



UW Undergraduate Research Symposium

FEB 12, 2020, 11AM to 6PM

A celebration of undergraduate scholarship and creative work.

www.washington.edu/undergradresearch/symposium

UW Bothell students presented their research at the 2020 UW Undergraduate Research Symposium as oral presentations, visual arts & design displays, or as research posters. Below is a list of students who presented. We encourage everyone to come and support our UW Bothell students annually during the spring!

Use #UWSymp if you post about the symposium on social media.

2020 Undergraduate Research Symposium

The Calculus of Clovers

Presenters:

Dave Edward (Dave) Diaz, Sophomore, Civil Engineering, Lake Wash Tech Coll
Alana Yao, Fifth Year, Computer Science & Software Engineering
Eric Trofimchik
Matthew Capozzoli, Non-Matriculated, Engineering, Lake Wash Tech Coll

Mentors:

Narayani Choudhury, Engineering, Mathematics, Physics, Lake Washington Institute of Technology, Kirkland

Description:

The clover-leaf is a fundamental shape that manifests often in nature. We have studied the calculus of the clover-leaf shape. We use multivariable calculus-based methods to estimate the average height of water in a clover-shaped swimming pool. Using double integration with polar coordinates, we find the areas of these shapes. The methods we use are very generic that elucidate the calculus of clovers. Such studies have many real-world applications as this shape is seen in leaves, flowers, tRNA, etc. tRNA (transfer ribonucleic acid) is a type of RNA molecule that helps decode a messenger RNA (mRNA) sequence into a protein. Clover leaf shapes are used in engineering design elements. The electronic d-orbitals have a three-dimensional clover

leaf shape. The Chandra observatory discovered exciting findings of clover-leaf quasars that provides evidence of large-scale star formation in the early universe. We have a cloverleaf interchange at the 85th street at Kirkland. The calculus of clovers thus has many applications in fundamental sciences, engineering and transportation. We show how multivariable calculus studies using polar and cylindrical coordinates help study the characteristics of these shapes.

Optimizing data storage in optical and magnetic media: Mathematical modeling and photonics studies

Presenters:

Kylie Dillon, Sophomore, Computer science, Lake Wash Tech Coll

Sam F. (Sam) Wolf, Junior, Computer Science & Software Engineering

Taylor Mills, Junior, Aeronautics & Astronautics

Jay Quedado, Junior, Computer Engineering

Alana Yao, Fifth Year, Computer Science & Software Engineering

Mentors:

Narayani Choudhury, Computer Science & Engineering, Mathematics, Physics, Lake Washington Institute of Technology, Kirkland

Hany Roufael, Engineering & Mathematics, Physics, Lake Washington Institute of Technology

Description:

There is currently extensive demand for optical media like CDROM, DVD and Blue ray disks for data storage with computer technologies. Here we combine mathematical modelling studies and photonic laser diffraction experiments to study the optimization of data storage in different types of optical media. Using calculus-based studies, we estimated the data storage capacities in these systems and calculated the CD, DVD and blue ray disk arc length and data storage linear densities. These are in good agreement with reported values. Using red, blue and green laser sources at our photonics lab, we conducted laser diffraction studies and estimated the line spacing of CDROM, DVD and Blue ray disks. The advancement from CDs to DVDs yields higher data storage densities. In the high capacity blue rays disks, because the physical structures called pits that store data on the disks become smaller, there are other challenges in realizing these smaller devices, which make it more expensive. The CD/DVD players' lasers operate at the diffraction limit resolution of light and provide maximum data capacity for their geometry. Magnetic media like floppy disks, hard disk and magnetic tapes are also used for computer data storage. We have estimated the maximum data storage capacity from magnetic floppy discs. We used curve fitting methods to analytically represent the magnetic read-back pulse as Lorentzian functions for data modeling. Our studies provide an integrated STEM learning of data storage in optical and magnetic media.

Pioneer Conifer *Abies procera*'s Influence on Early Successional Plant Communities at Mount Saint Helens.

