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THIRTY-FOURTH ANNUAL SYMPOSIUM OF TRINITY COLLEGE UNDERGRADUATE RESEARCH

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BIOLOGY

1.

ULTRASTRUCTURAL ANALYSIS OF THE YOLK PROCESSING PATTERN IN THE AMERICAN ALLIGATOR, *ALLIGATOR MISSISSIPPIENSIS*

Farahana Appiah '21

Faculty Sponsors: Daniel Blackburn, Yunming Hu

The evolution of the terrestrial vertebrate egg required a yolk processing mechanism for the extracellular yolk mass. Recent studies revealed a mechanism of embryonic yolk processing in lizards, snakes, and turtles and this mechanism differs from that seen in birds. In the avian pattern, which was first studied, digested yolk products are taken up by cells that line the inside of the yolk sac. Digested yolk is then sent to blood vessels to be transported to the developing embryo. However, in squamates and turtles, endodermal cells invade the yolk sac, cellularize yolk and proliferate. These proliferating cells encompass small blood vessels forming elongated strands where digested yolk material is transported to the embryo for use. Yolk sac tissue harvested from early and mid-stage *Alligator mississippiensis* eggs reveal early extracellular yolk, proliferating endodermal cells, and clumps of cells that fill up the yolk sac cavity. These observations suggest that the reptilian mechanism of yolk processing is evident in *Alligator mississippiensis* and not the avian pattern.

2.

REGULATION OF THE CAUDAL GENE IN THE SEGMENTATION CLOCK OF *TRIBOLIUM CASTANEUM*

Suzanne Carpe '22

Faculty Sponsors: Jim Camp, Terri Williams, Lisa Nagy (University of Arizona)

The embryo of the red flour beetle *Tribolium castaneum* develops by adding segments in an anterior-to-posterior progression using a “clock”-like mechanism similar to that of vertebrates. This segmentation clock is regulated by a molecular oscillator: three pair-rule genes *even-skipped* (*eve*), *odd-skipped* (*odd*), and *runt* produce waves of expression during elongation, and previous studies indicate that these oscillations are driven by a gradient of the transcription factor *caudal* (*cad*). Since the frequency of the clock changes during development, we examined embryonic *cad* regulation to better understand *Tribolium* segmentation and its evolutionary relationship to other arthropods. We used the bioinformatics tools MCAST and MAST to predict binding motifs and clusters and identify putative enhancer regions. We then cloned mCherry reporter constructs driven by putative enhancers in the upstream, intronic, and downstream regions. Data from *Drosophila* transgenics expressing different putative *cad* enhancers shows distinct *cad* expression profiles in late embryos in the salivary glands, gut, and anal papillae. Due to the lack of mCherry detection in early embryos, we performed RT-PCR experiments and *in situ* hybridization to test for rare transcripts, and preliminary data show early transcription of our downstream construct. We plan to use the putative enhancer sequences in a yeast-one hybrid assay to identify potential transcription factors regulating *cad* expression. This systematic study will reveal more information about the *cis*-regulatory elements and *trans*-acting factors regulating *cad* expression in *Tribolium* to help us better understand its role in segmentation. Funding provided by NSF IOS #1755124.

3.

REGULATION OF SEGMENTATION CLOCK REGULATOR *CAUDAL* IN *TRIBOLEUM CASTANEUM*

Suzanne Carpe '22, Marissa Howlett '22, Dimosthenis Sampatakos '24

Faculty Sponsors: Terri A. Williams, Jim Camp

Bodies of metazoans are very commonly divided in segments created in embryonic life. In arthropods this process is called segmentation and it is considered responsible for evolutionary diversity in arthropods, the most speciose phylum. The process of segmentation in *Tribolium castaneum*, and many other arthropods, is controlled by a segmentation clock. A segmentation clock is an oscillating transcription of three genes during the segmentation process and the clock is initiated by *caudal*. Although Wnt is known to regulate *caudal*, other regulators remain poorly understood. To examine other possible regulators, predictions for transcription factor binding were made using the computational software, MCAST. These predicted putative *caudal* enhancer sequences were divided into smaller fragments to be cloned and transformed into yeast. Binding activity will be detected with yeast one hybrid experiments for all fragments individually to see what genes bind on the putative *caudal* enhancer regions. The proteins that bind to the yeast inserted fragments will indicate what genes regulate *caudal* during the segmentation process. Finding what genes regulate *caudal* will be a very useful tool to understand more about the segmentation process and investigate what factors regulate the segmentation clock further. Getting that information will also assist in understanding more about how the segmentation process has evolved among arthropods.

4.

MOLECULAR-ASSISTED ALPHA TAXONOMY OF THE GENUS *DASYA* (DELESSERIACEAE, RHODOPHYTA) FROM THE EUPHOTIC AND MESOPHOTIC ZONES OFF BERMUDA

Maggie Cassidy '21

Faculty Sponsors: Craig W. Schneider, Department of Biology, Gary W. Saunders, University of New Brunswick

Examination of the genus *Dasya* in Bermuda revealed three novel species. Deep water collections from 60–90 meters by technical divers and submersibles resulted in the identification of two new species unique to these mesophotic waters. Genetic sequences (COI-5P, *rbcL*) and morphological characteristics showed that *D. sylviae* sp. nov. is distinct from other known pseudodichotomous *Dasya* spp. worldwide. Despite morphological similarities to a Bermudian shallow water species, *D. cryptica*, molecular sequencing and morphological comparisons demonstrated that a set of inshore specimens represented another new species, *D. orae*. The mesophotic offshore collections also allowed us to re-examine the *D. 'baillouviana-pedicellata'* complex in the western Atlantic by comparing inshore specimens from Bermuda presently known as *D. baillouviana*. Our genetic results uncovered a complex of species residing under these two currently synonymous names that calls for clarification. Molecular sequencing and morphological comparisons demonstrated that the mesophotic collections, despite their similarities to *D. baillouviana*, represent a new species, *D. bathypelagica*. Inshore collections presently known as *D. baillouviana* (type locality, Mediterranean Sea) were compared genetically and morphologically with the generitype, *D. pedicellata* (type loc., New York), resulting in the resurrection of *D. pedicellata* for certain Bermudian euphotic collections as well as collections from New England/New York.

5.

SPATIOTEMPORAL VARIATION IN CELL CYCLING CORRELATES WITH SEGMENTATION IN A CRUSTACEAN

Rothswell Lanting '24, Nicole Duan '18

Faculty Sponsor: Terri A. Williams

During embryogenesis, most arthropods develop a segmented body through elongation and sequential addition of segments from the growth zone in the posterior. Since most studies focus on sequential patterning of segments in arthropods, the cellular mechanisms that drive embryonic elongation and segmentation are still poorly understood. Therefore, this study aims to investigate how cell cycle is coordinated and regulated with segment patterning. A study of the crustacean, *Thamnocephalus platyurus*, shows spatial synchronization of S-phase cells throughout the developing larva which maps to domains of segment patterning gene expression. Also, preliminary study suggests that cells in the posterior take a longer time to complete S-phase. We quantify temporal variation of S-phase by analyzing the intensity of EdU staining. Our analysis confirms that S-phase is spatially and temporally varied: S-phase in the posterior takes about 3 hours to complete and cells in the newly added segment are synchronized in S-phase. EdU intensity analysis shows spatiotemporal variation of S-phase within the posterior growth zone such that cells in the lateral region fluoresce brighter and faster than those in the central posterior region. We then use a cell cycle model to predict the outcome of BrdU/EdU double labeling to determine the dynamic of spatiotemporal variation of cell cycle throughout the *T. platyurus* embryo. The BrdU/EdU double labeling model shows that 90 minutes of EdU exposure and 45 minutes of BrdU exposure will result in unique staining for cells at different times of S-phase. Our data suggests that regulation of cell cycle is crucial for segment patterning and BrdU/EdU double labeling is an effective tool to study the timing of S-phase, as a basis for further exploring the dynamics of cell cycle regulation.

6.

EXAMINING EXPRESSION AND REGULATION OF CAUDAL GENE IN DROSOPHILA MELANOGASTER

Marissa Howlett '22

Faculty Sponsors: Terri A. Williams, Jim Camp

The red flour beetle *Tribolium castaneum* embryo develops its segments anteriorly to posteriorly using a “clock” like mechanism, which is similar to vertebrates. This clock mechanism is regulated by a molecular oscillator of the pair-rule genes: *even-skipped (eve)*, *odd-skipped (odd)*, and *runt* which produce waves of expression during elongation. These waves of expression are controlled by a gradient of expression of the transcription factor *caudal (cad)*. This transcription factor *caudal (cad)*, is also found in other arthropods such as the *Drosophila melanogaster*. The frequency of the clock mechanism changes during embryogenesis and is observed in other arthropods but not fully understood, so we decided to examine embryonic *cad* expression regulation in *Tribolium castaneum*. MCAST and MAST bioinformatics programs were used to predict binding motifs and clusters and to identify enhancer regions. These enhancer regions were cloned into mCherry reporter constructs driven by putative in enhancers in the upstream, intronic, and downstream regions. These regions were then inserted into *Drosophila melanogaster* to make transgenics. Data obtained from these transgenic flies showed *cad* expression in late embryos in regions of the salivary glands, gut, and anal papillae. Early embryos showed a lack of mCherry protein expression. We then used the alternative strategy to detect mRNA of mCherry. We used cDNA of

early (or 3 hour) *Drosophila* embryos to do a Polymerase Chain Reaction to check for the presence of our mCherry reporter construct. By using this alternative method we hope to reveal more information about the various factors regulating cad expression in *Tribolium* to understand the role it plays during segmentation.

