2024 SUMMER UNDERGRADUATE RESEARCH CONFERENCE

NSERC CRSNG

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Acknowledgements

The Faculties of Science, Environmental & Urban Change, and Liberal Arts & Professional Studies would like to thank the Natural Sciences and Engineering Research Council of Canada (NSERC) for its support in funding summer research positions at York University through its Undergraduate Student Research Awards program.

The Faculty of Science is grateful to Dr. Earle Nestmann for his support in creating the Earle Nestmann Undergraduate Research Award program in the Faculty of Science, which funded six positions this summer.

Thank you to all of our faculty members and research staff for supporting, training and supervising undergraduate research students in your labs this summer.

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Rui Wang

Dean, Faculty of Science

Dear students,

Thank you for joining us for the annual Summer 2024 Undergraduate Research Conference hosted by the Faculty of Science at York University.

Congratulations to all of you for receiving competitive summer research awards to work with research teams across York University. At this year's conference, we are joined by student researchers in the Faculties of Science, Environmental & Urban Change, and Liberal Arts & Professional Studies who received Undergraduate Summer Research Awards (USRA) from the Natural Sciences and Engineering Research Council of Canada (NSERC). We are also proud to include Faculty of Science students who received Earle Nestmann Undergraduate Research Awards (ENURA) and York Science Scholars Awards (YSSA).

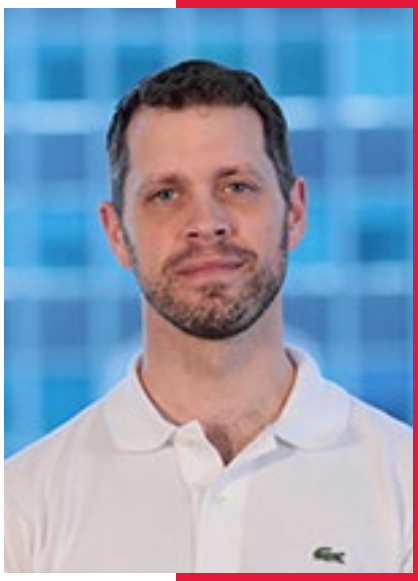
Your summer research projects – exploring topics ranging from dark matter to mathematical disease modeling to antibiotic resistance and beyond – are inspiring; your research is probing important questions about our world and exploring solutions to the most pressing issues we face as a society and planet. This conference is an opportunity to share your important work with your peers and other researchers at York University. You will also find summaries of your research in this booklet, which I encourage you to browse through to learn more about each other's projects and to save as a memento of your hard work.

I hope that your summer term as researchers was fulfilling and offered opportunities to learn, grow and explore your interests as scientists. I would also like to thank you for your contributions – your efforts are making a positive impact on the research achievements of our University and leading to discoveries that will change the world.

I hope you have a wonderful conference experience.

Yours truly,

Rui Wang
Dean, Faculty of Science
York University



Matthew Vincelli

Director of Scholarships & Fellowships Division, NSERC

Congratulations to all students completing their Undergraduate Student Research Awards (USRA) this summer.

The USRA program provides an exceptional opportunity for Canadian researchers to leverage top student talent in pursuit of their goals. USRAs nurture an interest and develop their potential for graduate studies and future research careers in the natural sciences and engineering disciplines.

The Natural Sciences and Engineering Research Council of Canada (NSERC) views the USRA program as a key component of the Canadian research ecosystem. Since 1980, NSERC has supported research experiences for students through the USRA program. The program provides direct support for research work terms for more than 3,000 students each year.

Should you wish to undertake graduate studies in the NSE fields, you may be eligible to apply for other NSERC scholarships. Refer to the Students and fellows section of NSERC's website for more information.

We would like to express gratitude to the professors who hosted and supervised your research experiences and to all graduate students, postdoctoral fellows and technicians from York University who played a mentorship role and otherwise supported your efforts. We would also like to express our appreciation to the York University staff members who manage the USRA program. The time and attention that you have invested in training the next generation of researchers in Canada are invaluable.

Sincerely,

Matthew Vincelli.
Director | Directeur
Scholarships & Fellowships Division | Division des programmes de bourses
Natural Sciences and Engineering Research Council of Canada | Conseil de recherches en sciences naturelles et en génie du Canada

BIOLOGY

Evon Alesker

York Science Scholars Award

PROJECT

Modeling the structure and vibrational modes of BaF embedded in cold rare gas matrices

PROGRAM

Biology

SUPERVISOR

Rene Fournier

The focus of the research is to calculate the vibrational frequencies of BaF inside cold Ne crystals through the use of a geometry found in past research. Subsequently, using these values in an experimental setting, the goal of the long-term research if to measure the electric dipole moment of an electron.

Ashraf Adam

NSERC Undergraduate Summer Research Award

PROJECT

Enhancing Gene Editing Precision

PROGRAM

Biomedical Science

SUPERVISOR

Bill Kim

This project aims to establish and validate Cas12f and Cas12j nucleases as genome editing agents in human cells, focusing on precision and efficiency. These nucleases are crucial for expanding the scope of next-generation genome editing systems, by enabling more flexible and precise genetic modifications. The project has two main components: validating these nucleases through Green Fluorescent Protein (GFP) cutting assays and targeting endogenous genes. The GFP sequence serves as a model to assess cutting efficiency and precision. First, I will clone and test Cas12f and Cas12j nucleases with guide RNAs targeting GFP. Successful cutting of GFP reduces its fluorescence, which can be detected and quantified via flow cytometry. Next, I will design and clone multiple guide RNAs for Cas12f and Cas12j to target various human genes and compare their performance with Cas12a. Indel quantification using Sanger sequencing and tools like DECODR and ICE will identify the most effective guide RNAs. These new CRISPR systems will facilitate the development of more potent genome editing technologies, such as Prime Editing that utilizes reverse transcriptase for genome writing.