Presenters:

Katey Callegari (Katey) Queen, Senior, Biology, *Mary Gates Scholar*

Isabel Rodriguez, Senior, Biology (Bothell Campus)

Alex Wachter, Senior, Earth System Science *Mary Gates Scholar*

Mentors:

Cynthia Chang, Biological & Environmental Sciences

Description:

The northern side of Mount St. Helens violently erupted in 1980 providing a unique opportunity to study the ecological theories of primary succession. The previous sub-alpine environment was destroyed by the pyroclastic blast where new plant communities can be observed or manipulated. We seek to know which factors in the current alpine meadow influence the most change as the environment transitions to a woody forest. To test which facilitative factors influence plant communities associated with pioneering *Abies procera* (Noble Fir), forty experimental plots were established across an elevational gradient. The sites consisted of a control and four equidistant plots; a naturally established *Abies procera* specimen, while the other three plots had carbon, nitrogen, and shade additions. For carbon addition, *Abies procera* needles were collected, dried, weighed and dispersed to each plot. For shade addition, a shade netting was applied early in the growing season. For nitrogen addition, the soil will be treated with a nitrogen supplement. Plant species abundance and coverage was assessed at peak growth. R statistical program was used to calculate the species richness, evenness, and non-metric multidimensional scaling (NMDS) similarities. Species richness was found to be higher in sites of lower elevation, with little to no difference in treatments within the forty macro-plots. Plots treated with shade proved to have no significant species evenness when compared to the control, despite observations that the vegetation appeared healthier and more robust. NMDS results showed a strong similarity between experimentally manipulated plots and a large dissimilarity between those and the established tree. Although these preliminary results suggest little significant differences, they will continue to be used in a long-term ecological study to document the presence of woody trees as they catalyze the shift of plant communities towards a sub-alpine forest.

Which Job First?: A Meta-Analysis of the Effects of Temporal Distance Perception in a Multidisciplinary Setting on Task Prioritization in Project Teams

Presenters:

Spencer Onstot, Sophomore, Pre-Major, UW Bothell *NASA Space Grant Scholar*

Mentors:

Deanna Kennedy, Business Administration (Bothell Campus), University of Washington Bothell

Description:

Task prioritization, or choosing which order to do tasks, is an essential skill to possess. However, there are no definitive answers to the question of “how” we prioritize tasks. There are numerous factors that are considered in task prioritization, including a vast array of queuing rules (FIFO or First In First Out, EPT or Earliest Processing Time, etc.) However, many of these systematic methods of prioritization don’t account for task complexity. Another common way to prioritize tasks, which will be the focus of this study, is finding the task that seems the closest in time. This perception of Temporal Distance does address task complexity because we balance task complexity and due date when deciding which task is closer or farther away in time. Though individual Temporal Distance Perception is a widely researched topic, there has not been much research conducted on application in a team setting. Prioritizing one’s tasks individually is difficult, but it gets much harder when others’ schedules need to be factored in as well as an individual’s schedule. In addition to this issue of schedule navigation, this research will take place in a multidisciplinary setting, so teammates will not be able to know in detail how long a teammate’s task will take. This too makes it more difficult to choose which task comes first. My research question is this: How does Temporal Distance Perception in a Multidisciplinary Setting affect Task Prioritization in Teams? I am conducting a synthesis of literatures about Task Prioritization, Multidisciplinary Teamwork, and Temporal Distance Perception, as well as creating a data model based off the synthesis. I was sourced the results of team building exercises from NASA’s Human Research Program, which include a variety of real-world examples of how astronaut teams prioritize tasks.

Assessment of Cinnamaldehyde in Cytochrome P450 2A13 (CYP2A13) Supersomes as a Lung Cancer Preventive Agent

Presenters:

Brandon San, Senior, Biology (Bothell Campus)

Mentors:

John Harrelson, Pharmacy, Pacific University

Brendan Stamper, Medicinal Chemistry, Pharmacy, Pacific University

Description:

Nicotine is the addictive substance found in various tobacco products. CYP2A13 is an enzyme localized in the lungs, metabolizes tobacco-specific nitrosamine carcinogens that contribute to lung cancer. Therefore, pinpointing CYP2A13 inhibitors is an approach to lower tobacco-based lung cancer risk. Cinnamaldehyde is a common flavoring agent in the fluids of electronic nicotine vaping devices. Cinnamaldehyde was found to be a potent inhibitor of CYP2A6, another enzyme that metabolizes nicotine. Because CYP2A13 and CYP2A6 exhibit overlap in substrate/inhibitor selectivity, the goal here was to evaluate the inhibition of CYP2A13 by cinnamaldehyde. A time-dependent inhibition coumarin assay was performed to determine the kinetic parameters for cinnamaldehyde in recombinant CYP2A13. Primary incubations contained cinnamaldehyde, CYP2A13 Supersomes, and potassium phosphate buffer. Incubations were initiated with NADPH. Secondary incubations contained coumarin, NADPH, and potassium phosphate buffer. At selected time points, an aliquot of the primary incubation mixture was transferred to the secondary incubation tubes, which were terminated with trichloroacetic acid after heating at 37°C for 5.5 minutes. A linearity study was conducted to determine the appropriate termination time. CYP2A13 activity was measured by the detection of hydroxycoumarin using high-performance liquid chromatography (HPLC) and a fluorescence detector. Hydroxycoumarin formation decreased with time and inhibitor concentrations. Maximal inhibition following an 18-minute incubation was 38.3 ± 1.6 and $4.0 \pm 0.6\%$. The maximal rate of inhibition was 0.109 per minute. The results provide evidence that cinnamaldehyde is a time-dependent inhibitor of CYP2A13. Furthermore, cinnamaldehyde appears to be a more potent inhibitor of CYP2A13 than CYP2A6, based on the maximal rate of inhibition. The results imply that cinnamaldehyde could interfere with the bioactivation of nitrosamine lung carcinogens. Additional kinetic studies are needed to confirm the results of this study and to evaluate the safety and toxicity profiles of cinnamaldehyde in complex physiological models.

Characterizing Trends in the Atmospheres of Exoplanets

Presenters:

Hielen (Helen) Enyew, Senior, International Studies: Europe

Shushmitha Radjaram, Sophomore, Pre-Major

Wynter Broussard, Senior, Physics *Mary Gates Scholar, NASA Space Grant Scholar*

Mentors:

Paola Rodriguez Hidalgo, Science, Technology, Engineering & Mathematics

Description:

In recent decades, researchers have begun to learn about exoplanets, which are planets that orbit a star outside of our solar system. Exoplanets are very diverse in their properties, for example, their masses, periods, radii, average temperature, and average densities. They also show a variety of elements and molecules in their atmospheres. One of the ways that we use to analyze the composition of their atmospheres is by using transmission spectroscopy. In our research group we are interested in learning whether there are any trends between the physical and orbital properties of the exoplanets, the host stars, and the atmospheric composition of the exoplanets. Our study centers on exoplanets with up to 3.5-days orbits and radii between 1 to 2 times the radius of Jupiter, the so called “hot Jupiters”. The Habitable Zone Gallery is a website which provides information about planetary parameters and how much time each planet spends in its stars habitable zone. The habitable zone is the region in which exoplanets can be found where they have the ability to hold liquid water on their surface. This region is a specific range of circumstellar distance from the host star depending on the host star. We will present the results of this study, utilizing data from the Habitable Zone Gallery, Astrophysics Data System for published data on each exoplanet, and NASA Exoplanet data archive for additional information. We have focused on studying the wavelength range from 3000 to 17000 Å, which is where absorption by sodium, potassium, and water can be found. Any trends between physical, orbital and atmospheric properties will be useful for future selection of targets.

Automation of Data Processes in Searching for Trends in the Atmospheric Compositions of Extrasolar Planets

Presenters:

Shushmitha Radjaram, Sophomore, Pre-Major

Hielen (Helen) Enyew, Senior, International Studies: Europe

Wynter Broussard, Senior, Physics *Mary Gates Scholar, NASA Space Grant Scholar*

Mentors:

Paola Rodriguez Hidalgo, Science, Technology, Engineering & Mathematics

Description:

Since the discovery of extrasolar planets (planets orbiting another star) in the early 1990's, more than 4,000 exoplanets have been confirmed to exist by January 2020 according to the NASA Exoplanet Archive. We are searching for trends between exoplanets' atmospheric compositions and their physical and orbital properties. To do so, we gather and analyze numerous publications of transmission spectroscopy data on the atmospheres of these planets. The focus parameter space of each search we conduct is expanded incrementally throughout the research process. This expansion requires remaking plots and reanalyzing data, which is a step that has the potential to be simplified. Another problem was needing to input data that would later be used for representation manually. This allowed for the possibility of errors in the data. We also were not able to easily represent all the aspects of the exoplanets we desired to in our graphs and plots, such as stellar type and atmospheric absorption of elements. In order to accomplish these tasks in a more effective and efficient way, the team is automating the data collection, expansion, and representation processes through developing computer programs that are used alongside database queries. This includes developing code that will reduce the amount of human interaction with the data aggregation and representation steps. We will present the improvements introduced with the SQL Server database to store our large data intake and query relationships between planetary properties. Python code is used in SQL Server Management Studio to visually represent these relationships in plots and graphs. This makes for a more efficient pipeline from information intake to representation, which can then be used for planetary analysis. These results will be included in the Habitable Zone Gallery, making it accessible for the community of researchers who wish to use the information as well.

CNN-Based Iterative Image Reconstruction Techniques for Sparse-View and Limited-Angle CT Images

Presenters:

Yiran Jia, Fifth Year, Mathematics

Mentor:

Thomas Humphries, Science, Technology, Engineering & Mathematics

Description:

Since Computed Tomography (CT) scans expose the patients to high x-ray radiation dose which may potentially induce lifetime risk of cancers, researchers have been finding ways to reduce the radiation dose while maintaining the high quality of reconstructed images. One approach to lower the total X-ray radiation dose is to reduce the number of projections acquired, which generated sparse-view CT image. However, when the number of view angles is too less to satisfy the Shannon/Nyquist sampling theorem, serious streaking artifacts will appear on the reconstructed images. In this work, we present two iterative reconstruction algorithms, which implement convolutional neural networks (CNN) in each iterative step, to help eliminate these defects. The first algorithm is LEARN, which uses a CNN in place of a regularization function while solving a least squares problem. The second algorithm is based on SART and the superiorization methodology (an iterative method for constrained optimization), where the CNN is used to perturb the solution between SART iterations. We use Tensorflow and the Pyro-NN library in Python to train on data obtained from The Cancer Imaging Archive's QIN LUNG CT dataset, and compare the performance of these two frameworks from the perspectives of PSNR value (often used to exam the quality of an image), training loss, penalty term, and learning rate. Besides testing on different sparse-view imaging datasets, we also demonstrate the performance of the proposed networks in limited angle CT image, where some view angles are missing due to geometric constraints.

Data Encryption and Scramble Using Mathematical methods

Presenters:

Sam F. (Sam) Wolf, Junior, Computer Science & Software Engineering

Alana Yao, Fifth Year, Computer Science & Software Engineering

Kylie Dillon

Alex Klimecky

Mentors:

Narayani Choudhury, Applied & Computational Math Sciences, Applied Mathematics, Lake Washington Institute of Technology, Kirkland

Description:

Data encryption finds important applications in cybersecurity and is vital for sensitive data including online financial transactions, preventing data breach from social media platforms, data security, etc. We have used various mathematical algorithms using matrix algebra for data encryption. We have developed a phone app for secure data transmission and relay which is suitable for data encryption for email, internet and social media. We have used static and dynamic data encryption as well as data scrambling methods to provide additional layer of security. The methods we use are suitable for storage and transmission of text, images, audio and video on the internet. The algorithms we employ include Hill Cipher, Modulo arithmetic, hash functions, random data shuffling, data scrambling, LU factorization and other linear algebra methods for data encryption. We have studied advanced encryption standards (AES) used for compliance for financial processing. We propose mathematical algorithms involving end-to-end data encryption which may be suitable for video data relay or online data processing for banking, credit card and other financial transactions. The project provides real-world applications of Mathematics for Cybersecurity and Data Sciences.