7.

THE SEARCH FOR CANDIDATE EFFECTOR MOLECULES DURING BEETLE ELONGATION: THE INVOLVEMENT OF CRUMBS, INNEXIN 3, & STARRY NIGHT

Jeffrey P. Sagun '21

Faculty Sponsors: Terri A. Williams, Lisa M. Nagy, PhD, Benjamin Goldman-Huertas, PhD, Hector D. Garcia, University of Arizona

For an embryo to develop from a fertilized egg into an adult, the body axis must elongate. Elongation has been actively studied in the red flour beetle *Tribolium castaneum*. It is found that segment addition in *T. castaneum* is not linear. Instead, cell and tissue behaviors are dynamic and variable, where early cell movements do not produce highly elongated clones while late cell rearrangement do. This suggests that elongation might be driven by distinct convergent extension mechanisms, which differs from the model organism *Drosophila*. However, little is known about the effector molecules that lengthen the embryo. Primary pair-rule genes, such as even-skipped (*Tc-eve*) and odd-skipped (*Tc-odd*), function as transcriptional repressors and activators to control embryo elongation. Silencing these genes can halt the processes of elongation. Here, we used RNA interference (RNAi) by injecting double-stranded RNA (dsRNA) into *T. castaneum* embryos to produce *Tc-eve*^{RNAi} and *Tc-odd*^{RNAi} knockdown phenotypes. We then used RNA-seq downstream analysis on our *Tc-eve*^{RNAi} knockdowns and selected the transmembrane cadherin protein starry night (*Tc-stan*) and gap junction protein innexin 3 (*Tc-inx3*) as potential candidate effector molecules during beetle elongation based on their functions during embryo morphogenesis. The transmembrane protein crumbs (*Tc-crumbs*) was not found in our *Tc-eve*^{RNAi} knockdown dataset but is known to have a strong effect on *T. castaneum* germband extension. So, we amplified *Tc-crumbs*, *Tc-inx3*, and *Tc-stan* from *Tc*-DNA, cloned each gene, and synthesized dsRNA for RNAi to study its expression and morphology on development. In future work, we will reproduce the *Tc-crumbs*^{RNAi}, *Tc-inx3*^{RNAi}, and *Tc-stan*^{RNAi} phenotypes at specific timepoints during early and late embryogenesis and collect the knockdowns for RNA-seq analysis. Comparative transcriptome analysis will be used to identify other candidate effector molecules that drive elongation to select and directly test, via knockdown, more candidate effector molecules. These data will help us understand the mechanistic basis for the differences in elongation among taxa.

CHEMISTRY

8.

SYNTHESIS OF BETA-SHEET PROTEIN MIMETICS BY APPENDAGE OF PEPTIDES TO A BIMETALLIC RING SYSTEM

Cate Kneebone '24

Faculty Sponsor: Timothy P. Curran

The study of beta-sheet protein mimetics has the potential to answer questions about how this secondary structure is involved in protein-protein interactions, which possibly include interactions with potential medical uses. However, beta-sheet mimetics developed to date suffer from their

ability to aggregate and be insoluble, lessening their usefulness. This work focuses on the appendage of peptides to a bimetallic ring system; this ring system features a ferrocene moiety along with a tungsten bis-alkyne complex. The nature of this bimetallic ring system holds the two alkynes bonded to the tungsten in the syn-orientation. The two alkynes are spaced about 3 Angstroms apart, which is roughly the same distance between the two peptides in a beta-sheet. It has been hypothesized that this spacing will allow for intramolecular hydrogen bonding between two peptides appended to the two alkynes and adoption of the beta sheet conformation. These complexes were created by first reacting ferrocene diacid with N-hydroxysuccinimide (HOSu) to form the di OSu ester. The diester was reacted with 1-amino-4-chloro-2-butyne and diisopropylethylamine to produce a dichlorodialkynylamide. The dichlorodialkynylamide was dissolved in methanol and heated with ammonia in order to substitute an amine groups for the two chlorines; the two amines were then acylated with Boc protecting groups. The target molecule was made but in low yield. An ESMS was run, and confirmed that the composition of the molecule is correct. A DMSO titration will be performed to determine which NH protons are involved in intramolecular hydrogen bonding in the molecule. An H NMR spectrum will be taken to determine the purity of the complex. If the pure product develops intramolecular hydrogen bonding, the molecule can be further analyzed to see how suitable it is against factors of a biological environment; thus allowing for the investigation into the structure and function relationship of these structures.

COMPUTER SCIENCE

9.

BESUCHA: THE BETTER ENROLLMENT SOFTWARE USING A CONFLICT HANDLING ALGORITHM

Edwin Aldrich '21, Logan Drescher '21, Bettina King-Smith '21

Faculty Sponsor: Ewa Syta

Our project, BESUCHA, or the Better Enrollment Software Using a Conflict Handling Algorithm, is a proof of concept desktop application that could replace or supplement Trinity's current course registration system. We think that the current course enrollment system used by Trinity, one in which students are arbitrarily enrolled into sections on enrollment day, is a system that could be improved with an algorithm. Therefore, we designed an algorithm that matches students with courses, based on a ranked list of preferred courses provided to us by students, and returns a proposed list of student-course matches. We believe that using an algorithm to match students and courses can increase student satisfaction with the resulting course schedules, and additionally reduce stress and labor for the Registrar's Office. Thus, we hope that BESUCHA can increase student, faculty, and administrator satisfaction with the course registration system.

10.

RECIPEME APP

Erika Bates '21

Faculty Sponsor: Madalene Spezialetti

Society's high pace lifestyles have significantly affected the way communities prepare day to day meals. People often struggle to put together meals using the ingredients they already have, unaware of the quantity of items within their food storage. This leads to more significant problems such as food waste, unhealthy eating, and inability to track food budget. This mobile application aims to ease the task of preparing meals with a practical system of food management. I will present my mobile application that allows users to store an inventory of items, find meal and drink recipes that use your current ingredients, explore Ketogenic, Pescetarian, Vegan, Vegetarian, and regular recipes, as well as desserts. My goal for this project was to create a user friendly cross-platform application that promotes dietary health and lessens food waste, while also easing the stress that meal planning may cause.

11.

PRACTICAL APPLICATIONS

Thu Bui '21

Faculty Sponsor: Takunari Miyazaki

A hash function is critical and valuable in Information Security as it offers both data reliability and security for many practices. Even non-cryptographic hash functions have numerous applications, ranging from compilers and databases to video games and computer networks. Thus, in this study, we propose constructing collision-resistant hash functions from expander graphs. It is typically called expander hash function or expander hash and used to map a string with an arbitrary length to a number. We try to apply fundamental mathematical results from Number Theory and Graph Theory on Expander Graphs because Expander Graphs give good randomness properties, which are already widely used in the field. Moreover, it is proved that the distribution of the final nodes reached by the random walk asymptotically tends to the uniform distribution. We implement our hash function for several Expander Graphs constructed by Explicit and Random Methods and compare their output distribution and speed with the most non-cryptographic hash functions. Some applications of non-cryptographic hash functions are also explored.

12.

RE-IMAGINING CINESTUDIO'S TICKETING SOLUTION

Will Estony '21, Erkin Verbeek '21

Faculty Sponsor: Ewa Syta

Cinestudio is a non-profit arthouse-style cinema founded in 1970 on the campus of Trinity College in Hartford, Connecticut. For years Cinestudio has relied on volunteers to keep itself running; however, the current ticketing software they use is slow, unreliable, and difficult to learn. For this reason, we intend to develop an efficient and intuitive ticketing system replacement for the theater. We interviewed many people involved with Cinestudio so that we could get a strong idea of the issues our solution should address. Over the course of the past year, we have utilized the JavaFX front-end framework to implement a full-fledged point of service (POS) application. Our application stores customizable users, events and donors in a secure database, protected by 128-

bit AES encryption. Our project also interfaces with the Square Terminal API to ensure a reliable transfer of funds from patron to Cinestudio takes place every time a ticket is sold. We are confident that our modern and straight-forward interface will appeal to users from any technological background.

13.