Alrishia Agard

NSERC Undergraduate Summer Research Award

PROJECT

The impact of road de-icers on the osmoregulatory physiology of Chironomus riparius larvae

PROGRAM

Biomedical Science

SUPERVISOR

Andrew Donni

Road de-icers used during the winter season are known to be common contributors to increased levels of salts in freshwater. Sodium chloride (NaCl) is a widely used de-icer that has been reported to lead to an increase in both sodium and chloride ions in freshwater. Recently, brine-beet juice de-icer (BBJD) has been used as an eco-friendly alternative. Due to de-icers becoming a pollutant to freshwater, it can affect freshwater ecosystems to a greater extent. Freshwater organisms have various mechanisms that allow them to deal with their dilute environment, which includes sequestering salts. However, when subjected to higher ionic concentrations, freshwater organisms must adjust their osmoregulatory physiology to maintain ion and water balance. This research utilizes Chironomus riparius larvae to assess the impact of the de-icers NaCl and BBJD on the osmoregulatory organs, focusing on the expression of septate junctions (SJs) that regulate the paracellular transport pathway in invertebrates. Molecular and physiological techniques, including qPCR and SIET, will be used to assess changes in SJ expression and ion fluxes. The findings of this study will provide novel insights into the paracellular transport pathway of C. riparius larvae and their gut in high salinity conditions.

Ram Ahuja

NSERC Undergradute Summer Research Award

PROJECT

Constraining vision models to predict image memorability yields significant gains in producing more brain-aligned models of the primate ventral stream

PROGRAM

Biomedical Science

SUPERVISOR

Kohitij Kar

The primate ventral visual stream that culminates in the inferior temporal (IT) cortex supports critical functions, including object recognition and visual memory. Previous work has demonstrated that artificial neural networks (ANNs) optimized for object categorization exhibit unprecedented but partial alignment with ventral stream representations. However, it remains unknown whether ANNs constrained to predict human image memorability could explain a unique part of the neural variance – potentially bridging the remaining explanatory gap. We observed that models trained to predict image memorability predict unique variances of the IT neural responses. Interestingly, joint categorization and memorability training yielded networks that captured significantly more variance in neural responses than models trained on either objective alone. Our results suggest that incorporating diverse, functionally relevant objectives leads to ANNs more closely aligned with the primate ventral visual stream's representational geometry and functional properties.

Nandini Badhan

York Science Scholar Award

PROJECT

Using mathematical disease modeling to explore in-host immunity dynamics in a susceptible population

PROGRAM

Biology

SUPERVISOR

Jane Marie Heffernan

This project introduces an infectious disease model that incorporates rapid antigen testing and cross-immunity dynamics between the common cold, influenza, RSV and COVID-19. This model also takes into account vaccine distribution and immunity gained from a former infection to effectively model infectious disease outbreaks. During the early phase of an infection, the innate immune response is triggered to control viral replication via the production of antiviral cytokines. Since the innate immune response is non-specific, a state of activated innate immunity can protect an individual against additional infection from a different disease. By running simulations and sensitivity analysis pertaining to this in-host model, one can predict the general trend of an outbreak based on various testing rates and cross-immunity efficacy. Insights gained through this model can enable public health workers and policy-makers to monitor disease transmission, prepare for waves of infection, gauge the effectiveness of medical interventions or policies, etc.

Madeline Blanco

NSERC Undergraduate Summer Research Award

PROJECT

Investigating the Applicability of Obtaining Single Residue-Level Resolution with Electron Capture Dissociation for Routine HDX-MS Workflows

PROGRAM

Biology

SUPERVISOR

Derek J. Wilson

Hydrogen-Deuterium Exchange (HDX) is an important method of characterising protein dynamics and allows an understanding of rapid processes like protein-ligand interactions. Time-Resolved HDX-MS is especially useful for characterising unstable conformations of intrinsically disordered proteins or for automated and continuous labelling times to understand protein motions on a millisecond timescale.

However, in TRESI HDX-MS experiments, back exchange is always a worry, such as in the quench step, the proteolytic chamber, and the ESI process required for MS analysis. Conventional and TRESI HDX-MS experiments involve a Collision-Induced Dissociation cell that yields peptide-level resolution and can result in the loss of the original labelling pattern. This project entails investigating the effects of TRESI HDX-MS when combined with a mass spectrometer with an Electron-Capture Dissociation (ECD) cell.

We plan to use the Zeno-TOF 7600 machine with an ECD cell to analyse deuterium exchange at the amino acid-level and understand the compatibility of routine HDX with an ECD-containing MS. Since it has been proven that the machine can be tuned to negligible levels of scrambling, the project will involve conducting TRESI-HDX experiments on the well-characterised P1 peptide and eventually insulin. Amino acid-level resolution will allow for a deeper understanding of protein motions and protein-ligand interactions.

Amirashkan Bouriayee

NSERC Undergraduate Summer Research Award

PROJECT

Determining a correction factor to account for the forward and backward deuterium exchange that occurs in Hydrogen/Deuterium Exchange Mass Spectrometry (HDX-MS) experiments

PROGRAM

Biomedical Science

SUPERVISOR

Derek J. Wilson

Hydrogen/Deuterium Exchange Mass Spectrometry is a powerful and cutting-edge technique that is used for obtaining valuable information about proteins, such as protein folding, stability, interactions with ligands, and conformational changes that occur under different conditions. Furthermore, the use of Time-Resolved Electrospray Ionization Mass Spectrometry (TRESI-MS) coupled with HDX provides researchers with the ability to investigate protein interactions that occur in the millisecond time frame. However, with such a sensitive technique, there are challenges that researchers encounter. One of these challenges is the forward and back exchange of deuterium that occurs during TRESI-HDX-MS experiments. This forward and back exchange of deuterium causes TRESI-HDX-MS to have a high error in its results, albeit being very sensitive.

