrants surgery as more than a high-stakes performance. In many other professions that demand a similarly high standard of execution, preparation before performance is often required. However, as important as peak performance is in medicine, surgeons do not typically allot time to prepare their minds and bodies prior to surgery. This study explores whether a short duration of exercise at a defined intensity level (low, moderate, high) improves laparoscopic task proficiency in undergraduate premedical students (n=26). In the context of this study, the term “warm-up” for a performance-based task will be referred to as a Preoperative Aerobic Routine (PoAR). Each participant was randomly assigned a target heart rate zone and instructed to reach and maintain that level of heart rate output for six minutes. Participants then performed a peg transfer task to quantify performance. All experimental groups presented faster times and fewer errors when compared to control data. Participants in the highest intensity exercise level produced the greatest improvement in time-based proficiency. This study hypothesizes that consistent PoAR habits may have long-term benefit to laparoscopic performance and supports the need for further research to strengthen the link between aerobic exercise and surgical benefit.

Gaurav Ghosh, Tathagat Prayaga, Harry Divaris, and Srikhar Chilukuri
1V90 Laproscopy/Harvill

The Effect of Unknown Time as a Pressure on Laparoscopic Ability of Undergraduate Students

When a life is at risk, time is of the essence. The multitude of factors to consider during surgery is overwhelming, and a factor that specifically plays an important role is the amount of time allotted for a surgery. The amount of time is unpredictable since random events, like blood loss, can alter it within seconds. Surgeons are constantly under the pressure of time and are¬†forced to work quickly while maintaining a very high standard of accuracy. This led us to question: What is the relationship between time and the efficiency of a surgeon while performing surgery, including, when does the quality of the procedure begin to suffer due to a time constraint being placed on the surgery?

To answer this question, we conducted a research experiment in which multiple trials with different goals were conducted. The trends of the data showed whether limitations of time on surgery would affect the speed, accuracy, and/or precision of participants while completing the procedure. This can be related to surgeons and their efficiency when it comes to performing surgeries under a time constraint and whether a time constraint affects the performance of surgeons or not (1).

The null hypothesis: When the pressure of time (either negative or positive) was applied performance of laparoscopic students would not suffer

The alternate hypothesis: When a negative pressure of time was applied, the performance of laparoscopic students would suffer, and more errors would be made.

The task that the participants performed in this research experiment also forced the participants to be very focused and alert. The task that the participants were asked to complete recruited the use of motor skills like those used in surgery in that the participants used a laparoscopic box and tools used in laparoscopic surgery to complete the task (2 and 3).

The data collected in this research project gives insight on the time limit,Äôs effect on patient care and explores the idea of whether practicing surgery with unpredictable time limits can prove advantageous in some regards (4).

Esther Lee, Ashley Smelley, and Katie Steele
1V90 Laproscopy/Harvill

An Analysis of Caffeine's Effect on Laparoscopic Performance in Unpredictable Situations

Physicians consume more than double the recommended intake of caffeine per day to stay alert during surgeries. Emergency surgeries make up a significant portion of the overall operations performed by doctors, so it is important to understand caffeine,Äôs effect on these unanticipated surgical procedures. In this study, laparoscopic surgery simulators with a modified pegboard exercise and undergraduate students (n=26) were used to determine the effect of caffeine on laparoscopic performance in an unpredictable situation. Participants were split into two groups, with one receiving caffeine and the other receiving water as a control. Following the consumption of their treatment, subjects completed the modified laparoscopic pegboard exercise ten times, or as many times as possible in the allotted time frame. Additionally, surveys were given to the participants before and after the experiment to identify correlations between their lifestyle practices and their performance on experimental day. There was no significance between the performance of participants in the control group and the performance of the participants in the treatment group on experimental day (Unpaired t-test; P=.6701). The study found that there was a significant difference between the performance of subjects on control day and the performance of subjects on experimental day (Paired t-test; P=8.6336 x 10-5). An analysis of our survey data revealed that there was no correlation between any of the lifestyle practices of the participants and their performance on experimental day.

Jeremy Hsu and Jeanie Han, Kristiana Kasper
1V90 Laproscopy/Harvill

Effects of Growth and Fixed Mindset for a Laparoscopic Novel Exercise

Research has shown that people with growth mindsets, that is, they believe in a malleable skillset, are more motivated than those with fixed mindsets. The experiment applies this idea to laparoscopic techniques; it examines the relationship between growth and fixed mindsets, and time taken to learn a novel laparoscopic training exercise. Two different videos designed for each mindset were shown in the pre-survey exercise to cultivate students to temporarily adapt characteristics of each mentality. Each group completed several puzzles; the average time to complete each exercise was recorded. To analyze the significance of the data, a t-test was conducted on the times, and the survey data was quantified as well.