SMART SCHEDULING BUDDY

Julian Garcia-Sanabria '21, Lewis Nikuze '21, Ziad Sakr '21

Faculty Sponsor: Chris Armen

The Trinity ID office has a ticketing system used to inquire on ID requests, yet they do not have a system to schedule appointments in a user-friendly way. Before the pandemic, clients could walk up to the desk and inquire about their issues; a staff member would create a ticket for the user, the user and staff would correspond via email, and the client would come in at their convenience to find in-person assistance as needed. Now, with the pandemic, if any in-person assistance is needed, appointments are required. Because of this, it is harder to find a time that works for the clients and staff, as well as finding an efficient way to keep everyone safe. Therefore, we seek to make this process more direct and easy for everyone. Using Angular, Firebase, and DialogFlow, we have developed the Smart Scheduling Buddy, a web application that will allow users to schedule appointments at their convenience. This application will help in finding common times to receive assistance, and with the help of a chatbot, cut down on unnecessary appointments as well as get users the help they need as soon as possible.

14.

ADAPTIVE AGENDA ASSISTANT

Ryan Gress '21, Will Laroche '21

Faculty Sponsor: Madalene Spezialetti

Time management in the modern era has become simultaneously more important and more difficult. This project aims to streamline the process of managing deadlines by keeping track of its users tasks, building them custom schedules each day, and adapting them as things change, ensuring that every deadline is met while minimizing the effort required on the user's end. This minimization is extremely important; human inconsistency is a common and traditionally difficult to avoid pitfall in otherwise robust scheduling and time management efforts. By significantly cutting down the time needed to both construct a schedule, and reconfigure it when things change, users will therefore be more able to adhere to the plans put forward by the application, thus staying on top of all their responsibilities and deadlines with ease. This tool takes the form of a web application accessible on both mobile and desktop. Events are added by giving descriptions including deadlines and total time needed, and they are automatically scheduled for the users based on when free time is available. Smart suggestions beyond simply scheduling are made. For instance, larger projects, which take significant time, are broken up and distributed for the user across multiple days. The key difference between this and other tools is its flexibility. If a previous task goes too long, or the user doesn't start on time, the rest of the day will be moved around to fit the changes. Rather than just moving everything forward, tasks are rearranged so the user can end their day of work at the same time as usual, with more important events prioritized, and others moved to other days of the week. Likewise, if something is finished early, it allows users to get ahead by finding them something to do with their gained time. Overall, it hopes to optimize both users' approach to time management, and in doing so optimize their schedules and maximize productivity.

15.

MENSTRUAL CYCLE TRACKING FOR THE CONTRACEPTIVE PILL USER

Kelly Ido '21

Faculty Sponsor: Chris Armen

Even though there is a number of menstrual cycle tracking apps today, there are two main problems with current tracking apps. Firstly, the prediction of the app is often inaccurate. Secondly, users would not come back to the app daily even though daily input is crucial to give an accurate prediction. To solve those issues, Menstrual Cycle Tracking for the Contraceptive Pill User will be developed. This app will make the prediction using the hormone level according to the users' medication. Moreover, it allows users to record the time that the medication is taken by simply holding the NFC tags sticker on an NFC tag reader, which is an iPhone. As the first step, formula to predict the expected date of menstruation is developed using the hormone levels and the sample data. Then, the basic features such as the function to predict the date of the period and the function to keep track of past data are implemented. After that, a function that makes it easy to record the time that the medication is taken with an NFC tags sticker will be included.

16.

GET HOME SAFE

Kevin Klotz '21, Kyle Long '21

Faculty Sponsor: Chris Armen

Get Home Safe is an iOS app that helps students at Trinity College get back to their rooms safely and efficiently. The app allows students to track the location of the campus bus and a function that locates emergency blue light phones around campus. This project is meant to solve the problem of the campus shuttle being an underutilized resource at Trinity. Most students opt to not use the shuttle because its whereabouts are unknown and as seniors, we wanted to create an application that has the potential to improve the quality of life on campus. Our app is powered by installing an old iPhone that will act as a beacon for the shuttle to transmit the location to our server where the shuttle's location will be logged and then distributed to the users of the Get Home Safe app. When opened, the application tracks the shuttle bus in real time and displays the locations of blue light phones for the user.

17.

PLAYLIST PRO

Aidan Lee '21

Faculty Sponsor: Chris Armen

Playlist Pro is an iOS music application for Spotify users to make the perfect playlists. Quickly import an existing Spotify playlist into the application and then add any music available on YouTube as well. They can then be played together through the Playlist Pro App. This is achieved by finding a YouTube video of the same audio for each of the Spotify songs and all the audio is downloaded through YouTube. Playlist Pro gives you full control to cater the playlist experience: you can crop individual songs, add crossfade transitions between songs, and change the playback speed of songs, alongside all the basic playlist management features you would expect from a music application. With Playlist Pro you can make the perfect mix for any occasion, entirely on your iOS device.

18.

MOBILE DATA COLLECTION IN FIELD SAMPLING ENVIRONMENTS

Giles Lemmon '21

Faculty Sponsor: Chris Armen

This project greatly simplifies the process of collecting data when sampling in the field. These field surveys are common in Environmental Science, where a researcher goes out into the environment, and records the same type of information repeatedly (species of tree, and height, for 100 different trees, for example). This process is vastly simplified with this mobile application, enabling researchers to create surveys, add samples to those surveys, and then export the underlying data in an easy to access excel format. This application was developed using the SwiftUI framework for deployment on iOS devices.

19.

A REAL-TIME OBJECT DETECTION AID FOR THE VISUALLY IMPAIRED

Alisa Levin '21, Rahul Mitra '21

Faculty Sponsor: Peter Yoon

2.2 billion individuals world-wide suffer from visual impairment. Current technology-based aids are expensive and inaccessible. In our project, we leveraged advances in microcomputer technology to create an efficient, easy-to-use, real-time object detection system for the visually impaired. This system consists of a Jetson Nano microcomputer which receives video input from an attached camera. The Nano uses a deep learning model to identify objects in the user's immediate environment in real-time. This information is then relayed to the user auditorily through an iOS smartphone application that interfaces with the Nano. To achieve this, we implemented a pre-trained object detection model, SSD Inception v2, as well as a Bluetooth GATT server on the Nano. We developed an iOS application in order to facilitate the real-time wireless transfer of this model's classification labels from the Nano to the user's smartphone. The system was mounted on a white cane to enhance a tool already commonly used. We hope our system is a step towards an open source and affordable alternative to current visual aid technologies.

20.

ARTFLOW

Quinn Luong '21

Faculty Sponsor: Ewa Syta

Creating art is an explorative experience. Artists do not make art only to reach the end goal of how the art piece should look, but also immerse themselves in the process of art creation. Thus, it is common for artists to take pictures of their work in progress (WIP). While numerous platforms such as Instagram and DeviantArt exist for artists to upload their WIP photos, they are not designed to record the journey, but to present the "perfect" final product. My project goal is to develop an iOS application that focuses on the progressive and transformational aspects of art creation. I used XCode as my IDE and Swift as the main language to create the iOS application. CoreData is used for the database of the application. Figma is utilized for the design process to create the user interface and an enjoyable user experience.

21.

PERSISTENT VIRTUAL GRAFFITI

Hunter Moore '21, Wayne Sassano '21, Tyler Somerville '21

Faculty Sponsor: Peter Yoon

Persistent Virtual Graffiti (PVG) is a project to enable messaging and creative expression take root in an Augmented Reality setting, allowing users to publish a painting on a real world wall that will be displayed to other users if they were to walk past that same wall and look at it through our app. Graffiti is a divisive subject given a growing disparity of viewpoints, aesthetic sensibilities, and preferences of people all living in the same area. PVG lets sharing ideas, messages, or art be nondestructive yet still public, and trivially simple to filter out art that isn't to one's taste. Currently, there are platform bound graffiti apps but the artwork vanished when the session ends, and there are cross platform messaging apps, but no persistent AR writing / messaging app across iOS and Android devices. ARKit and ARCore both use different systems to store world anchors to 'remember' rooms but Apple's will not work with Google's and vice versa. Our system is platform agnostic and enables the focus to stay with the users and their content. With millions of colors to draw in and support for a billion devices, PVG is in a good position as AR only becomes more widespread.

22.

PAIRS TRADING ANALYSIS: A LOOK INTO THE S&P 500 CONSTITUENTS AND THE BEST PAIRS TO TRADE

Gabby Rogers '21

Faculty Sponsor: Chris Armen

In finance, pairs trading is a market neutral strategy, meaning it can provide excess returns irrespective of the overall market trends if implemented correctly. The pair of securities share a common economic link, and the price spread of the two securities remain constant throughout time. However, at times, there may be a divergence in the spread in which one stock moves up while the other moves down relative to each other. If you expect this divergence to revert to normal with time, you can make a pairs trade by selling the outperforming stock and buying the underperforming stock. This past year, I have developed a software system that computes the underlying statistical analysis of S&P500 data for the user. I specifically narrow in on the Communication Services and Information Technology sectors of the S&P500, and the most profitable trading pairs within those sectors

23.