In this project, our goal is to come up with experimentally determined correction factors that can be used by researchers to account for this unwanted exchange that occurs. We hope to make this new method practical so that researchers can easily make the necessary corrections for their experiments. Determining these correction factors would help decrease the high error associated with TRESI-HDX-MS and provide researchers with more reliable data.

Mahnoor Chauhan

NSERC Undergraduate Summer Research Award

PROJECT

Investigation of Novel Transcription Factors involved in Oxidative Stress

PROGRAM

Biotechnology

SUPERVISOR

Terrance Kubiseski

Intracellular oxygen radicals are reactive oxygen species (ROS) that can be produced by endogenous causes (by-products of aerobic metabolism), or environmental factors like UV radiation. Some examples of ROS include superoxide radicals and hydroxyl radicals. The accumulation of ROS can damage vital cellular material like DNA, RNA, proteins, and lipids. ROS has also been linked to cardiovascular diseases, neurodegenerative diseases (Alzheimer's and Parkinson's), and cancer. The plan for my project is to carry out a biochemical analysis of the Caenorhabditis elegans transcription factors and mediators involved in the oxidative stress response. C. elegans have sophisticated signaling pathways to regulate ROS levels via the production of detoxification enzymes.

One of the enzymes involved is superoxide dismutase (SOD), which works by converting superoxide radicals into less toxic by-products. The goal of my project is to test how certain transcription factors (FKH-9, SKN-1, and DAF-16) as well as mediators (MDT-15) interact with sod-3, skn-1c, and gst-4 luciferase fused promoter constructs via Luciferase assays. Furthermore, I plan on using co-immunoprecipitation to study protein-protein interactions of these transcription factors. Overall, these studies will characterize the oxidative stress response in C. elegans and provide us with the basis for further study of this detoxification process.

Alessia D'Addario

York Science Scholars Award

PROJECT

CRISPR Prime Editing in Bacteria

PROGRAM

Biomedical Science

SUPERVISOR

Bill Kim

As the development of CRISPR continues to enhance the scope of genetic manipulation, Scientists have discovered new ways of performing gene editing that will revolutionize the treatment of genetic disorders. This summer I will be testing the efficacy of CRISPR-Prime Editing in its ability to terminate gene expression by screening bacterial green fluorescence proteins (GFP) and the β-galactosidase pathway. The prime editor will introduce a stop codon, prematurely terminating the translation of the target gene. The validation of this stop codon edit will be shown through a colour change. Wild-type GFP and β-galactosidase protein expression results in green and blue-coloured colonies respectively, therefore I am expecting to see white colonies if the stop codon is introduced successfully. After establishing these reporter genes I will screen compounds nominated through computational molecular docking for their ability to inhibit Prime Editing in bacteria. These inhibitors can be further developed in the future as a means to control genome editing for improved safety and potency during gene therapy.

Fatimah Dasu

York Science Scholars Award

PROJECT

Analysis of Science Syllabi: Evaluating Current Practices and Student Perceptions

PROGRAM

Biomedical Science

SUPERVISOR

Tamara Kelly and Tanya Da Sylva

Inclusive teaching incorporates evidence-based, student-centred strategies that provide high structure, and recognizes the multiple identities that students bring with them into the learning environment. The syllabus is an important element of inclusive teaching as it is the point of first contact between instructors and students, and an opportunity to promote an equitable course climate. In Fall 2022, the Faculty of Science (FSc) introduced an equity, diversity, and inclusion (EDI) centred syllabus template with an annotated guide explaining the purpose of specific elements, and ways instructors may personalize their syllabi. Subsequently, there has been interest to adopt the EDI syllabus as a standard FSc template.

Through a mixed methods approach involving analysis of multiple syllabi from various FSc departments and student focus groups, we are investigating current syllabi practices, and how the EDI syllabus shapes student views. Specifically, syllabi will be coded for the presence or absence of specific elements while focus groups with undergraduate FSc students will provide insights into how the EDI syllabus shapes student perceptions of the course climate. Results of common theme analysis of student responses will be used to refine the current EDI syllabus to maximize accessibility and equitable learning experiences.

Farah Hashemi-Sabet

NSERC Undergraduate Summer Research Award

PROJECT

The Physiological and Osmoregulatory Effects of Microplastics on Larvae Chironomus riparius

PROGRAM

Neuroscience
Biology

SUPERVISOR

Andrew Donini

The prevalence of microplastics (MPs) has increased in Canada's freshwater due to increased runoff, littering, and overall abundance of MPs. The emergence of MPs has led to a greater need to research their environmental impacts and potential effects on freshwater organisms. The larvae of the midge, Chironomus riparius are ubiquitous in freshwaters of the northern hemisphere throughout the world and are ecologically important because they contribute to organic matter recycling, nitrogen cycling, and serve as a vital food source for other aquatic organisms. Research has shown that MPs can accumulate in the sediment of freshwater, the habitat of C. riparius, potentially disrupting their fundamental functions and impacting the overall stability of the ecosystem.