Poorvi Balaji, Caroline Graham, Conrad Harvill, and Leah McAleer (Research Mentor)
1V90 Laproscopy/Harvill

Effect of External temperature on laparoscopic performance in males and females

The focus of this study is to determine if there are adverse effects on a surgeon,Äôs performance as a result of cold stress and to investigate those effects for men and women. We attempted to induce cold stress consistently across the students and they performed the laparoscopic pegboard procedure while recording the time it took to complete the task along with the number of errors committed. To measure differences in manual dexterity and performance between male and female participants under surgery-like conditions, undergraduate students trained in the Fundamentals of Laparoscopy (FLS), completed pegboard exercises at 20C, and again in the same room wearing an ice pack around their necks to stimulate a colder, Operating Room, environment. To serve as an indicator of the temperature stress, students self-reported how cold they felt at various points during the trials, and simultaneously, had their external temperatures measured. Contrary to our initial hypothesis, females showed more of an improvement in trial times between control and experimental trials than did males, and both male and female trial times were shorter in the colder experimental conditions. A statistically significant difference was found between the effects of the cold stress on male and female performance ($p=0.0218$), indicating that males and females are affected differently by conditions in the operating room.

Victoria Beede and Amanda Ziegler
1V90 Laproscopy/Harvill

The Analysis of Laparoscopic Certified Undergraduate Students,Äô Performance of a Differential Exercise

Laparoscopic surgery is a type of minimally invasive surgery done on the abdomen or pelvis of the patient. The Laparoscopy course offered to freshmen at Baylor University employs different exercises using a laparoscopic box to train students in laparoscopy. This experiment consisted of a different exercise set up: a wire and a clear pvc tube. Students had 1 hour to complete ten separate trials, along with reporting their concentration levels after each trial was performed. It was hypothesized that participants with a lower average control time would have a higher average experimental time, and that students with higher concentration levels would therefore have lower experimental times, and therefore demonstrate proficiency. The results were indicative of a connection between the performance on control day and the performance with the new exercise, showing students with quicker times were able to adapt more quickly to the new exercise.

Marigrace McDowell, Sarah Stellberg, Sophia Chatzigiannidis, and Sowmya Duddu
1V90 Laproscopy/Harvill

An Analysis of the Effects of Personalization of Patient Care on Surgical Performance Through the Use of Laparoscopic Students

In an age of increasing reliance on technology over individualized patient care, the nature of patient care has shifted away from patient personalization in favor of more industrious and efficient methods of care. This study examined the effects of patient personalization on laparoscopic performance to determine if personalization affected surgical performance or the surgeon's mindset throughout the procedure. The presence of a correlation indicates that deliberate patient-physicians relationships influence the quality of care, suggesting that physicians should deliberately invest in patient interactions. 26 first year students across 2 Laparoscopic surgery classes were instructed to complete a pre-experimental survey of short answer questions inquiring about their personal lives, including their major, hobbies, interests, and future ambitions. A third of the students' responses were formatted within a template to construct hypothetical patient biographies reflecting the specific participants' survey response. Another third of the class received a generic hypothetical patient biography utilizing the same template as the personalized group. The final third was given minimal patient information. The three groups were instructed to memorize their hypothetical patient information in the week prior to the experiment. Immediately before completing ten trials of a pegboard exercise, all students recited their patient information. After 5 trials, all students were falsely informed that their patient was in critical condition. Statistical analysis supports the conclusion that although the group of students with personalized information felt a stronger connection to their hypothetical patients, personalization did not affect physician performance.

Alisha Hoefs, Isabelle Ford, and Diamond Nguyen
1V90 Laproscopy/Harvill

The Effects of Caffeine Consumption on Laparoscopic Performance on Practical Exercises

Surgeons are often on-call for surgery throughout the day. Their lack of sleep is why many rely on caffeine. Research on surgical performance and caffeine is important to investigate because caffeine could influence patient care. This study aimed to understand how caffeine affects a subject's performance on a laparoscopic practice exercise. It was hypothesized that individuals would perform worse after consuming caffeine. A sample of twenty-three students was taken from the Undergraduate Laparoscopy Lab at Baylor University. Each student performed the same pegboard exercise. Each participant was given a score that was calculated by adding their time in seconds plus an additional ten seconds for any error. An error is when a peg is dropped out of reach or out of the camera frame. Proctors recorded peg drops that did not count as errors as well. Students performed the pegboard exercise on control day, and they were not allowed to consume caffeine. Students were randomly assigned to either drink a single shot espresso or a double shot espresso before completing the exercise on the experimental day. The results from the paired t-test to compare the control and treatment scores indicated significance in the results. Therefore, we can conclude that the mean score in caffeinated individuals is greater than the mean score in individuals who didn,Äôt consume caffeine, meaning individuals who consumed caffeine performed worse. Therefore, further studies should be conducted to verify these findings as understanding whether caffeine can impact laparoscopic performance.

Jason Leaf, Grace DeAlessandro, and Jacque Matthews
1V90 Laproscopy/Harvill

Ergonomics of Monitor Display Positioning While Performing a Novel Laparoscopic Cyst Dissection Technique

Determining optimal monitor height for practicing laparoscopic surgeons is essential for maximizing surgeon comfortability and, thus, efficiency. One of the most important factors in surgical ergonomics is the height at which the monitor is placed. This experiment evaluated subject comfortability at three monitor position heights (low, medium, high) while performing continuous attempts of an previously unpracticed novel “cyst dissection” technique. Monitor height and angle were adjusted to exemplify their respective impact on subject comfortability. Participants completed a pre and post-survey ranking discomfort in the neck, wrists, shoulders, back, and forearms on a scale (1-5). Participant preference and success rate was evaluated at each of the three positions. Survey responses generally demonstrated less musculoskeletal discomfort at the medium position, while performance was optimized at the highest monitor position. Correlation between participant’s preference and successes at that position was observed.