SQUASH PROGRAM MANAGER

Min Jie The '21

Faculty Sponsor: Madalene Spezialetti

The goal of this project is to develop a functional web-based squash program management system that will help improve the communication and administration system that is currently in place at the New Haven Lawn Club Squash Program. Using this software, the Director of the Squash Program will be able to share up to date information with clients, which includes the types of services they provide, coaches profiles, and program updates. He will also be able to coordinate and share data through a portal that will only be accessible by himself and his assistant coaches.

Using the data as a guideline, coaches will be able to plan programs that are specifically tailored for each client. They can also revisit and update the database, so the client profiles match their current performance. The data can also be shared with clients so all parties can share a mutual understanding on what needs to be improved in order to help clients achieve their best potential in the sport.

24.

TRINTRADE

Ted Tierney '21

Faculty Sponsor: Peter Yoon

At the beginning of every school year new as well as returning students find themselves looking to buy new furnishing for their rooms whether it's a fan or a bed. This makes dorm living more expensive as well as arduous to complete for college students who may not have flush bank accounts or a car to go pickup items, we can solve this with our own Trinity unique shopping/selling site. throughout the course of this year I have completed both the design phase and development stage of creating this website using InVision to create a wireframing of the user interface and react in coordination with firebase to develop the application. While this does fall short of my initial goal of having the application hosted by this time, I am satisfied with my work.

ENGINEERING

25.

TENSOR BIOMECHANICS USING PYTHON

Stephen Antogiovanni '24

Faculty Sponsor: Joseph L. Palladino

Tensor mechanics computing explores a hyper specific cross section between engineering and computer science, serving as a crucial foundation for future biomechanical applications. The use of Python as a scientific computing language allows for inherent flexibility and library importability, extending the scope of the project beyond normal boundaries. The lab required both basic and complex coding techniques, with the aid of numerous libraries, such as *NumPy*, *SymPy*, and *Matplotlib*. Online tutorials, guides, textbooks, and videos were referenced for guidance on previously unknown coding concepts. The lab was successful in graphing a stress plot, coding various tensor mechanics concepts, and exploring the transition into biomechanical work. The majority of the lab's springtime duration was devoted to building and mastering tensor mechanics computing to expand into future projects. The lab's future endeavors seek out using biomechanical analysis software to calculate stress transformations for local human body coordinate systems.

26.

BIRD UP! AUTONOMOUS ORNITHOPTER TAKEOFF

Kirk Boyd '21, Nathan Dancy '21, Weiqi Gao '21

Faculty Sponsors: Kevin Huang, Clayton Byers, Travelers Insurance

The aim of this project was to demonstrate a proof of concept of a robotic ornithopter (a flapping wing aircraft) which can take-off from the ground autonomously and maintain flight without initial assistance from a human. A secondary goal was to incorporate bioinspiration in the design process, as the authors believe strongly that there is much to be learned from evolutionary adaptation, a natural iterative process where the best natural designs thrive. This problem was solved by breaking it into two motions: jumping and flapping. Data were recorded using a load cell, an accelerometer and two ratiometric hall effect sensors to characterize flapping and processed in MATLAB. The jumping was characterized using Kinovea (a video analysis software) and MATLAB where a model of simple projectile motion was fit to the trajectory. While flight was not achieved, criteria were developed such that with more time, improvements could be made to create a robot which does fly.

27.

RELATIONSHIP BETWEEN AORTIC STENOSIS SEVERITY AND FREQUENCY THROUGH SPECTRAL ANALYSIS OF FLOW TURBULENCE

Alexandra Berenice Barbosa Gonzalez '24

Faculty Sponsor: Clayton Byers

Aortic stenosis is one of the most common heart valve diseases that occurs due to the narrowing of the aortic valve. Heart murmurs are abnormal sounds caused by turbulent blood flow due to the narrowing of the valve. This study seeks to understand the relationship between stenosis severity and murmur frequency. The experimental setup includes 3D aortic valve models with different area restrictions made up of elastic resin. A pulsatile pump was used to regulate the flow and contact microphones collected the sound pressure levels at the narrowing for both restricted and unrestricted conditions. The data obtained were further analyzed by performing spectral analysis. The results show an increase in energy across all frequencies as the severity of the narrowing of the aortic valves increases. As the restrictions become increasingly narrow, the energy present across all frequencies increases, though not in a predictable manner. These results encourage future research into broader mapping and analysis that varies area restriction of the valves and stroke volume to obtain a clearer picture of its potential for clinical diagnosis. Further work includes improving the anatomic and biological 3D model of the valve and expanding the methods of data analysis into more advanced signal processing techniques.

28.

THE THERMODYNAMIC STUDY OF A VAPOR-COMPRESSOR REFRIGERATION CYCLE

Maalik McPherson '23

Faculty Sponsor: John D. Mertens, Hartford Steam Boiler Inspection and Insurance Company

The ability to predict a system's impending failure and pinpoint the cause of the issue is one of great value. With such foresight valuable resources can be saved and the system can perform its perhaps critical functions without interruption. Refrigeration plays an important role in our

everyday lives, and while food preservation may come first to mind, the storage needs of COVID-19 vaccines is one of many examples of the critical functions refrigeration systems may provide. A fully operational commercial refrigeration system is the subject of this ongoing research project, and it employs the commonly used vapor-compression refrigeration cycle. The system removes the heat from the refrigerated space by cycling the refrigerant through different states as it passes along the refrigeration line and through its four major components (Compressor, Condenser, Evaporator, & Expansion Valve). When the system was professionally installed, the refrigeration line was retrofitted to include pressure transducers, thermocouples, and a flowmeter in key locations. The pressure, temperature, and flow rate data from the sensors are needed to perform Thermodynamic analyses, one of which can yield a coefficient of performance, a measure of how efficiently the system is working. The aim of this research project is to determine if the data alone or a Thermodynamic analysis of said data, can predict an impending failure and diagnose the specific issue ailing the system. At this phase, the primary objective is to finalize a streamlined data acquisition process. This will allow for the raw data from the many sensors to be aggregated together, converted to proper units, and stored for immediate or later access. Once completed, the next objective is to obtain experimental data by simulating the three most common insults the system may suffer: a leak or loss of refrigerant, an underperforming or failing condenser, and an underperforming or failing evaporator. Thus, the final objective is a comprehensive Thermodynamic analysis of the experimental and control data, whose findings could both have immediate applications as well as spur further research.

29.

INCREASED GRANULARITY IN CONTACT SENSING VIA ACTIVE OSCILLATORY ACTUATION

Rahul Mitra '21, Divas Subedi '22, Alexander Prigge '22, Elizabeth Schoemer '24

Faculty Sponsor: Kevin Huang

"Precise contact and distance sensing can assist in task and state observation for robot manipulation of delicate structures. This work investigates the design of a dual-mode acoustic contact and proximity pretouch sensor. Previous work utilized frequency response of a mechanically actuated vibration signal of a rigid link to ascertain contact locations - shift in damped natural frequency as measured by an inertial sensor was the distinguishing feature used. The implementation presented here incorporates this contact sensing mode with acoustic pretouch sensing using a hollow cavity. Active vibrating modes are actuated with a small speaker, and sonic oscillatory modes are measured with a microphone embedded within the cavity. The sensor detects both contact and proximity by alternating between passive and active acoustic sensing. The active acoustic sensing emits a chirp that sweeps the audible range and bleeds into infrasonic and ultrasonic. The resonance within the cavity determines the nature of the contact. In contrast, passive acoustic sensing presumes that no contact has been made and measures the proximity of an object using the "seashell effect", where the spectrum of the noise inside the cavity, induced by ambient noise, of the device changes with the proximity to an object. Future work aims to characterize and implement finer granularity contact locations while improving the sensitivity to contact.

30.

ADDITIVE MANUFACTURING OF MICROREACTORS FOR FLOW CHEMISTRY TO SYNTHESIZE PHARMACEUTICALS

Meghan Spaulding '24

Faculty Sponsors: Clayton Byers, Jo-Ann Jee

Additive manufacturing has many capabilities but the possibilities of combining 3D printing with flow chemistry can allow for the production of active ingredients in over the counter or prescription medications. By printing microreactors, a small-scale device with unique mixing channels, different flow reactions can run through and mix to yield the desired products. Due to the difficulty of mixing on a small scale, as a result of low Reynolds number flow, different passive mixing techniques must be put in place. Using geometrical shapes and designs such as ridges, slopes, and wedges will help the viscous substances combine by way of passive mixing. Additionally, it is important to understand the best printing practices to minimize obstructing support structures and possible warping of the microreactor. The results produced in this research may help identify the best style microreactor and how to 3D print it for the production of active pharmaceutical ingredients. The current finding suggests that printing in two pieces with no inner support structures will allow for the best microreactor and with no obstructions. Microreactors may allow for a more effective system in the production of active pharmaceuticals on a small scale.

ENVIRONMENTAL SCIENCE

31.