Larvae of the same developmental stage will be subjected to acute (48 hours) and chronic (7 days) treatments of MPs. MP stock (45-53 µm) will be diluted to different concentrations (0.01-2 mg/mL) and compared against controls without MP exposure. Larvae gut and Malpighian Tubule (MT) epithelia will be examined using hydrogen peroxide digestion, filtration, and histological techniques. Gut function will be assessed by measuring ion transport rates using scanning ion-selective electrode technique and MT function will be assessed using secretion assays. These studies will determine if MPs of different concentrations impact the function of gut and MT, important osmoregulatory organs in midges.

Paradis Khodaverdi

York Science Scholars Award

PROJECT

Investigating cisplatin induced hearing loss in cancer patients

PROGRAM

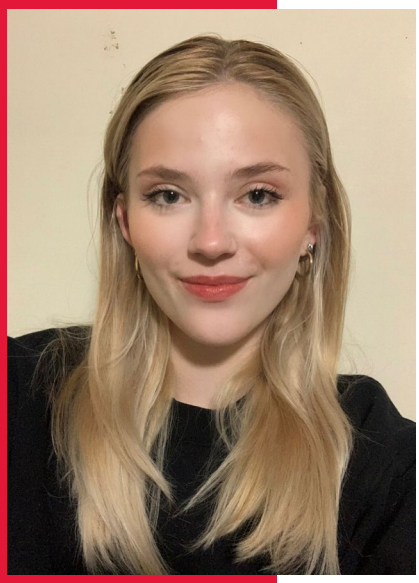
Neuroscience

SUPERVISOR

Christopher Bergevin

Cisplatin, an alkylating agent used in chemotherapy for cancer patients, has been proven to induce irreversible hearing loss, which has shown to impact their future employment, social development and education. But, how does it do so?

This project will aim to visualize cisplatin induced hearing loss using U Rochester's computational model for hearing-loss visualizer, by examining a cancer patients hearing threshold (in dB) via movement of inner hair cells, band-enhanced cells, and band-suppressed cells at n amount of cycles of cisplatin. By analyzing these projections, this research will try to understand what exactly occurs in the body that leads to the gradual development of hearing loss via cisplatin.



Elizabeth Krelove

York Science Scholars Award

PROJECT

Optimising mRNA display methodology to allow for generation of a combinatorial library of cyclic peptides

PROGRAM

Biotechnology

SUPERVISOR

Ryan Hili

The ability to discover ligands able to bind clinically relevant proteins is the main focus of many drug discovery methods. Messenger ribonucleic acid (mRNA) display libraries are a type of drug discovery library that covalently links polypeptides to their encoding mRNA, serving as a tag for peptide identification. mRNA display techniques that generate cyclic peptides are especially promising because cyclic peptides often have increased cell permeability, protease resistance, and demonstrate enhanced target binding by reducing the degrees of movement in a peptide chain. In this project, mass spectrometry will be used to confirm that peptide cyclization is occurring. Initially, unmodified linear peptides will be assessed to validate the protocol before executing cyclization in vitro on mRNA display libraries. Additional work may be done to optimise other aspects of the previously developed mRNA display method to improve yield and reproducibility. Modern mRNA display protocols are increasingly employing unnatural amino acids and cyclizing peptides, highlighting the importance of updating the current methodology used within this research group.

Siena Locsin

York Science Scholars Award

PROJECT

Beyond Human Hearing: AI and the Cocktail Party Effect

PROGRAM

Biomedical Science

SUPERVISOR

Christopher Bergevin

Imagine being at a crowded party with many conversations happening at once. Despite all the background noise, you can still have a focused discussion with a friend. This is the cocktail party effect in action. While humans do it effortlessly, separating sounds in a crowded space is a complex task for machines. Research on artificial intelligence is an ongoing field of study and there is more to uncover about how machines can achieve this level of auditory discernment.

This project examines machine learning and its role in computational audiology, more specifically, how AI models can be trained on large datasets to identify and prioritize certain types of sounds and voices. How is this possible, and what are its potential applications? Why is this research important?

Through investigation, this research aims to contribute to our understanding of artificial intelligence, technology, and how it can be used in the auditory system. A deeper understanding of machine learning could contribute to a future design of biologically-motivated artificial intelligence. By uncovering these insights, we can pave the way for significant development in hearing prosthetic technology, improving the quality of life for those who rely on it.

Daniel MohammadiAsl

Earle Nestmann Undergraduate Research Award

PROJECT

Exploration of the role of the TrkC-PTPσ complex in short-term synaptic plasticity within the mouse hippocampus

PROGRAM

Biology

SUPERVISOR

Steven Connor

Impaired synapse development and function are linked to neurological disorders such as autism and epilepsy. Accordingly, understanding how synapse properties are established should provide insights into the cellular basis for brain disorders. Synaptic organizer proteins are primary regulators of synapse development and organization. Tropomyosin receptor kinase C (TrkC) is an established synapse organizer which promotes excitatory synapse development through transsynaptic interaction with presynaptic Receptor type protein tyrosine phosphatase-sigma (PTPσ). To further explore how the TrkC/PTPσ contributes to synaptic function, mice harboring TrkC point mutations (TrkC knock-in) that selectively prevent PTPσ binding were generated and assessed for changes in synaptic plasticity. Analysis of long-term potentiation (LTP), a cellular model for memory, was conducted by measuring changes in synaptic strength in response to protocols that elicit an “early” or decaying form of LTP. These experiments could reveal central roles for TrKC-PTPσ complexes in activity-dependent changes in synaptic strength associated with memory and provide insight into why these processes are compromised in neurodevelopmental disorders.