Malay Shah, Alex Crego, Michael Ho, Arav Wijesinghe, and Arvind Muruganantham
1V90 Laproscopy/Harvill

Development and validation of a low-cost virtual reality (VR) assisted laparoscopic intestinal tumor removal surgery simulator

Virtual reality (VR) has recently gained a role in medical training for simulating complex procedures. Furthermore, high-quality surgical simulators modeling specific surgeries are often prohibitively expensive to be made widely available to medical students and surgical residents. In this study, we simultaneously developed a low-cost laparoscopic intestinal tumor removal surgery simulator while testing subject performance before and after VR augmentation. The simulator was constructed with a pliable plastic casing to contain the operating field and rubber tubing to simulate the large intestine. Rubber pegs, simulating cancerous masses, were placed under flaps in the tubing to be discovered by an endoscope lowered by the user at the top of the simulator. A second camera allowing a view of the entire operating field was also placed at the top of the simulator to be easily maneuvered by the user. To evaluate the efficacy of VR augmentation on laparoscopic surgery simulation, we recruited a cohort of Baylor University undergraduate students enrolled in the BIO 1V90 Laparoscopy Lab to pilot our simulator. Subjects were allowed to familiarize themselves with the simulator for 5 minutes before being instructed to complete the tumor removal exercise. Afterwards, subjects were allowed to survey the operating field using a VR 180-degree photograph shown to them on a Google Cardboard headset and were instructed to complete the exercise again. A pairwise comparison of subject performance pre/post-VR augmentation was conducted and survey data was analyzed to yield important insights on the role of VR in surgical training.

Neha Mullassery, Jaishnav Reddy, and Jessica Ngo
BIO 1406 SEA-PHAGES/Adair

Cross-cluster Analysis of Tape Measure Protein Structure in Siphoviridae Arthrobacter Phages

Bacteriophages (phages) are host-specific viral particles that lyse bacteria. The bacteriophage population is dynamic and genetically diverse. Phages in a cluster exhibit similarity, but inter-cluster pairs usually show little nucleic acid similarity. The tape measure protein (TMP) determines phage tail length and helps deliver phage genome into the host cell. This study examined the similarities in the conserved sequences between the tape measure proteins of siphoviridae *Arthrobacter sp*. ATCC 21022 phages across different clusters in order to gather evidence regarding the evolutionary history of these phages in their tape measure proteins. Primary, secondary, and tertiary structures of one phage from each of 5 clusters, AM, AQ, AK, AU, and AR, were visualized using bioinformatics tools such as BLASTP, Phyre2, Emboss Pepinfo, and Geneious. The primary sequences of the TMP do not indicate a high degree of similarity across phages. However, the secondary and tertiary structures contain areas of similar folding potentially due to similar amino acid properties as seen in the hydropathy plots. In four of the five phages, alternating hydrophobic and hydrophilic regions give rise to alpha-helix patterns, while one phage, Amigo, folded as beta pleats likely due to its hydrophilic nature. In addition to the phylogenetic tree of TMP across clusters, these results provide evidence for an evolutionary relationship between siphoviridae phages of *Arthrobacter sp*. ATTC 21022.

Emily Yamada, Mikyla Khan, and Sydney Trampedach
BIO 1406 SEA-PHAGES/Adair

Investigation of Arthrobacter Phage Casserole Gene 29 with structural alignment with Human Talin 1

The Casserole Arthrobacterphage, annotated by the Baylor University SEA-PHAGE program, is of the podoviridae morphology which is known to have short, non-contractile tails and lacks a tape measure protein. The tape measure protein dictates the length of tails in other morphologies like siphoviridae. Gene 29 in Casserole is the longest gene and is located in the tail coding region. Gene 29 has synteny to all other phages in the AV cluster, indicating its significance. Since the gene has no known function, the aim of this study was to analyze the amino acid sequences and protein structure of Casserole gene 29,Äôs highest coverage hit from the Yang-Zhang lab program in order to observe the possible functions of gene 29. We initially hypothesized that gene 29 in Casserole could represent an ancestral relic tape measure protein. After running multiple blast alignments with proteins from Pham 57431, consisting solely of tape measure proteins, against Casserole_29, there were no BLAST hits. This led us to reject our hypothesis. We observed amino acid percentages within gene 29 using Predict Protein as well as the Yang-Zhang Lab program to obtain a partial 3-D protein prediction, alignment, and amino acid sequence. The Yang-Zhang program found an alignment of 92.8% with the Human Talin-1 genome. With evidence of no significant alignments to a tape measure protein and amino acid compositions, we observed a significant correlation between Casserole_29 and Human Talin 1. Since structure aligns with function, we suspect that the gene may have basic cellular functions similar to Talin such as binding, which can be further researched.