A Mathematical Study of Real-Time Solar Power Data and Vector Calculus of Silicon

Presenters:

Alana Yao, Fifth Year, Computer Science & Software Engineering

Dave Edward (Dave) Diaz, Sophomore, Civil Engineering, Lake Wash Tech Coll

Kylie Dillon, Sophomore, Computer science, Lake Wash Tech Coll

Alex Klimecky

Sam F. (Sam) Wolf, Junior, Computer Science & Software Engineering

Mentors:

Narayani Choudhury, Engineering, Mathematics, Physics, Lake Washington Institute of Technology, Kirkland

Description:

Solar power provides a renewable energy resource that reduces carbon footprints and lowers global warming. Solar panels use photovoltaics which convert light to electricity. Most commercial solar panels use silicon wafers. Electrons in these semiconducting silicon panels are freed by solar energy and are induced to travel through an electrical circuit, powering electrical devices or sending electricity to the grid. We have analyzed the reported crystal structure of silicon, which crystallizes in the same pattern as diamond and has a face centered cubic structure with lattice constant 5.4307 \AA . We employed vector calculus-based methods to calculate the nearest-neighbor bond lengths (2.3516 \AA) and bond angles (109.471°) of crystalline silicon. These calculated bond-lengths and angle values are in good agreement with reported data. We visualized the electronic charge-density of silicon. Using vector-calculus based methods, we derived the equation for the plane of the solar panel and estimated the power that a solar panel can produce. Real time data from solar panel grids are currently available from energy databases. We determined the total energy produced by a solar panel array over the course of a day by finding the area under the power-vs-time real-time data reported in energy databases using integral calculus-based methods. To understand seasonal variations, we compared solar energy production on a hot summer day and during an overcast winter day. Our studies provide a microscopic atomic level understanding of solar energy and provides an integrated study of mathematics with solar physics and engineering.

Searching for Trends in the Atmospheres of Exoplanets

Presenters:

Wynter Broussard, Senior, Physics, *Mary Gates Scholar, NASA Space Grant Scholar*

Hielen (Helen) Enyew, Senior, International Studies: Europe

Shushmitha Radjaram, Sophomore, Pre-Major

Mentors:

Paola Rodriguez Hidalgo, Science, Technology, Engineering & Mathematics

Description:

Since they were first discovered in the 1990's, technological advances have led to a rapid growth in the study of exoplanets, which orbit stars outside of our solar system. Sodium was first detected in the atmosphere of an exoplanet in 2001 with transmission spectroscopy, and a limited but growing number of the 4100+ exoplanets which have been discovered to date have had their atmospheres probed with this technique. Despite the growing number, few studies exist with the aim of comparing the physical properties of different planets and atmospheric information. The goal of our research is to gather previously published data in order to characterize trends relating exoplanet physical properties to their atmospheric compositions. Our research has started with a focus on hot Jupiters: gas giant exoplanets which orbit very close to their host stars. We have expanded the parameter region of interest we are studying, and are working on streamlining the search so that results can be shared more easily with the community through the Habitable Zone Gallery website.

Accelerated Degradation Testing of Wax Binders Used in Horse Racing Surfaces

Presenters:

Cham Hang (Jacky) Yeung, Senior, Electrical Engineering Mechanical Engineering

Mentors:

John Bridge, Mechanical Engineering

Description:

A series of ultraviolet exposure tests were conducted on a high-oil content, paraffin-based wax binder used in an operational U.S. Thoroughbred horse racetrack to simulate multi-year outside exposure. This type of hydrocarbon binder is commonly used in synthetic granular composites used in North American Thoroughbred horse racetracks and other equine sports surfaces. The function of the binder is to hold together the sand, polymer fiber, and rubber particles that constitute the surface. Previous research on this binder extracted yearly from the same racetrack over a six-year period, during which the track was not altered compositionally, showed that environmental oxidation increases over time. This degradation can potentially affect the mechanical performance of the overall surface which may impact the safety of both horse and jockey/rider. The goal of this work is to understand how the binder changes over time and replicate the atmospheric aging of racing surfaces in a much-reduced timeframe (from years to days). Tests conducted include Fourier transform infrared spectroscopy (FTIR), differential scanning calorimetry (DSC), gas chromatography (GC-FID), and rheometry.