Harry Parmar

NSERC Undergraduate Summer Research Award

PROJECT

Examining Functional Architecture of Frontal Eye Field in the Macaque Monkey

PROGRAM

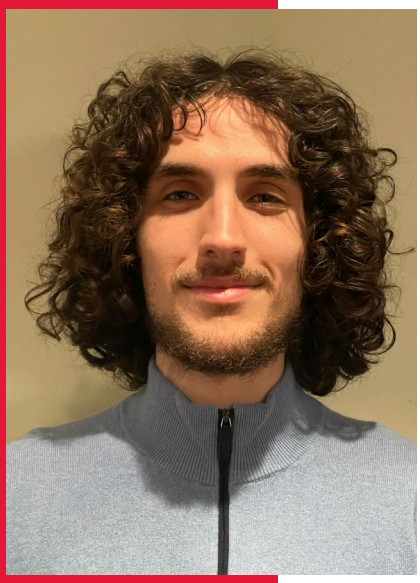
Health Sciences at Queen's University

SUPERVISOR

Jeffrey Schall

The frontal eye field (FEF) in the frontal lobe generates commands for voluntary saccades towards targets during visual search. In the following study, linear electrodes were placed in the FEF of two monkeys performing a visual search task to sample single-unit neural spike recordings from pre-saccadic activity cells, including visual and movement cells. Visual cells exhibit spikes upon the onset of a target stimulus, facilitating target selection, while movement cells' spikes initiate the motor response, creating voluntary saccadic eye movements.

Computed tomography and magnetic resonance imaging was used to pinpoint the exact locations of these electrodes in the FEF to determine where neurophysiological signals were collected. By doing so, the proportions of the aforementioned cell types in each cortical layer of the FEF could be identified, offering insights into the functional properties of each layer and refining the understanding of the cortical microcircuit involved in voluntary saccades



Michael Petosa

Earle Nestmann Undergraduate Research Award

PROJECT

Practical Cyclization of Imines into Functionalized Piperidines for the Synthesis of Drug-Like Molecules

PROGRAM

Biomedical Science

SUPERVISOR

Arturo Orellana

Nitrogen heterocycles are ubiquitous structural motifs present in many pharmaceutical drug molecules. However, synthesis of complex polycyclic heterocycles often requires multi-step approaches and expensive reagents. Herein we aim to develop a practical method of synthesizing polycyclic scaffolds using a one-pot procedure as the key step under mild reaction conditions and readily available reagents at low cost. Importantly, the target compounds contain two of the most commonly encountered heterocycles in drug molecules, specifically piperidine and pyridine. The ultimate goal of this project is to generate a library of polycyclic heterocycles with wide structural variability, making it an attractive synthetic method for pharmaceutical industry.

The synthesis begins with a commercially available pyridine derivative that is converted to a nucleophile under basic conditions. This intermediate is then quenched with an electrophile to gain access to an alkylchloropyridine. This specialized pyridine is then elaborated to an azide analogue in a one-step reaction. At this point, a simple treatment with triphenylphosphine (Staudinger reaction) generates the key phosphazene intermediate which is quenched with commercially available aldehydes (aza-wittig reaction). Ultimately, the simple addition of chloroformate derivatives in the presence of base yields the final product.

Vida Razmjou

NSERC Undergraduate Summer Research Award

PROJECT

Evolution of Staphylococcus aureus two-component system in the face of antibiotics

PROGRAM

Biology

SUPERVISOR

Dasantila Golemi-Kotra

The project investigates the role of clinical mutations in the VraS protein on antibiotic resistance in Staphylococcus aureus. VraSR, a two-component signal transduction system, is crucial for the bacterial response to antibiotics like penicillins and vancomycin, which target cell wall biosynthesis. Mutations in VraSR, particularly in VraS, a histidine kinase, have been linked to increased resistance to antibiotics.

The study focuses on three clinical single-point mutations in VraS, T331A, P327S and R266A and their impact on ATP-binding affinity and the subsequent phosphorylation of the VraR transcription factor. Isothermal titration calorimetry (ITC) will be employed to assess changes in ATP-binding affinity due to these mutations. The process involves introducing these mutations into the VraS protein, followed by protein expression and purification. The binding affinities of the mutant VraS proteins to ATP will then be characterized using ITC. Additionally, the ability of each VraS variant to phosphorylate VraR will be evaluated.

This project aims to elucidate the mechanistic effects of these mutations on VraS function and their contribution to antibiotic resistance in S. aureus, providing insights that could inform the development of new therapeutic strategies.

Yash Shrestha

NSERC Undergraduate Summer Research Award

PROJECT

Probing Late-LTP following selective inhibition of TrkC-PTPσ complex formation in a mouse model

PROGRAM

Health Sciences at Queen's University

SUPERVISOR

Steven Connor

Synaptic impairments contribute to the pathogenesis of major neurodevelopmental disorders, including autism spectrum disorder (ASD). Synaptic organizer proteins control synapse development, validation and function, and genes coding for some of these organizers have been linked to ASD. Tropomyosin receptor kinase C (TrkC) is a glutamatergic synapse organizer that mediates the development of excitatory synapses through interactions with it's presynaptic binding partner, Receptor type protein tyrosine phosphatase-sigma (PTPσ). The roles this complex play in mediating basal properties of glutamatergic synapses have been established, however, little is known about how TrkC/PTPσ binding contributes to enduring synaptic changes associated with learning and memory. To probe the roles of TrkC/PTPσ complexes in "Late" or enduring forms of LTP, TrkC point mutations (TrkC knock-in; KI) were generated that prevent PTPσ binding in mice. Analysis of late-LTP, a cellular model for long-lasting memories, was conducted by measuring changes in synaptic strength in the TrkC-KI mouse hippocampus, area CA1. Using robust protocols that induce enduring forms of synaptic plasticity, we tested whether multiple train LTP was altered in mice lacking TrkC/PTPσ complexes. Our results have important implications for understanding the cellular basis for neurodevelopmental disorders and how this complex contributes to memory regulation within the hippocampus.