Sai Sagireddy, Kim Phan, and Mary Mersereau
BIO 1406 SEA-PHAGES/Adair

A Study of Direct Terminal Repeats and Terminases in AP, AQ, & AV Arthrobacter phages

The DNA packaging strategy of a bacteriophage is determined by its genome ending. Different bacteriophage genome endings include 5'cos, 3'cos, Headful, Direct Terminal Repeat (DTR), and Host Fragment. This study analyzed nineteen Arthrobacter sp. ATCC 21022 phages (from the AP, AV, and AQ clusters) that each contain a DTR genome ending, which is characterized by a repeated genomic sequence at the beginning and end of the genome. Phages that have a DTR of a few hundred base pairs are predicted to use the linear concatemer packaging strategy, while phages with a DTR of over one thousand base pairs are predicted to use the complex concatemer packaging strategy. In addition to DTRs, terminase proteins are important for DNA packaging because they cleave DNA during the replication process. In this study, the DTRs of the nineteen phages were analyzed and compared within their own cluster as well as to the other two clusters, packaging strategies were predicted, and the correlation between DTR length and terminase protein structure was explored. For each phage, genome length, DTR length, and percent DTR were calculated and recorded. Based on this data, clusters AV and AQ were predicted to use complex concatemer replication, while cluster AP likely uses linear concatemer replication. Superpose, a bioinformatic tool, was then used to determine if phages with a similar DTR length also share similar terminase structure. The results suggested that most phages in the same cluster share a similar DTR length, as well as similar terminase structure. Although clusters AV and AQ share a statistically similar DTR length, their terminases were notably different, showing that terminase structure depends on the phage cluster, rather than the genome-ending characteristic. Future research can determine the impacts of differing terminsases as well as confirm the predicted packaging strategies of the three clusters.

Lauren Crowhurst, Madelynn Howard, and Anne Madison Trammell
BIO 1406 SEA-PHAGES/Adair

Analyzing the impact of point mutations on amino acids and protein structures for the major capsid & protease fusion protein gene in twelve Arthrobacter AM bacteriophages

Bacteriophages are viruses that kill bacteria, and have shown potential for usage in fields of research and medicine. Phage genetics can be viewed in terms of the Central Dogma of molecular biology, which describes the transfer of information from nucleotides to amino acids to protein structure. The aim of this research is to trace the impact of single nucleotide point mutations on the amino acid sequences of one gene for multiple phages, and analyze the resulting protein structures for changes that could impact its overall function. The AM cluster phage major capsid and protease fusion protein gene, which assembles and processes the capsid of the bacteriophage, was the center of this study. Several bioinformatics tools were employed such as Phamerator, which provided the nucleotide and amino acid sequences. Clustal Omega aligned the sequences, which were then put into Jalview to obtain a consensus sequence for each. The consensus displayed the overall most accepted sequence for the nucleotides and amino acids. Each sequence of nucleotides or amino acids was compared to the consensus using BLASTP and BLASTN. RaptorX gave a visual representation of each phage's protein, and these structures were superimposed using UCSF Chimera. It was observed that single point mutations can lead to changes in protein structure, though the overall protein structure in this study was strongly conserved. This research is important in understanding the potential impact of point mutations on structures and functions of phage proteins. Future research may determine which functions, if any, are consistently altered by point mutations present in the Arthrobacter AM cluster.

Noor Khader, Anne Estes, and Elijah Roberts
BIO 1406 SEA-PHAGES/Adair

A Comparative Analysis of Arthrobacter AV Cluster Primase/Helicases and RecA-like Recombinases

Due to inherent similarities in function, many of the proteins of a prokaryotic replisome are very similar in sequence and shape. This study was conducted to investigate the relationship of the DNA primase-helicase protein of the AV Arthrobacter phage cluster and various related RecA-like Recombinases. After reviewing select replisome proteins and RecA-like recombinases, protein sequences were input through BLAST to find similar sequences. Certain sequences were then selected and modeled for 3D protein structure and were grouped according to sequence similarity using a phylogenetic tree. Significant variation was found within the replisome proteins of Arthrobacter sp. phages. No BLAST hits with an e-score better than 1x10^-20 were found outside of the AV cluster except in one singleton phage of the same pham. Of the next 12 best results, 10 were recombinases, and 2 had no known function. The phylogenetic tree that was generated grouped AV primase/helicases closer to rec-A like recombinases of other hosts and clusters than known primase/helicases of the same host and other hosts, indicating more shared sequences and possibly a closer evolutionary relationship. Furthermore, 3D prediction modelling confirmed this, as AV primase/helicases showed extreme visual similarity to recombinases. These data suggest that AV primase/helicases have significant sequence similarities with recombinases and have an evolutionary gap between them and other known phage primase/helicases.