BIOACCUMULATION OF MERCURY IN FISH IN AN URBAN POND AND TURTLES IN A RURAL STREAM

Jared Buchman '21

Faculty Sponsor: Amber Pitt

The bioaccumulation of different trace metals, specifically mercury, in organisms that may be consumed by humans is an environmental and public health concern. Mercury levels were analyzed in Bluegill fish (*Lepomis macrochirus*) from Keney Park Pond, as well as three species of turtles, Northern Map Turtle (*Graptemys geographica*), River Cooter (*Pseudemys concinna*), and Red-eared Slider (*Trachemys scripta elegans*) from the North Fork of the White River in Ozark County, Missouri. The mean (\pm SD) mercury concentration for fish samples was 0.1040 (\pm 0.015) ppm (n=5). The mean (\pm SD) mercury concentration for turtle samples was 0.2747 (\pm 0.085) ppm (n=7). None of the Bluegill fish or turtles exceeded 1.0 ppm, the federal standard for mercury levels. The mercury levels in the fish exceeded the limit (0.1 ppm) deemed safe by Connecticut state guidelines. The mercury levels in the turtles were within the range considered to be of general human health risk (0.2-0.3 ppm) per Missouri state guidelines. Results from this study show that there are increased levels of mercury in fish in an urban pond and turtles in a rural stream, making them unsafe for human consumption.

32.

THE EXPANSION OF A NATIVE GENERALIST SPECIES FOLLOWING COMPETITOR RELEASE AND HABITAT DEGRADATION

Ellie Tate '21

Faculty Sponsor: Amber Pitt

The understanding of competitive release and a generalist species' ability to exploit an available niche assists in explaining short- and long-term changes in ecological communities. I evaluated the expansion and establishment of a native generalist species, the red-eared slider (*Trachemys scripta elegans*), into a river community studied over a 50-year period (1969-2019). My objective was to analyze the *T. s. elegans* population upon expansion and how the population has been affected by the short- and long-term changes of the ecosystem. The turtle community in the North Fork of the White River, Ozark County, MO, USA faced habitat degradation, harvesting, a record shattering flood resulting in changes of the riparian habitat, and other stressors. I concluded that the *T. s. elegans* population was able to expand their population into a new geographic area following the reduction of competition and increased niche habitat due to habitat degradation. The short-term effects of flooding had no impact on the expanding population. Within the 50-year period, the generalist species the (*T. s. elegans*) was able to exploit and thrive in a small niche without harming the dominant species, the northern map turtle (*Graptemys geographica*).

HEALTH FELLOWS

33.

DETERMINING MINIMUM CLINICALLY IMPORTANT DIFFERENCE (MCID) FOR THE PERSONAL IMPACT OF EPILEPSY SCALE (PIES)

Fumika Ando '21

Faculty Sponsors: Alison Draper PhD, Trinity College, Gabriel Martz MD FAES, Gregory Panza PhD, Hartford Hospital, Amy Hunter MPH PhD, University of Connecticut Department of Public Health Sciences

Background: Quality of life (QOL) surveys are a part of standard care for epilepsy patients, measuring the impacts of epilepsy and treatment based on the perception of the patient. The Personal Impact of Epilepsy Scale (PIES) is a QOL questionnaire developed to assess consequences of seizures, medication effects, and mood and social factors. Minimum clinically important difference (MCID) represents the smallest score change that reflects meaningful change in patient QOL. Establishing the MCID of PIES would enable more reliable determination of change in patient status over time. This study is intended to establish MCID of PIES.

Methods: Participants were adult epilepsy patients (age>16) who were treated at the Norton Neuroscience Epilepsy Center between January 1, 2015 and December 21, 2017. Patients completed PIES at a baseline visit and a follow-up visit. PIES was scored using the validated method. A chart was prepped by the unblinded reviewer by recording demographics, visit information, diagnoses, PIES scores, and medication, and then removing PIES data for the blinded reviewer. The blinded reviewer evaluated QOL of patients at each visit and in comparison to baseline visit. Only patients with valid PIES and blinded reviewer scores at two consecutive visits were included in analysis. MCID will be calculated using the anchor-based approach with blinded review as the anchor. Blinded reviewer ratings are grouped into better/same/worse, and the mean of the change in PIES score for each group will be used to determine MCID.

Results: 400 patient charts were reviewed. 120 patients had consecutive visits with qualifying PIES scores. 43.4% of patients were male and 56.6% were female. Patients reported an average of 9.26 ± 24.09 seizures per month at baseline. From crude analysis, the mean PIES for the improved group was 107.5 ± 58.5 for visit 1 and 80.1 ± 50.7 for visit 2, with the change in mean being -27.4 ± 36.5 . For the group that remained the same, the baseline and follow-up visit had a mean PIES score of 67.5 ± 58.9 and 59 ± 53 , respectively, with a -8.5 ± 36.3 difference. The patients who got worse scored 101.6 ± 68.7 at the first visit and 109.8 ± 62.6 at the second visit, with a mean change of 8.2 ± 48.3 .

Conclusion: Analysis is ongoing, but the PIES score change can be predicted to be negative for improved patients and positive for worse patients. The MCID will help PIES guide clinical decision making and improve patient care.

34.

PERCEPTION AND BARRIERS TO VIRTUAL MEDICINE IN HISPANICS AND UNDERREPRESENTED POPULATIONS IN CENTRAL CONNECTICUT.

Katarina Bade '22

Faculty Sponsors: Alison Draper PhD, Amy Hunter PhD, Emily Hsu MD, Jyoti Chhabra PhD CAP, Alvaro Menendez MD, Hartford Healthcare

Background:

Perception and barriers to virtual medicine (VM) in Hispanics and underrepresented population (H/UP) is unknown. We investigated these parameters in a multicenter oncology trial in hopes of improving quality of care and minimizing potentially negative healthcare outcomes related to VM.

Methods:

An IRB-approved 27-item questionnaire was offered in English and Spanish to all pts. receiving care at participating cancer centers over a 4-month period. Examined variables included demographic information, preferences and perceived barriers regarding VM. Multivariable analysis was performed using Chi Square test to determine association between demographic variables and participants preferences and perceived barriers.

Results:

A total of 180 pts were enrolled. H/UP rely more on social media to receive health information (32.6% vs 23.9%) as opposed to face-to-face. Less H/UP have received oncological care through VM (27.9% vs 32.9%) despite comparable preferences regarding incorporation or exclusive use of VM (23.2% vs 24.6%). Similar levels of satisfaction with current healthcare delivery methods were noted (83.7% vs 86%). H/UP involve family members more frequently through VM (48.8% vs 29.1). H/UP have more technical barriers to VM as they were up to 2.6 times more likely to not pose phone/ipad/similar or have access to internet (23.3% vs 9%; and 16.3% vs 8.2% respectively).

Conclusion:

H/UP are equally interested and comfortable in receiving oncological care through VM. Given the shift towards outpatient and home-based care, aging population, and cultural appropriations, VM excitedly allows re-incorporating of family/caregiver in medical management. However, a lower

number of them are currently utilizing VM which could be secondary to H/UP's specific barriers or healthcare bias. Behavioral interventions do not appear to be justified at this time since H/UP barriers are predominantly technical and targetable with appropriate policies. Confirming healthcare bias and follow up visits are warranted.

35.

A PROSPECTIVE COHORT STUDY ON THE ASSOCIATION BETWEEN DEPRESSIVE SYMPTOMS AND ADHERENCE TO ENDOCRINE THERAPY

Shereni Baez '21

Faculty Sponsors: Alison Draper PhD, Amy Hunter PhD, David Finitsis, PhD, Hartford HealthCare Cancer Institute, Amy Hunter, PhD, UConn Health

Breast cancer is a disease where cells in the breast will over-reproduce to create tumors. Estrogen positive (ER+) tumors can grow with the presence of estrogen. Even after primary breast cancer treatment for these ER+ tumors, breast cancer recurrence is high. Due to this risk, women will take endocrine therapy (ET) medication to reduce recurrence. However, adherence to endocrine therapy tends to be low and there may be several possible reasons for this. Some reasons include: negative side-effects of ET medication (e.g. hot flashes, vaginal dryness, joint pain), fertility concerns, miscommunication about how often to take medication, cost of medication, etc. In this prospective cohort study, we looked at how depressive symptoms may play role in adherence to endocrine therapy. To measure depressive symptoms, the Patient Health Questionnaire 9 (PHQ-9) was used. The PHQ-9 is a nine item depression scale that uses DSM-IV criteria for major depressive disorder and scores patients based on the severity of any possible depression they may have. Lower overall PHQ-9 scores (usually below 10) indicate less severe depressive symptoms while higher scores indicate more severe depressive symptoms. We collected PHQ-9 scores of 21 English-speaking female early-stage breast cancer survivors (ductal carcinoma in situ, invasive ductal carcinoma; Stage 0-II) ages 35-75 who had not taken endocrine therapy medication prior and would soon be undergoing endocrine therapy. Monthly unannounced pill counting from 2016-2019 was used to measure participants' adherence to endocrine therapy medication for 6 months. A bivariate logistic regression was used to determine the association between depressive symptom scores from the PHQ-9 and adherence from unannounced pill counting. Depressive symptoms and adherence were found to have no association in this study, perhaps due to sample size and length in which adherence was measured. These findings indicate that there may be other factors affecting adherence to endocrine therapy. More studies looking into reasons for non-adherence to endocrine therapy must be conducted. By doing so, we can find effective ways to understand and work with breast cancer patients to encourage adherence to endocrine therapy. This can then help decrease a patient's risk for breast cancer recurrence, which can also decrease mortality rates as a result.