Tomas Tjew

NSERC Undergraduate Summer Research Award

PROJECT

Functionalization and Oxidation of 3-Substituted Pyridines with Phosphonate Using Practical Reagents

PROGRAM

Biology

SUPERVISOR

Arturo Orellana

This project focuses on developing a direct synthetic method of accessing organophosphorus bearing a heterocycle under mild reaction conditions using readily available reagents. Pyridine-based heterocycles are among pharmaceuticals' most commonly found structures due to their favorable pharmacological properties. Similarly, organo-phosphonate compounds are prevalent in pharmaceutical drugs. These target compounds are valuable building blocks for drug discovery due to the presence of both pyridine and phosphonate ester motifs. Hence, an efficient method of installing a phosphonate on a pyridine, would readily expand the chemical space and facilitate access to potential drug hits.

Traditionally, synthesizing pyridine-containing phosphonate compounds requires using expensive palladium catalysts in a multi-step approach. These factors compromise the cost and efficiency, limiting our ability to access large libraries of these compounds for drug discovery.

My research aims to access decorated phosphonate pyridine derivatives through a one-pot procedure, specifically the formate electrophile addition of the phosphonate nucleophile followed by oxidation with oxygen. The optimized conditions use acetonitrile solvent, avoiding the viscous and hard-to-separate solvents like DMSO, which are conventionally used. Thus, our optimized approach significantly enhanced the yield and streamlined the reaction process, augmenting efficiency and environmental sustainability.

Adriano Vettese

NSERC Undergraduate Summer Research Award

PROJECT

Investigating Connections Between TOR (Target of Rapamycin) Activity and Circadian Rhythmicity in the Fungus Neurospora crassa

PROGRAM

Biology

SUPERVISOR

Patricia Lakin-Thomas

Circadian (24-hour) rhythmicity is driven by a biological clock present in nearly all eukaryotic cells that permits cells to adapt to and anticipate daily changes in their environment. Existing research has identified TTFLs (transcription/translation feedback loops) responsible for the functioning of this clock. This model however fails, as rhythmicity can still be seen when TTFL components are missing in knockout mutants. The Lakin-Thomas lab has discovered that the TOR pathway, a nutrition sensing pathway, that activates growth in eukaryotic cells, is rhythmic and may be the potential unknown oscillator responsible for rhythmicity in the absence of a TTFL. My project aims to identify feedback loops that regulate the TOR pathway. If TOR is the unknown oscillator, disruption of these feedback loops should alter both TOR activity and rhythmicity. I will assay TOR activity by measuring TOR output, the phosphorylation of S6 protein by Western blotting, and detect rhythmicity by fungal spore formation. I will disrupt the feedback loops by pulse treatments of amino acids and direct activators/inhibitors of autophagy. By providing a deeper understanding of these mechanisms in eukaryotic cells, my research will also provide insight on the circadian mechanisms present within other species that have similar pathways.

Elizaveta Yakubovskaya

NSERC Undergraduate Summer Research Award

PROJECT

Effects of motion adaptation on object position representations in the macaque IT cortex

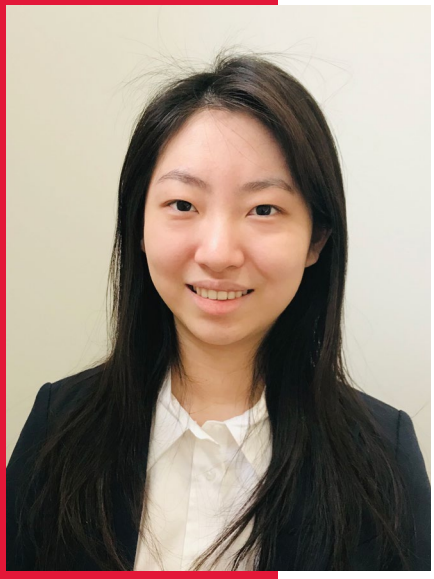
PROGRAM

Neuroscience

SUPERVISOR

Kohitij Kar

The brain's representation of visual object properties, such as shape, size, and pose, plays a crucial role in effective human-object interaction. Traditionally, a dominant view in the field –the "two-stream hypothesis," suggests that the ventral ("what") pathway represents object identity while the dorsal ("where") pathway represents spatial properties. However, recent findings challenge this segregation by demonstrating behaviourally relevant object position information in the inferior temporal (IT) cortex of the ventral stream. In this study, we aim to stress-test these claims by examining whether IT responses can predict positional biases induced by motion adaptation and exploring neuronal adaptation signatures in the IT cortex following prolonged motion exposure. Large-scale neural recordings were conducted in adult macaques viewing stationary images preceded by moving gratings. We test for perceptual position biases in the adapted IT population code, motion direction tuning, and direction-specific response suppression across IT units and populations. We also investigate whether exponential decay functions can model the time course of IT responses to the grating adapters. The results will expand our understanding of the ventral stream's contributions to visually guided behaviour and improve computational models of dynamic scene perception, potentially revolutionizing our understanding of the brain's visual processing pathways and their interactions.