Gabriela Perales, Brianna Lieblang, Gabriela Perales, Brandon Cunningham, and Jamie Roberman
BIO 1406/Harvill

The Effects of Temperature & Melatonin on Mitosis in Dugesia dorotocephala

This experiment disproves the hypothesis that the increase in melatonin concentration and temperature will promote the rate of *Dugesia dorotocephala* regeneration. To do this, five test groups and one control were compared. The control group was no melatonin at 21C; 21 C being the ideal temperature for *Dugesia dorotocephala*. Test groups consisted of concentrations of 10^-6 and 10^-4 µM of melatonin at 21 C and 28.5 C. The *Dugesia dorotocephala* in each group were measured every three days for two weeks. It was found that the increase in melatonin concentration and temperature does not promote the rate of *Dugesia dorotocephala* regeneration. Temperature had insignificant effects on regeneration rate, and melatonin decreased the regeneration rate.

David Tran, Jack Cantarella, and Angelita Munoz
BIO 1406/Harvill

Studying Memory Consolidation in Crayfish through operant conditioning to determine viability as a model organism

Sleep modulates the phenomenon of memory consolidation for vertebrates and invertebrates; utilization of invertebrates for sleep studies would allow for less restrictive experiments. Crayfish provide a potential model for the effect of sleep on memory consolidation. Crayfish will be conditioned with electric shocks before sleep cycle disruption. Disruption of sleep may affect memory consolidation and increase time for successful conditioning. Results could be used to justify the use of crayfish as model organisms for future cognitive experiments to explore the relationship between sleep and memory.

Samuel Frison, Jackson Karpinsky, Brandon Cunningham, and Randy Nguyen
BIO 1406/Harvill

Magnetoreception in Dugesia dorocephala

Magnetoreception is the ability to detect magnetic fields. This ability can be found in various organisms, like birds, ants, bees, and even smaller organisms such as bacteria. This experiment tested if *Dugesia dorotocephala* , a species of planarian, had magnetoreception by monitoring their behavior and movement patterns as they swam in a Petri dish with magnets under it. The data did not show any statistically significant difference between the presence or absence of the magnets, suggesting that they do not detect or behave differently around magnetic fields.

Nathaniel Takle, Johnathan White, and Daniel Alarcon
BIO 1406/Harvill

Dugesia dorotocephala Regeneration Observed Under Chromium (VI) Oxide & Glutathione Exposure

In this study we observed the effects of chromium (VI) oxide and glutathione on the regeneration rates of freshwater planarians. A control group containing 20 planaria submerged in 50 mL of spring water was compared to two trials run synchronously with 50mL of the corresponding low and high doses for both substances. Results showed: 20 control planaria to have survived and regrown completely; planarias with the chromium high treatment showed a decrease in mean growth; and all other groups showed no statistically significant increase or decrease in average growth. We hope to apply our findings to the effect of high chromium concentrations in water on humans, and the possibility of glutathione to have an opposite effect by preventing cancer progression and promoting antioxidant activity.

Christian Chang and Conrad Harvill
BIO 1406/Harvill

Crops Ability to Grow Under Mars Like Conditions

The purpose of this research is to explore to what extent it is possible to grow crops in Mars like conditions. We hypothesized Earth crops were not going to grow well in the mars like conditions. The crops were sealed in containers with mars soil and earth soil and with a 95% CO2 concentrated atmosphere. Corn had a higher dry mass than wheat and beans.

Hannah Whittaker, Kayleigh Mann, and Gracie Tillman
BIO 1406/Harvill

The Study of Planarian Regeneration Under Different Temperatures

This experiment examined the growth of *Dugesia dorotocephala* at the temperatures of 6C, 14C, 21C, and 25C. These worms were severed in half and placed in water baths of the prior temperatures for four weeks while their lengths were monitored. Another notable factor of the planarians that was comparable among the different temperatures was the typical behavior of the worms. Concerning the regeneration growth, the variable of temperature in our data resulted in a p-value of .3919 (Figure 1), concluding that the factor of temperature did not produce a difference in planarian growth.

Andrew Littlefield and Nick Tibbs
BIO 1406/Harvill

Effects of Vitamin B12 on Algal Growth & Oil Production

In a field full of cutting-edge research, and a world running through non-renewable resources, it's a race to find reliable and renewable resources. Algenol, a frontrunner in algae biofuel research and production, converts algae into biofuel with yields nearly 17 times higher than those of corn, while producing 1.4 gallons of fresh water per every gallon of fuel produced, (Legeer). The experimental factor in this research study is the concentration of additional Vitamin B12, which is a main factor in biofuel production in Chlorella. There will be two trials, with each trial composing of 1) Control (0ng), 2) Sample 10ng, 3) Sample 100ng, 4) Sample C (1000ng). Over the course of three weeks, algae population density readings will be recorded, then collected, vaccum filtrated, and pressed.

Katelyn Jackson, Caroline Kotarski, Allie Weber, Lydia Saucedo, and Emmie Jenkins
BIO 1406/Harvill

The Effects of Circadian Rhythm and Usage of Caffeine on *Drosophila melanogaster* Development

The intent of this study is to observe the effects of altered circadian rhythm and caffeine on development of *Drosophila melanogaster*, or fruit flies. Caffeine is a widely used stimulant by humans, and is associated with increased alertness and wakefulness following consumption. *Drosophila melanogaster* are known to have the same sleep cycle as humans. In this study, *Drosophila melanogaster* were split into four groups and received either a standard circadian rhythm (12hr light/darkness) or an altered circadian rhythm (6 hr light/darkness), along with either receiving caffeine (dosage), or no caffeine. The amount of pupa and flies were counted regularly in each vial to document the development of the Drosophila. Upon the collection of the results, it was determined that the circadian rhythm was the only variable to have a statistical significance on the number of pupa, as the groups that received the standard had a higher average number of pupa (10) compared to those that received the altered circadian rhythm. Additionally, it was shown that the caffeine was significant in the number of flies in the standard circadian rhythm, as overall the groups that received caffeine had lower numbers of flies compared to those who received the standard medium. Therefore, the data supports the proposed hypothesis that caffeine hindered the development of the flies.