36.

AN EVALUATION OF COMPLIANCE WITH SURGICAL BUNDLES FOR THE PREVENTION OF SURGICAL SITE INFECTIONS IN PEDIATRIC COLORECTAL CASES

Grace Chouinard '22

Faculty Sponsors: Alison Draper, PhD, Amy Hunter, PhD, Brendan Campbell MD, MPH, FACS, Director of Trauma, Pediatric Surgical Quality and Safety Officer, Donald Hight Endowed Chair of General Pediatric Surgery at Connecticut Children's Medical Center

Surgical site infections (SSIs) are post-operative infections of the incision site and a leading contributor to harm caused in pediatric patients. High implementation of pre-operative and intraoperative protocols and preventative bundle elements reduce complications caused by SSIs through improving patient care and outcomes. Bundles are composed of three phases: the pre-operative phase, intra-operative phase, and post-operative phase. The aim of this study is to examine the effect of mechanical bowel preparations, appropriate antibiotic selection and timing, and the presence of a surgical closing table on the occurrence of superficial, deep, and organ/space SSIs.

The Connecticut Children's Medical Center's (CCMC) chapter of a national project lead by the SPS, a coalition of Children's hospital's focusing on reducing harm in pediatric colorectal procedures, is focusing on the compliance of pediatric surgeons in executing comprehensive preventative bundles for pediatric colorectal procedures and establishing the optimal bundle to prevent SSIs.

This descriptive chart review study includes 56 pediatric patients ranging from 2 weeks to 25 years of age who underwent colorectal procedures performed by 6 pediatric surgeons at CCMC from 1/03/2020 to 12/22/2020.

Preliminary results indicate that 71.4% of patients received appropriate antibiotics, 64.3% of these patients were administered the antibiotic in the appropriate timeframe, 19.6% of patients had a surgical closing table, and 1.8% of patients had a mechanical bowel prep. 10.7% of patients experienced a SSI (3.57% for each organ, superficial, and organ space SSI).

CCMC lacks data regarding effective surgical bundle elements that will decrease the occurrence of SSIs and improve outcomes for pediatric colorectal patients. Known interventions exist that when implemented consistently will improve the quality of patient care and reduce post-operative complications, but promoting strict adherence to surgical protocols is complex and requires both flexibility and responsibility among surgeons. The standardization of a surgical protocol will provide CCMC the opportunity to create and regulate a quality approach protocol that will prepare the operating room staff for routine operations without the confusion of differing methods between surgeons and ensure reliable high quality of care for pediatric patients.

37.

MALNUTRITION AND WEIGHT LOSS IN PARKINSON'S DISEASE (PD)

Andrew Frankini '21

Faculty Sponsors: Alison Draper, PhD, Amy Hunter, PhD, Duarte Machado MD, David & Rhoda Chase Family Movement Disorders Center at Hartford Healthcare

Parkinson's Disease (PD) is one of the most common progressive neurodegenerative disorders, mostly observed in patients over the age of 50. Previously, it has been established that malnutrition is related to the progression of PD, but a clear link between malnutrition and PD remains unclear. This study aims to investigate this link, by observing the prevalence of malnutrition and weight loss among PD patients.

In this study, we conducted a collection of clinical data using questionnaires and scales for analysis, with participants who were recruited from the Hartford Healthcare Movement Disorder Center. Demographics, diagnosis of PD, current medications and labs (serum levels) were obtained from the patient's medical records, while questionnaires and scales were used to mainly address nutritional status and PD progression status. SAS, a statistical program, was used to run chi-square tests and t-tests to determine whether data was statistically significant.

The expected results for this study are that there will be a greater rate of malnutrition and weight loss in patients with severe PD. Further, the expected results should indicate a greater risk for gastrointestinal dysautonomia symptoms in patients with PD who are at risk for malnutrition and weight loss, as well as a greater rate in the use of medications associated with malnutrition and weight loss in patients with PD who are at risk for malnutrition and weight loss.

Focusing on the high prevalence of malnutrition and weight loss in patients with severe PD, this study will hopefully encourage physicians to be more aware of the risk, to provide information to PD patients about this risk, and prevent further malnutrition.

38.

EVALUATION OF DIAGNOSTIC TESTS AND HISTORY ELEMENTS IN DIAGNOSING CHILDHOOD SYNCOPE

Michelle Mordasiewicz '22

Faculty Sponsors: Alison J. Draper PhD, Amy Hunter PhD, Francis DiMario MD, Department of Neurology, Connecticut Children's Medical Center

Syncope or fainting and breath-holding spells (infantile syncope) is a spontaneous and self-limited transient loss of consciousness due to cerebral hypoperfusion and hypoxia. The descriptive symptoms obtained from a patient evaluation generally provide more diagnostic utility than laboratory tests and examinations; however, there is a gap in understanding the diagnostic utility of these elements in pediatric cohorts, as well as a lack of corresponding quantitative data. The objective of this study is to describe which aspects obtained from a patient medical appointment are most predictive of a final diagnosis of syncope. This is a single-center retrospective case series in which the diagnostic utility of experiences and symptoms reported by a pediatric patient or their parents were tabulated, in addition to the diagnostic utility of laboratory tests and examinations performed. Results were analyzed using descriptive statistics. A total of 50 patients with a mean age of 9.73 years were reviewed, and 10 patients were selected for a case series including 4 female and 6 male subjects with a mean age of 7.7 years. None of the 17 individuals receiving laboratory tests had a diagnostic blood test. Three of 29 EEGs were diagnostic, 1 of 6 Holter monitoring exams were diagnostic, while none of the 31 EKGs, 14 MRIs, 6 echocardiograms, and 7 CT scans were diagnostic. The total yield of diagnostic exams was 4.3% (4/93). The most commonly

reported symptoms in the cohort were movement disturbances, visual disturbances, emotional upset, and dizziness. Although a detailed report on the sequence of symptoms during an event was most diagnostically useful, laboratory tests, imaging, EEGs, EKGs, and echocardiograms are obtained regularly despite infrequently contributing to a diagnosis of syncope. The low yield and relatively high cost of tests regularly ordered emphasize the utility of the patient story for clinical practice.

39.

DRONABINOL AS AN ANTIEMETIC IN PEDIATRIC ONCOLOGY PATIENTS: A MULTICENTER, RETROSPECTIVE PILOT STUDY

Kathryn Russell '22

Faculty Sponsors: Alison Draper, PhD., Amy Hunter, PhD., Dayna Kennedy, MPH, Andrea Orsey, MD, MSCE, Pediatric Hematologist/Oncologist, Connecticut Children's Medical Center (CCMC), Children's Oncology Group

Background: Advances in chemotherapy have allowed pediatric cancer survival rates to increase to more than 80%. However, chemotherapy as a cancer treatment is known to take an exceptional toll on the quality of life of cancer patients due to the adverse side effects, with chemotherapy-induced nausea and vomiting (CINV) being a particularly distressing side effect. Two Δ^9 -tetrahydrocannabinols, dronabinol and nabilone, have been shown to have antiemetic properties, and nabilone underwent a multicenter retrospective study which indicated that it was poor at controlling acute CIV. However, there are currently no large-scale studies investigating dronabinol the safety and efficacy of dronabinol at quelling CINV in pediatric oncology patients.

Methods: We initiated a retrospective, multicenter chart review of 55 patients 18 years of age or less from four cities across the country who had an oncology diagnosis and received dronabinol during an inpatient admission for chemotherapy between January 1, 2014, and April 8, 2020, in order to determine whether dronabinol warrants a larger-scale prospective study. Participants were divided into two groups based on whether or not they received dronabinol prophylactically (n = 23) or as a breakthrough treatment (n = 32). We obtained data on the dosage of dronabinol, reasons for dronabinol use, adverse effects such as dry mouth, dizziness, or vertigo, and efficacy as measured by the number of vomits to determine if CINV was controlled or uncontrolled.

Results and Conclusions: Preliminary results from descriptive statistics indicated that 60.6% of the prophylactic group and 90.6% of the breakthrough had complete control over their CINV. No patients experienced failure to control CINV. Additionally, minimal adverse effects were reported; there was one case each of increased LFTs and sedation/drowsiness neither of which are directly attributable to dronabinol, along with one instance of headache which resolved with a decrease in dronabinol dose. These preliminary results indicate that dronabinol appears to be an effective antiemetic that produces minimal adverse effects and therefore warrants a larger prospective study to determine its optimal usage.