Mu Ran Zheng

NSERC Undergraduate Summer Research Award

PROJECT

Role of NLRC5 in Trophoblast Differentiation during Development of the Placenta

PROGRAM

Medical Science at University of Western Ontario

SUPERVISOR

Chun Peng

Differentiation of trophoblast progenitor cells to extravillous trophoblast (EVTs) during placental development invades the uterus and remodels the spiral arteries to increase blood flow to the placenta as well as the fetus. Insufficient differentiation to EVTs as well as transformation of the spiral arteries causes decreased blood flow and results in the development of preeclampsia.

NLRC5 protein isoforms 17 and 18 have been determined by Peng lab to suppress EVT differentiation. Additionally, FUS has been identified as a potential interacting protein of the NLRC5 isoforms. The interaction between FUS and NLRC5 isoforms is suggested to regulate placental development and dysregulation of NLRC5 may contribute to the development of preeclampsia. The goal of the project is to understand the interaction between the NLRC5 isoforms and FUS by determining the region responsible for this interaction. Understanding the molecular basis of the FUS-NLRC5 interaction provides more insights into the mechanisms and functions of NLRC5 in placental development as well as determine factors that contribute to preeclampsia.

CHEMISTRY

Parmeetpal Dhillon

York Science Scholars Award

PROJECT

A Unified Nonlinear-Regression Model for Accurate Determination of Both Michaelis Constant (Km) and Equilibrium Dissociation Constant (Kd)

PROGRAM

Biochemistry

SUPERVISOR

Sergey Krylov

Michaelis constant (Km) is a parameter describing the steady state in an enzymatic-catalysis reaction, while the equilibrium dissociation constant (Kd) is a parameter that characterizes the stability of an affinity complex formed in a reversible target–ligand binding process. Despite the apparent conceptional difference between Km and Kd, we mathematically confirmed that a universal model for nonlinear regression of experimental results can be used in the determinations of the two physicochemical parameters. Surprisingly, an analysis of recent publications reporting Km values revealed a lack of use of the Kd-specific regression model for Km determinations. The advantages of a unified nonlinear regression model include the standardization of data-processing approaches for both enzymatic reactions and binding processes. Moreover, leveraging the parallelism between Kd and Km determinations allows for the extrapolation of key determinants of Kd accuracy to enhance the understanding and reliability of Km measurements. Our findings indicate that insights from Kd determination studies are directly applicable to Km determination, and vice versa, offering valuable implications for future research and data analysis in enzymology and molecular binding studies.

Luca Rustico

NSERC Undergraduate Summer Research Award

PROJECT

Selection and Evolution of DNA Aptamers Using Ligase-catalyzed OligOnucleotide PolymERization (LOOPER)

PROGRAM

Biochemistry

SUPERVISOR

Ryan Hili

Aptamers are single-stranded nucleic acid polymers engineered to bind to specific targets with high affinity and specificity. In the rapidly growing fields of therapeutics and diagnostics, aptamers serve as nucleic acid analogues to traditional antibodies but possess advantages like reversible denaturation, longer shelf-life, and lower production costs. Unfortunately, DNA aptamers are limited in their chemical diversity due to the four canonical bases (A, G, C and T), which only allow for modifications up to 4^n, where “n” represents the polymer length in base pairs. Thus, expanding the chemical diversity of nucleic acids is key in bridging the gap between aptamers and antibodies, which contain a notably wider chemical diversity due to the 20 proteinogenic amino acids that encode them.

The Hili Lab has developed a technique called Ligase-catalyzed OligOnucleotide PolymERization (LOOPER), a synthetic method to generate aptamers with similar chemical side chains seen in their protein counterparts. Using T3 ligase, this method can produce aptamers with modified side chains every third nucleotide, effectively broadening the chemical diversity of DNA aptamers. During my summer research project, I will use LOOPER-SELEX to evolve DNA aptamers against a clotting factor, α-thrombin, from a starting library of 10^23 chemically diverse aptamers.

Savreet Sangha

NSERC Undergraduate Summer Research Award

PROJECT

Degradation of NF-KB protein using an aptamer-directed PROTAC system

PROGRAM

Chemistry

SUPERVISOR

Ryan Hili

Aptamer-directed PROteolysis-TArgeting Chimeras (PROTAC) is a technique which enables the targeted degradation of disease-causing proteins within cells. This method uses RNA aptamers, which are nucleic acid polymers that bind proteins with high affinity and specificity, to colocalize endogenous ubiquitin ligases with a protein of interest (POI). This interaction increases the ubiquitinylation rate of the POI, marking it for degradation by the proteosome. There are two types of RNA aptamers: linear RNA aptamers and circular RNA aptamers. Linear RNA aptamers are less stable resulting in a limited lifespan within a cell which results in reduced protein degradation. In contrast, circular RNA aptamers are more stable and have a longer lifespan within cells, leading to greater protein degradation. Our research focuses on demonstrating that circular RNA aptamers are more effective for PROTAC applications compared to linear RNA aptamers by targeting degradation of NF-KB protein using PROTAC system. To confirm and measure NF-KB protein degradation, we will use two independent validation methods namely cell fluorescence assay and western blotting to compare the efficiencies of the linear and circular targeted degradation systems. In conclusion, our research will provide significant insights to improve aptamer-directed PROTAC systems for therapeutic applications.