Kayla Smith, Laura Demchak, and Meagan Manalo
BIO 1406/Harvill

The Effects of Diphenhydramine on Daphnia m. Reproductive Rates

The project had the intentions of quantitatively describing the effects of Diphenhydramine on *Daphnia magna*. The discovery of pharmaceuticals remaining in water systems despite prior water regulation laws provoked curiosity regarding the unknown effects of diphenhydramine in water systems on organisms. Since some aquatic organisms have the primary role of reducing the amount of harmful toxins in our sewage system, putting their species in danger is detrimental to our health (Helfrich et al.). After multiple trials with various dosages of diphenhydramine, it was difficult to obtain accurate results due to undetectable variabl

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Effects of Ethanol on Motor Control, Memory Consolidation, and the Potential for Tolerance on Dugesia tigirina

Dugesia tigrina was tested over the course of three weeks to determine the effect of ethanol upon memory consolidation, motor control and tolerance. Planarians were separated into groups containing dilute concentrations of ethanol (1%, 2%, 2.5%, and 3%). Two samples of 10 *Dugesia tigrina* were used in each of the dilute, constant, concentration of ethanol groups. One control group as well as three groups (each containing 20 Dugesia tigrina) that were exposed to increasing amounts of ethanol in an effort to measure tolerance. Ethanol proved to significantly inhibit memory consolidation for the increasing concentration of ethanol groups and motor control of *Dugesia tigrina* introduced to >1% ethanol. Tolerance was not achieved by *Dugesia tigrina* as they were immobilized far sooner than anticipated (at 2% rather than 3%) for the increasing concentration of ethanol groups.

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The effect of mutating W387 on tln-1 (kq387) in C. elegans

Caenorhabditis elegans are a soil nematode that has been used in the past decades to study genetics and neurobiology. They are favorable model systems to use in genetic studies due to their short generation time, a large number of progeny, and relative ease of cultivation. In this project we will be focusing on characterizing the function of the gene tln-1(kq387) using CRISPR-Cas9. The tln-1 protein is ultimately responsible for integrin NPXY motif binding which promotes integrin linkage between actin cytoskeleton and the extracellular matrix. Without this binding, defective mechanotransduction can occur which has been shown to cause many diseases in humans. The tln-1 protein also aids in the assembly of actin filaments, cell survival, cell adhesion, and cell migration. Although the exact mechanism of these interactions remain to be understood, mechanical forces on the cell membrane are essential for morphology, organelle arrangement, and overall viability. Using the CRISPR-Cas9 gene-editing system, we induced a W387A mutation (tryptophan to alanine in amino acid # 387) in the FERM F3 domain of tln-1 gene. This mutation expect to repress β integrin NPXY motif binding which in turn, disrupts cell migration and cytoskeletal organization. To produce the edited mutants, CRISPR-Cas9 was used to creat the tln-1(kq387) allele from wild-type *Caenorhabditis elegans*. This mutation ultimately disrupted W387 located in the FERM F3 domain rendering the β integrin NPXY motif binding site inactive. Previous studies indicated this mutation decreases cellular morphology which was observed through comparing the phenotypes of the wild-type to the mutants. The application of this research is evident in the well-known repercussions of mechanotransduction defects. Through this experiment, we can examine the importance of the tln-1/talin gene to further our understanding of the mechanisms behind diseases resulting from these mechanotransduction defects such as muscular dystrophies, cancer, and cardiomyopathies.

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The study of deb-1/vinculin in *Caenorhabditis elegans* using the CRISPR-Cas9 gene-editing system.

Caenorhabditis elegans, commonly known as *C. elegans*, serve as a useful model organism for research because the genome has been sequenced. Many developmental pathways can be directly compared to processes in more complex organisms like humans. In *C. elegans*, deb-1 is a protein that is associated with actin cytoskeleton, which localizes to multiple cellular components, including the dense bodies and muscle M-lines. DEB-1 is an orthologue of the mammalian vinculin (VCL) that is linked to dilated and hypertrophic cardiomyopathy, but its function still remains fully understood. Using the CRISPR-Cas9 genome editing system, we mutated the 99th amino acid Y, a putative tyrosine phosphorylation site, to A (alanine), designated kq99. To do that, wild-type N2 worms were micro-injected with "deb-1" crRNA with dpy-10 co-CRISPR marker and tracrRNA and isolated deb-1(kq99) worms. Preliminary analysis of deb-1(kq99) phenotype indicated that the resulting progeny displays mildly uncoordinated movements. In humans, vinculin plays a critical role with actin-myosin focal adhesions and the mechanotransduction within the cardiac muscle cells. This study will induce further understanding to the role of deb-1/vinculin in relation with dilated and hypertrophic cardiomyopathy.