Applying Intense Focused Ultrasound as a Treatment for Hydrocephalus in Pediatric Patients

Presenters:

Haneen Tahir Alissa, Senior, Biology

Annika Sahota, Senior, Microbiology

Rhea Sanghavi, Freshman, Pre-Health Sciences

Cynthia Nguyen, Senior, Biology (Molecular, Cellular & Developmental)

Mentors:

Pierre Mourad, Neurological Surgery

Description:

Hydrocephalus is a condition in which the cerebrospinal fluid (CSF) accumulates in the brain, increasing pressure inside the skull. A common method of treatment in pediatric patients is the placement of a shunt inside the fluid-filled ventricle of the brain. Overtime, shunts will become obstructed, fail to work, and require brain surgery and reimplantation of a new shunt. We will apply an intense focus ultrasound to send a pulse through the catheters obstructed by astrocyte tissue cultures in a three-dimensional model for shunt failure. When the method has been refined, we plan to apply ultrasound on catheters clogged from cerebrospinal fluid (CSF) that will be obtained from shunt replacement surgeries performed at Seattle Children's hospital. Our aim is to improve the flow rate through the catheter, thus providing a less invasive method for shunt clearing in pediatric patients with hydrocephalus.

Mobilizing Knowledge: Zines and Peer Education

Presenters:

Nicole Carter, Senior, Community Psychology, Gender, Women, and Sexuality Studies

Mentors:

Julie Shayne, Interdisciplinary Arts & Sciences

Description:

Creative assignments like zines are accessible forms of knowledge that challenge traditional barriers to information, narratives, and histories of marginalized people. In my work, I helped craft a class that gave undergraduate students the opportunity to produce research on women from the Pacific Northwest whose stories deserved to be heard. Combining multiple disciplines like art, poetry, and videography, students were able to connect their work to their own personal narratives in meaningful and lasting ways. Based on their reflections, employing non-traditional forms of knowledge production like that of zines strengthens connection to course material and empowers students to see themselves as both a researcher and subject.

Predicting Airline Sales via Online Customer Reviews

Presenters:

Aaron Leon Jacobson, Senior, Computer Science & Software Engineering, Law, Economics & Public Policy

Thuy Phan, Senior, Business Administration

Mark Edward (Mark) Yo, Recent Graduate, Business Administration

Mentors:

Xiahua (Anny) Wei, Business Administration

Description:

With the proliferation of online review platforms, user reviews have become an important source of information to consumers about product quality. As a result, the word-of-mouth through online reviews can influence consumers' purchase decisions and thus a company's sales. Using the airline industry as a testing field, this study investigates whether online customer reviews can predict the sales of domestic flights or the company revenue of U.S. airlines. We compiled quarterly data from 2015 to 2018 based on three sources: financial reports of nine major U.S. airlines, domestic passenger data from the Bureau of Transportation Statistics, and online reviews of these airlines on the Consumer Affairs website. We found that the change in the number of reviews (volume) is more useful in predicting changes in revenue and the number of passengers than the change in the average rating (valence). Meanwhile, the predicted relationship becomes statistically insignificant when controlling for other factors such as seasonality. Further, we used sentiment analysis to create an average sentiment of the text of all the online reviews as an alternative measure of the average rating. We found that changes in the average sentiment is not a predictor of changes in airline revenue or the number of passengers. Our current findings and data limitations suggest a variety of promising avenues for future research, where we will expand the time period analyzed, cover a greater number of airlines, include international flights, account for layovers in routes, gather more extensive online reviews, and employ content analysis such as keyphrase extraction to identify trends in the topics of reviews.

Exploration of a Potentially New Canthariphilous Arthropod

Presenters:

Van Q (Van) Nguyen, Senior, Biology

Rana Yavarzadeh, Senior, Biology

Kimia Majidi, Senior, Biology

Mentors:

Michele Price, Biological Sciences

Description:

Cantharidin is a terpenoid produced by blister beetles (Meloidae) and false blister beetles (Oedemeridae) for defensive purposes. Despite its toxicity, a diverse range of organisms (mainly insects) are attracted to this compound in nature, but the specific role of cantharidin in the biology of insects is unknown. In summer 2011, a faunal survey was initiated in Northern Idaho and Eastern Washington to determine and observe the cantharidin orienting behavior of various arthropod species. Cantharidin-baited and control pitfall traps were placed in three localities to collect specimens. Through the survey, we discovered a new canthariphilous harvestmen species, *Togwoteeus biceps* (Thorell) (Arachnida, Opiliones, Sclerosomatidae). Distribution and phenological sex ratio patterns were analyzed to further understand what role sex might have with cantharidin-orienting behavior in this harvestmen species. A total of 281 *T. biceps* specimens were collected, and approximately 98% of the specimens were collected from the cantharidin traps. About 80% of the cantharidin-orienting *T. biceps* were female, suggesting a female bias in the canthariphilous behavior of this species. Through our study, we are providing the first documented North American harvestmen species and the second documented species in the world exhibiting the attraction to this compound. Historically, these species of arthropods are understudied despite their abundance, and our research sheds some light on their contributions to arthropod biodiversity.