40.

THE EPIDEMIOLOGY OF PEDIATRIC INJURIES DURING A PANDEMIC AT THE CONNECTICUT CHILDREN'S MEDICAL CENTER (CCMC)

Zach Yung '22

Faculty Sponsors: Alison Draper PhD, Amy Hunter PhD, Danielle Chenard, MPH, Department of Public Health Sciences, UCONN Health

In this pandemic, it is important to explore how the pediatric emergency department has been functioning in order to observe and safeguard children from the unforeseen or implicit effects of the pandemic. The primary focus of this study is to determine the incidence, mechanism, and severity of intentional and unintentional injuries in children < 18 years old who presented to a participating Emergency Department (ED) from January through September 2020 compared with the same time frame in 2019 to assess the effects of COVID-19 on injuries.

The sample was derived retrospectively from emergency medical records (EMR) for the pediatric Emergency Department at Connecticut Children's in the aforementioned time period, stripped of any identifiers, and analyzed to describe and identify patterns in the data. Pearson's Chi-squared test and Fisher's exact test was used to assess significance rates between injury mechanisms and age groups.

Of the 6,123 patients recorded, 57% were male while 43% were female. The majority of the patients were either Hispanic (33%) or Non-Hispanic White or Caucasian (37%). 56% of patients paid out of pocket, 26% had commercial insurance, and 17% had governmental insurance. There was an observed decrease in the number of injuries in the months of March and April, most notably in <1, 10-14, and 15-18 year olds. The top five most common injuries (in order of prevalence) were injuries to the head, the elbow and forearm, the wrist, hand, and fingers, the knee and lower leg, and the ankle and foot (the latter two are tied for third in terms of prevalence).

Identifying and characterizing trends in pediatric injuries during the pandemic will help us gain a better understanding of how the pandemic has been affecting children as well as general injury trends independent of the pandemic which enables us to plan and respond accordingly.

HEALTH AND MEDICINE

41.

WHOLE EXOME SEQUENCING FOR ASSESSMENT OF UNCLASSIFIED GLYCOGEN STORAGE DISEASES AND DISORDERS OF ENERGY METABOLISM

Uyen (Vivien) Doan '21

Faculty Sponsor: David Weinstein MD, MMSc, Connecticut Children's affiliated with the University of Connecticut School of Medicine

Co-authors: Julieta Sallago MD, Komal Parmar MD, Kathy Ross RD, LDN, Gail Butler RN, BSN, Amber Barry RN, BSN, CCRP, Taylor Dubreul CIP, Traci Resler MS

Statement of the Problem/Background:

There are currently 16 types of glycogen storage disease (GSD), each of which is associated with an enzyme that requires a type-specified treatment regimen. Approximately 4% of the patients followed by our program have liver biopsy proven GSD, but no identified genetic etiology. These patients present with hypoglycemia, hepatomegaly, metabolic acidosis, and other phenotypic

characteristics consistent with GSD, but targeted genetic testing has failed to elucidate any underlying genetic mutations.

Research question/Hypothesis:

The purpose of this study is to investigate these patients using whole exome sequencing (WES) to identify specific genetic mistakes and classify new uncharacterized disorders of energy metabolism.

Research Design/Methods Used in the Investigation:

Study enrollment was conducted during inpatient visits at the Connecticut Children’s GSD Program. Patients and immediate family members were enrolled as part of the study protocol. The patient DNA sample was obtained from blood, and family member DNA samples were collected via saliva kits. DNA extraction from blood and saliva was done in the GSD Program laboratory at the University of Connecticut School of Medicine. The purified DNA from blood was de-identified and sent to Novogene, Co. for WES, and the results were filtered to only include deleterious and damaging variants. The damaging effect of each mutation was elucidated using the PolyPhen-2 database, and a list of metabolically relevant genetic defects was compiled. The DNA from the saliva samples will be used to assess the pathogenicity of identified mutations by WES.

Results/Summary of the Investigation:

The WES data from two subjects have been analyzed. Subject one has 10,100 deleterious and/or damaging mutations and subject two has 10,224. According to PolyPhen-2, 238 mutations (69 homozygous, 169 heterozygous) for subject one and 247 mutations (75 homozygous, 168 heterozygous) for subject two are likely damaging. Based on these mutations, 157 metabolically relevant genes have been identified as potentially disease causative; 57 of which have mutations in both subjects.

Interpretation/Conclusion of the Investigation:

The shared, potentially damaging mutations found in the 57 genes likely contribute to the clinical symptomatology of the untyped GSD patient population. These genes provide an opportunity to better understand and treat patients with untyped GSD and other metabolically related disorders. Future studies on the DNA extracted from relatives will help clarify which of these genetic variations may be pathologic.

MATHEMATICS

42.

LANDSCAPES OF THE OCTAHEDRON: AN EXPLORATION OF SHORTEST PATHS ON POLYHEDRA

Emiko Saso ‘23

Faculty Sponsor: Houston Schuerger

Abstract: Building on the work of Fontenot et al., we extend the concept of finding the shortest paths on the surfaces of polyhedra to the octahedron. We utilize the idea of landscapes, which are subsets of nets of a polyhedron, and provide a coordinate system for the regular octahedron. We then develop formulas to find the shortest path between any two arbitrary points on an octahedron and to find any point along the shortest path.

NEUROSCIENCE

43.

MENTAL TIME TRAVEL: THE ROLE OF CULTURE AND LANGUAGE TIME PERCEPTION AND EPISODIC MEMORY AND FUTURE THOUGHT IN BILINGUAL LATINE POPULATIONS

Alicia Camuy '22, Ashley Diaz '24
Faculty Sponsor: Sarah A. Raskin

Language and culture have been shown to play a role in memory (Rivera Mindt et al., 2008) and time perception (Albada et al., 2019), and episodic memory is implicated in episodic future thought (D'Argembeau & Van der Linden, 2006). Our previous study found positive associations of an assessment of episodic future thought and self-reported U.S. acculturation ($r=0.41$, $p=0.004$). This study explores the impact of culture and language on episodic memory and future thought, and time perception in English-Spanish bilingual Latine populations. Recruited participants ($n = 20$) completed questionnaires about time perception (Shipp et al., 2009), memory (Bluck and Alea, 2007), culture and language (Zea et al., 2003), and demographic information; a time perception task; and assessment of episodic memory and future thought. Data is forthcoming. Time perception and memory assessment in Latine populations are relatively unexplored topics in neuropsychology and represent a movement toward inclusion of cultural differences in cognition.

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44.

CLINICAL STUDY ON SUBARACHNOID HEMORRHAGES AND NEUROGENIC STRESS CARDIOMYOPATHIES

Shirin Dadina '24
Faculty Sponsor: Kent Kilbourn, PA, Hartford Hospital

Subarachnoid hemorrhages (aSAH) are a dangerous form of stroke that are responsible for a large portion of deaths caused by strokes in America. Subarachnoid hemorrhages develop following the rupture of a brain aneurysm which can often be fatal. This leads to various severe behavioral and

neurological complications. aSAH patients may develop a complication known as neurogenic stress cardiomyopathy (NSC) which leads to worsening morbidity rates and behavioral outcomes. NSC causes the heart muscles to thicken and leads to overall cardiac failure. Literature supports that NSC results in increased inflammation, ventricular dysfunction and reduced cardiac output. Oftentimes NSC is found less severely within post-menopausal women and has not been studied extensively in the context of aSAH development. It is unknown exactly how NSC develops and what its connection to aSAH is. There is a great need to develop better treatment methods for these patients to improve their long-term functional outcomes. This clinical study focuses on ~300 patients with subarachnoid hemorrhages who were admitted to Hartford Hospital from 2014-2021. Data was analyzed from patient charts regarding environmental factors, cardiovascular health, and behavioral outcomes to track these factors in patients over multiple years. It was found that patients that develop NSCs have worse behavioral and neurological outcomes post original admission to the hospital as compared to aSAH patients who did not develop NCMs. After tracking behavioral scores, neurological outcomes, and cardiac health in the patient population, those who developed NSCs scored significantly worse in these tests. Examination of these findings will allow us to develop better treatment methods for patients and ways to detect the disease early on. The main goal being to improve the quality of life of these patients suffering with aSAH and NSC.

45.

MODELING VALUE-DRIVEN-ATTENTIONAL-CAPTURE

Jacob H. Deck '24, Jack Albanese '21

Faculty Sponsor: Michael A. Grubb

Cognitive processes cannot be directly observed. To combat this lack of observation, computational modeling can be used to predict how certain stimuli correlate to specific reactions and behaviors. One such model, the three parameter ex-Gaussian function, is well-suited to model response time distributions in psychological experiments. The ex-Gaussian function combines a normal bell curve and an exponential component to form the three-parameter function, which, in terms of cognitive processes, uses μ and σ as transduction components, and τ as the decision component. But before using a computational model, stimulations must be conducted to ensure that the parameters of the model can be “recovered”. Synthetic data was generated in MATLAB using the ex-Gaussian function and a range of parameters; the range of each parameter corresponded to the range of parameters estimated from a real dataset that had been gathered to assess value-driven attentional capture. Then, the synthetic data was fit with the model to estimate the parameters that best described the distribution. There was a very close correlation between the parameters used to simulate the data and the parameters that were estimated from the simulated data, meaning that parameters were recovered. Since the parameters were successfully recovered, there is a confidence in the estimates which come from the experimental data.