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Characterization of gene unc-52 (kq62) in C. elegans

The unc-52 gene contains four immunoglobulin domains which serve the purpose of forming an organized structure, a lattice, for proteins in the basement membrane. The mutation was located in the 14th immunoglobulin repeats in domain IV and is responsible for the phenotypic alterations. However, in humans, the gene homologue encodes a major proteoglycan core protein, Perlecan, a major component of the extracellular matrix (ECM). Before using CRISPR-Cas9, we placed wild-type *C. elegans* onto agar plates using aseptic techniques and later mutated the kq62 allele. Once kq62 was mutated, it was then cloned and amplified using PCR techniques. To ensure the cloning was successful, the wild-type and mutated samples were analyzed using gel electrophoresis. To visualize the genomic sequence which contained the mutated kq62 allele, Sanger Sequencing techniques were used, and conclusions were drawn about the location and characterization of the mutation. The mutation targeted exon 19 in the unc-52 gene, which resulted in a deleted allele in the 14th immunoglobulin repeat of domain IV. Upon mutation, the unc-52 gene was found to be correlated to uncoordinated movement in C. elegans. Further characterization of the genome is underway. Current experiments have found that unc-52 is a general basement membrane component in *C. elegans*. The role of unc-52 in *C. elegans* reveals it is specifically associated with contractile tissue. Looking to the future, there are possible areas of study when comparing the phenotype and genotype effects of mutation on the unc-52 (kq62) in C. elegans compared to the mammalian genome. One of which being determining the importance of the unc-52 homolog's role in the production and maintenance of the extracellular matrix. Further research can be conducted looking into possible treatments for diseases with ECM components, like Schwartz-Jampel syndrome 1 and Silverman-Handmaker disease.

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Phenotypic characterization of unc-52(kq61) mutant in Caenorhabditis elegans

The unc-52 is a gene expressed in *C. elegans* that is primarily responsible for the production of proteoglycan that aid in the direction of myofilament assembly and extracellular matrix (ECM) development. The unc-52 gene is similar to the mammalian gene HSPG2, which codes for the core protein of perlecan, which is a mammalian proteoglycan responsible for crosslinking ECM components through glycosidic linkages. Perlecan is a relatively large molecule that contains five different domains that bind in various ways to connect the cell. Human perlecan is coded by the heparan sulfate proteoglycan 2 (HSPG2) gene, and it is homologous to *C. elegans* unc-52. The phenotypic effects of known unc-52 mutations include retarded sarcomere construction, progressive paralysis, and general, uncoordinated movement of the animal (Martinez et al., 2018). Due to the nature of ECM development, the basement membrane perlecan has been implicated in many important stages of cellular development, such as gonad formation and myofilament lattice formation (Lee et al., 2020). UNC-52 contains five various domains - the fourth of which contains seventeen Ig-like repeats (Mullen et al., 1999). The kq61 is an allelic mutation on domain IV generated by the CRISPR-Cas9 gene editing system in the lab. Comparing previously studied mutations to different amino acid positions elucidates relevant, holistic information on the phenotypic effects of unc-52 mutations. A marker dpy-10 was used to identify the mutated worms. Once the worms were identified, they were isolated and analyzed for phenotype and molecular lesion. Considering perlecan's homology to UNC-52, research involving the unc-52 gene could potentially be used for further understanding of the behavior of heparan sulfate in the human body as well as the efficacy of immune response to wounds.

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Knockdown of five RGD motifs in HIM-4, the Orthologue of Human Hemicentin found in the Nematode Caenorhabditis elegans

The X-linked him-4 gene found in *Caenorhabditis elegans* is responsible for the production of Him-4, a highly conserved protein and orthologue of mammalian hemicentins. Human orthologue Hemicentin 1 is responsible for macular degeneration. HIM-4/hemicentin is accumulated between the basement membranes and forms the “B-Link” with other proteins to promote anchor cell invasion during vulva development. The protein also promotes the basement membrane degradation and is produced from muscle, gonad, and germ cells. In C. elegans, the loss-of-function mutation in him-4 causes lower brood sizes, abnormal reproduction, and high incidence of male (Him) phenotypes. The Arginine-Glycine-Aspartate (RGD) is a cell-binding motif of extracellular matrix (ECM) proteins. The ECM receptors like integrins bind to the RGD motifs and anchor the cells to the ECM. To study the function of RGD motifs in HIM-4/hemicentin, the 5th RGD mutation was introduced into the him-4 gene using a CRISPR guide RNA selection tool. Once the F1 generation was produced, they were screened and ran through a PCR genotyping; the worms showed the mutation were then screened further to isolate the F2 homozygous mutant. The HIM-4/hemicentin contains six RGD motifs. When three or four RGD,Äôs were knocked out using CRISPR/Cas9 Mutagenesis, no behavioral or mechanical changes were observed. Therefore, we created an additional RGD to RGE mutation in amino acid number 717. Now, five of the six were mutated into Arginine-Glycine-Glutamate (RGE).
Further research will provide greater insight into the nature of Integrin-RGD interactions. Targeted point mutations could illustrate the importance of other proteins in the fibulin family. Human Fibulin 1D is a tumor suppressor, which is owed to several protein-protein interactions in the ECM. Further research may reveal that hemicentins and other fibulins function in similar ways, and perhaps directed mutagenesis can be used to slow or stop tumor development.