Response of Neuronal and Glial Cells to Secreted Proteins from Inflammatory Monocytes after Cardiopulmonary Bypass

Presenters:

Patcharathorn Pat (Pat) Pookun, Senior, Biology

Mentors:

Vishal Nigam

Lan Tu, Pediatrics

Lance hsieh, Seattle Children's Research Institute

Description:

Surgical palliation/repair of congenital heart defects is associated with significant morbidity and mortality. During the majority of cardiac surgeries, the patient is placed on cardiopulmonary bypass (CPB) in order to minimize ischemic damage while the heart is being operated on. Exposure to CPB results in systemic inflammation and multi-organ dysfunction that is especially severe in neonatal and pediatric patients. Particularly, brain damage resulting in developmental and cognitive disorders have emerged as major concerns in this group of patients due to its negative impact on the patient's quality of life. Therapeutic intervention is currently limited as the mechanism how the systemic inflammatory response links to brain damage remains unclear. It is hypothesized that CPB-activated immune cells could infiltrate into tissues, releasing intracellular contents that cause tissue injuries. In order to understand how the brain – specifically the neuronal and glial cells – responds to secretory proteins from CPB-activated monocytes, we exposed differentiated neuronal cells (dSY5Y) and glial cells (U118) to conditioned media from either control static or CPB-mimicking sheared monocytes (THP-1). Quantitative polymerase chain reaction was performed to quantify potential changes of various target genes. The data suggested that chemokine C-C-motif ligand 2 (CCL2), chemokine CXC motif ligand 11 (CXCL11), chitinase-3-like protein 1 (CHI3L1), S100 calcium binding protein B (S100B) and interleukin-1-beta (IL1b) were significantly upregulated in both dSY5Y and U118 cells cultured in conditioned media from sheared monocytes compared to the static control. This is the first step to understand the mechanism of interaction between the brain and the activated immune system after CPB so that novel targets could later be identified for therapeutic development.

Investigation of Atrioventricular Valve Structure-Function Interaction Using an Integration of Biological and Computational Approaches

Presenters:

Najma Adan, Senior, Biology

Lana S (Lana) Sheykho, Senior, Biology

Shan Ali Siddiqui, Senior, Mechanical Engineering

Mitchell William Mote, Senior, Physics

Mentors:

Salwa Al-Noori, Science, Technology, Engineering & Mathematics

Description:

While the anatomy of the four-chambered mammalian heart is well understood, relatively little is known about how the difference in valve leaflet structure, that comprise the tricuspid and bicuspid atrioventricular (AV) valves, impact function of the valves as fluid control elements of the heart. The AV valves act in response to the pressure difference between their respective atria and ventricles. Here we ask the question, "How do transvalvular pressures and shear stresses change the mechanical functioning of tricuspid and bicuspid valves under physiologic conditions?". To address this, our research group utilizes computational modeling to evaluate the fluid-induced stresses on heart AV valves and determine their impact on function. We have developed a 2D computational representation of fluid-solid interaction of the heart valves during opening. Blood was modelled as a Newtonian fluid, allowing for use of the Navier-Stokes equations. This model implemented the immersed boundary method to solve the interfacing conditions. In all cases, azimuthal symmetry was assumed and the root of the valve leaflet was fixed while the rest of the leaflet deformed elastically. The exit orifice of the bicuspid valve has been noted in literature to be elliptical while the tricuspid is more circular. Given the assumed azimuthal symmetry and continuity, a changing exit condition based on the simplified geometry will contrast the AV valves and differentiate their functional relevance. This interdisciplinary research has relevance on multiple levels. It approaches a physiological question using integration of biological, physical, and engineering perspectives that contributes a more comprehensive understanding than single-discipline perspectives alone.