46.

THE ROLE OF CLINICAL SIMULATIONS IN IMPROVING PATIENT CARE

Ja'Quise Green '24

Faculty Sponsor: Kent Kilbourn PA-C, Hartford Hospital Ayer Neuroscience Institute

The COVID-19 pandemic has taken a huge toll on our healthcare system and its providers. Healthcare providers are on the frontline experiencing a healthcare system overstretched. Family members, normally accustomed to being at the bedside are now dependent on communication from providers and nursing more than ever. In an effort to improve patient care and communication among neuroscience providers and their patients within the Hartford Healthcare network, the Ayer Neuroscience Institute took the initiative to work on what barriers exist in communication while still providing quality care during the pandemic. This will be achieved with the help of Hartford Hospital and the Center for Education, Simulation and Innovation (CESI). Providers will partake in simulation labs involving a patient communication issue., The providers and nursing staff will use their training to use effective communication skills to work through the issue. At the end of the simulation, providers will debrief allowing for self and peer reflection based upon performance. Outcome data will be collected based upon a survey provided to the participants and will be observed with neuroscience patient press ganey scores before and after the initiation of simulation. Our hypothesis is there will be improved patient satisfaction scores surrounding communication. It is our priority to utilize clinical simulations to improve the communication and patient care abilities during difficult times. These results may initiate further work being directed towards utilizing simulation to prepare providers in times of crisis.

47.

YOUNG ADULT SPRAGUE-DAWLEY RATS ON THE KETOGENIC DIET

Erin Sullivan '21

Faculty Sponsors: Luis Martinez, David Ruskin

Chronic cocaine use is associated with adverse health effects, yet there are few effective therapies for the treatment of cocaine addiction. One potential therapy is the ketogenic diet (KD), given that it can positively impact the same brain processes that are negatively affected by drug addiction. Our previous work found that motivation for cocaine was diminished in KD-treated rats. However, it is unclear if these findings generalize beyond the single dose (10mg/kg) used in that study. Our prediction is that rats administered a KD will still fail to form a CPP when additional cocaine dosages are included. Male and female rats were put on a KD at 5 weeks old and assigned a treatment group: 0 mg/kg (control), 5 mg/kg, or 15 mg/kg. After 3 weeks on the KD, rats were tested for the impact of varying dose on motivation for cocaine using a conditioned place preference (CPP) apparatus. The rats went through a pretest, conditioning, and posttest to obtain a CPP score. This score is change in time spent in initially non-preferred chamber between posttest and pretest. We found that KD rats formed a CPP for 5 mg/kg, but not 15 mg/kg cocaine. When examining our data separately by cohort, we saw that this pattern of results was present in the second cohort of animals but not in the first. Since averages amongst cohorts were inconsistent, we are hesitant to draw strong conclusions about how varying doses of cocaine impact motivation for cocaine in KD rats.

PHYSICS

48.

MAGNETIC SCALAR POTENTIAL DESIGN METHOD FOR A DOUBLE COIL WITH HELICAL WINDING

Andrew Clark '21

Faculty Sponsor: Austin Reid

Generating uniform and specific magnetic fields is vital for nuclear physics experiments and biomedical applications. Any inconsistencies or artifacts within the magnetic field will produce unwanted effects and degrade the experiment or application that the field was designed for. Currently, many of these applications are limited by the difficulty of designing and manufacturing these coils. These problems may be mitigated with the use of a novel design and winding method. In this paper, the magnetic scalar potential method for coil design is described in detail and applied. By using the magnetic scalar potential, the design process is inverted from the traditional iterative approach. Instead of using the traditional approach which designs a coil with the hopes of generating a certain field and repeatedly tweaking the design until the desired magnetic field is generated, this method begins by defining the required field. The magnetic scalar potential is then chosen such that the gradient of the scalar potential is the desired field. The potential is found within the specified volume using Laplace's equation with Dirichlet boundary conditions. Although the scalar potential varies continuously on the surface, by discretizing it into a series of equipotential lines they become representative of a singular winding. Then, by perturbing the scalar potential with a signed arctangent function, the coil winding attains a continuous helical winding. This geometry allows for a single wire to be continuously wound around the defined volume, removing the need for a series of twisted pair returns and dramatically simplifying construction.

The double coil produced in this paper serves as a proof of concept for the validity of both the design method and the coil geometry. Using COMSOL Multiphysics, a cubic base and square pyramid end cap with an extended return region are generated. The return region allows for the magnetic flux to be contained within the coil, thus increasing the strength of the interior magnetic field and minimizing the effects of external magnetic fields. The simulated coil winding results from COMSOL are imported to Matlab to clean up the artifacts generated due to meshing effects. An array of these three-dimensional points for the coil winding are then imported to OpenSCAD to generate a STL file for 3D printing. This completed design demonstrates the ease of the design method, reproducibility of the results and should be used as a basis for future work to create more complicated fields and geometries as required.

49.

A NUMERICAL SOLUTION FOR A QUANTUM MANY-BODY PROBLEM USING JAVA

Dhiraj Ganji '23

Faculty Sponsor: Kalum Palandage

Studying the behavior of electrons in small Hubbard clusters can lead to a better understanding of electrical conductivity related phenomena such as transport properties, superconductivity and how to design new materials. To emulate and study these behaviors, the Hubbard operator (Hamiltonian) can be used to calculate the ground state and other excited state energy levels for two-dimensional and three-dimensional clusters. Since the model is exact, the results from it will not depend on any approximations which are

typical in these types of many body calculations. The programming language Java will be used to code a program to develop an algorithm so that it can calculate the energy values of the electrons in different sites, and to find the probabilities of finding electrons in these sites. We will start off with a 2-site, one orbital Hubbard cluster, as this is the simplest Hubbard model to work with. Once the desired values are achieved, we will move on to more complicated models and use the program to calculate the required values for those. This research will help us to learn more about transport properties of various materials, as it could be able to model some real materials with correct parameters.

PSYCHOLOGY

50.

INVESTIGATE THE CORRELATION BETWEEN STATE BOREDOM LEVEL AND ATTENTIONAL BLINK DEGREE

Kefei Wang '21, Julia R. Francis '21, Jack A. Miller '21, Raysa Leguizamon '21

Faculty Sponsor: Michael A. Grubb

Although previous experiments and studies had indicated there is a causal relationship between attention and boredom. However, most experiment use the initiative performance of an attentional requiring task as a measurement of attentional performance, and our understanding about state boredom and reactive attentional performance are still insufficient. This study aims to investigate the correlation between state boredom attentional blink performance. In this context, by specifying the types of boredom and attention phenomenon might contribute toward this field.

To examine the correlation, an online experiment was conducted requiring the participants to do a Multidimensional State Boredom Scale (MSBS), followed by a Attentional Blink Test, then an MSBS scale again to see the difference on state boredom. The result showed that two components of state boredom: disengagement and time perception, are significantly modulated by the attentional blink task; Changes in disengagement are correlated with the magnitude of the attention blink as quantified with hit rate. The more that people disengage, the smaller their attentional blink is.

These results suggest that State boredom disengagement scale negatively correlate with attentional blink effect.

51.

NICOTINE AND CANNABIS VAPING AMONG COLLEGE STUDENTS: FACTORS ASSOCIATED WITH INITIATION, PATTERNS OF USE, AND DEPENDENCY

Asa Wint '21

Faculty Sponsor: Laura Holt

Vaping has become a common method to consume nicotine and cannabis on college campuses across the United States. Between 2017 and 2019 there was a significant increase in the prevalence of both nicotine (6% to 22%) and cannabis vaping (5% to 14%) among college students. As of 2019, there were over 2,000 vaping-associated lung injuries or deaths and recent data suggest nicotine vaping was associated with greater risk of contracting COVID-19. In the present study, I examined data from an online survey of seven colleges and universities across the US ($N=2160$) to determine the prevalence of nicotine vaping, cannabis vaping, and dual use (i.e., nicotine and cannabis). A second aim was to determine whether these user groups differed by demographic

characteristics and other characteristics such as impulsivity, depression, anxiety, and family history of substance use. As hypothesized, males were more likely to endorse dual use and Whites were less likely to identify as nonusers. Contrary to my hypothesis, there was no difference in socioeconomic scores by user group. Dual users were higher in impulsivity, had a higher family history density, and had greater depressive and anxious symptoms than all other user groups, which was somewhat consistent with my hypothesis, although I expected single users to score higher than nonusers on these variables as well. These findings may help to inform the development of brief interventions that target dual users and take into account characteristics and vulnerabilities that are more likely in this group.