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The Role of Zyx-1 in Response to Mechanical Stress and Synaptic Stability

Caenorhabditis elegans are soil dwelling nematodes that are commonly used as model organisms for developmental genetics. In this experiment, we are focusing on the Zyx-1 gene, which is homologous to the Zyxin gene in mammals, including humans. The Zyx-1 gene is responsible for many functions in *C. elegans* including acting as a mechanical stabilizer (via LIM domains) of focal adhesions. By helping to stabilize focal adhesions, Zyx-1 in turn plays a role in protecting mechanosensory synapses from locomotion-induced forces. The goal of this experiment is to confirm the function of Zyx-1 as discussed. Using the Crisper Cas-9 gene editing system, we were able to delete about 90% of the Zyx-1 gene. With the loss of the gene we expected to find a decrease in response to mechanical stress, however, the results did not show any obvious phenotypic changes in the C. elegans. This evidence implies that the LIM domain may be able to mediate stress response independently of ZYX-1. We plan to conduct further research into the interaction of Zyx-1 and its role in stabilizing synaptic contacts during development. By further understanding the nuances of this pathway, it could lead to further exploration of the mammalian homolog, Zyxin, and better help those who have diseases due to disfunction of the gene.

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Motility variation of unc-52 mutants of Caenorhabditis elegans

The nematode, *Caenorhabditis elegans*, is a soil dwelling animal commonly used for developmental genetics due to its completed genome sequence and large number of mutant phenotypes induced to determine gene function. A gene of interest in *C. elegans* is unc-52 which plays a critical role for embryonic development as it encodes a nematode homologue of mammalian perlecan essential for myofilament assembly in body-wall muscle. The homologue protein of unc-52 in mammalian cells is a heparan sulfate proteoglycans specialized in the basement membrane of the extracellular matrix which is important for many biological processes. Mutations in unc-52 gene have been observed to induce defects in the regulation of distal tip cells (DTCs) that are responsible for the extensions of two gonad arms during development through the misregulation of growth factor signaling pathways. However, there are mutations in the motifs of the two alleles in the UNC-52 protein that may create varying phenotypic expressions, including some which have yet to be studied. Through the use of CRISPR-Cas9 gene-editing system, we induced mutagenesis by deleting a portion of unc-52 (kq52) in C. elegans. The new mutant would then be compared to unc-52 (e444), a previously studied mutant, to analyze the different phenotypes. We hypothesize that the kq52 mutated C. elegans will have an observable increase in coordinated movements than the previously studied e444 mutation. The mutant types were created by injecting the wild-type N2 C. elegans with "NAME_TBA" sgRNA with unc-52 co-CRISPR. Motility assays were used to determine the stimuli differences between mutated kq52 *C. elegans* and mutated e444 *C. elegans* to observe how each mutant may have induced distinct or similar degrees of uncoordinated movement. The results from this ongoing study will bring insight into a new mutation of unc-52 to aid in the study of the perlecan homologue and how it plays a role in muscle development in *C. elegans*. This can hopefully be used to further develop studies on perlecan and its role in rare genetic diseases such as Schwartz-Jampel syndrome or dyssegmental dysplasia.

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Effects of unc-52(kq74) mutation on C. elegans movement

The unc-52 gene in *Caenorhabditis elegans*, a soil dwelling nematode, encodes the mammalian homolog perlecan, which consists of a proteoglycan core protein. The UNC-52/perlecan is found specifically in the basement membrane extracellular matrix (ECM) and is composed of five protein domains (I-V), including the Ig repeat and the laminin-like domain. Normal function of the unc-52 gene results in proteins that are responsible for controlling body movement and are integrated into structures including the body wall, the gonads, and the intestines of *C. elegans*. Previous studies have found that unc-52 is an essential gene, as a mutation causes a severe impairment of its locomotion, specifically, uncoordinated movement (Unc) phenotypes. While it is understood that modifications of the unc-52 gene result in Unc phenotypes, the exact mechanism of protein function is not yet understood. In order to address how unc-52 interacts with other cells, the CRISPR Cas-9 was used to edit the 14th immunoglobulin repeat in the exon 19 (domain IV) and the kq74 allele was generated. However, we are unaware of the exact location of the molecular lesion that is caused by this CRISPR editing. The characterization of phenotypes and specific mutations is currently underway. The ortholog of the unc-52 gene in humans, perlecan, causes severe genetic disorders such as Schwartz-Jampel Syndrome 1 and Sylverman-Handmaker type dyssegmental dysplasia when the gene is mutated. These rare genetic diseases impact the bone and muscle structure of individuals and can intensely impact human mobility. Continued study of the unc-52 gene and its various mutations could result in the determination of the location of the cleavage made by CRISPR as well as a better understanding of genetic defects which can cause a lack of mobility in humans.

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