MATHEMATICS & STATISTICS

Shahen Alexanian

NSERC Undergraduate Summer Research Award

PROJECT

Evaluating the Introduction of a Variational Autoencoder into a Multi-omics Workflow

PROGRAM

Mathematics and Computer Science

SUPERVISOR

Xin Gao

In a recent paper, Al-Hurani et al. developed a machine learning model to predict various patient outcomes using multiple types of genomics and epigenomics data from publicly-available sequencing datasets. By using an autoencoder to compress the high-dimensional RNA expression, DNA methylation and copy number variation datasets into a lower-dimensional, latent representations and by up-sampling underrepresented classes using a generative adversarial network, Al-Hurani et al. were able to training a neural network classifier to classify and predict outcomes with high accuracy. This study attempts to replicate the experiment of Al-Hurani et al. referenced above, and then introduce the use of a variational autoencoder into this workflow to see if any improvement is obtained in the results.

Taiye Estwick

NSERC Undergraduate Summer Research Award

PROJECT

Development and comparative analysis of bioinformatic methods for target capture sequence

PROGRAM

Applied Mathematics

SUPERVISOR

Ryan Schott

Targeted sequence capture is a method that allows the selective enrichment of genomes for regions of interest prior to high throughput sequencing, allowing many more samples to be sequenced for the same resources. This has made the approach attractive for targeted resequencing and phylogenetic studies, but due to the difficulties in capture across divergent groups of species, is used less frequently for molecular and functional evolutionary purposes. Several research groups have captured complete coding sequences from broad phylogenetic groups, implementing different experimental and bioinformatic methodologies to solve the problem of divergent capture. Our group has recently completed a target capture experiment sequencing hundreds of genes from ~200 frog species and updated our assembly and analysis pipeline. This project will test those improvements on both the frog data, as well as previously generated data, by comparing assembly quality with our pipeline to pipelines from other studies. This will allow us to further improve our assembly approach and determine the degree to which the bioinformatics contributes to the overall data quality, compared to the experimental methodology. Our results will contribute to methodological development of cross-species coding sequence capture approaches and produce genetic data for studies of visual gene evolution in frogs.

Joshua Levine

NSERC Undergraduate Summer Research Award

PROJECT

New Differentially Private Rank Tests

PROGRAM

Statistics

SUPERVISOR

Kelly Ramsay

Hypothesis testing, which enables us to make inferences about an entire population based on only sampled data, is crucial to research in a variety of fields. Many real-world applications of hypothesis testing involve the use of individuals' sensitive information, creating the need to protect these data from attacks while still delivering accurate insights. This is the goal of differential privacy, a framework of algorithmic design which has seen usage by prominent institutions such as Google, Apple, and the US Census Bureau. Differential privacy, however, comes at the inevitable cost of reducing the power of the hypothesis tests on which it is implemented. Inspired by the percentile modification, we develop a new class of differentially private hypothesis tests for various testing problems. Our preliminary results show that at some privacy budgets, we can achieve higher power than some existing differentially private tests for the same problem. This will allow future researchers to continue drawing accurate data-driven conclusions while protecting individual privacy to a greater extent than what was previously feasible.

Eniola Ogunjimi

NSERC Undergraduate Summer Research Award

PROJECT

Exploring Combinatorial Bijections via Machine Learning

PROGRAM

Applied Mathematics

SUPERVISOR

Mike Zabrocki

Machine learning is often used to compress data files such as pictures, audio or videos. Autoencoders are a useful machine learning technique for implementing data compression using neural networks. Autoencoders have three parts; an encoder, a bottleneck and a decoder, we propose that by training an autoencoder on identical inputs and outputs of finite combinatorial sets, which represent subsets of integer vectors. We hope that we will be able to uncover a low dimensional encoding, given a dataset within our bottleneck layer of our autoencoder.

Thus far we have only trained our network on vectors of {0,1}^k dimensions as a starting point, but eventually we would like to apply this method to generally subsets of (a1, a2, ..., ak) for all a in the set of integers (Z), greater than or equal to 0. We believe that various data structures are used to store combinatorial objects and we want to identify an optimal network architecture of an autoencoder that will guarantee encoding the data structures as a 1-dimensional vector. In hopes of presenting our findings to a combinatorial audience.

Johann Peters

NSERC Undergraduate Summer Research Award

PROJECT

Lattice Animal Topologies

A lattice animal is a connected collection of nodes and edges on the d-dimensional hypercubic lattice. We may restrict these to special cases, eg lattice trees have no loops and self-avoiding polygons a a single, non-intersecting loop.

We investigate several problems regarding the topologies of lattice animals. So far we have proved the most common lattice tree topology (the underlying tree-graph) exponentially rare, and are working on the exponential characterization of self avoiding polygons of fixed knot-type.

PROGRAM

Mathematics

SUPERVISOR

Neal Madras

Stephano Ricci

Earle Nestmann Undergraduate Research Award

PROJECT

Risk management in the presence of heavy-tailed crypto-currency risks

PROGRAM

Statistics

SUPERVISOR

Edward Furman

Fat tails of returns are a common occurrence in portfolio management. Heavy tails may be caused by frequent price fluctuations, which are often found in such more volatile assets as cryptocurrency. In certain unique yet frequently occurring cases, heavy tails of returns result in infinite variances, limiting our ability to apply appropriate variance-based risk measures such as the vanilla standard deviation and (Tail) Standard Deviation/(Tail) Variance. (More generally, the issue of infinite variances is not a rare phenomenon in the risk management and insurance industry, with many professionals struggling to find a way to measure variability in such cases.) In this project, we will employ the Gini Shortfall risk measure [Furman et al., (2017). Gini-type measures of risk and variability: Gini shortfall, capital allocations, and heavy-tailed risks. Journal of Banking and Finance], as a foundation to new portfolio optimization approach (an alternative to the traditional standard deviation/variance based approach conceptualized by Harry Markovitz) and demonstrate how it can solve many problems currently faced by risk professionals in the context of cryptocurrency risk management.

Adeeb Rouhani

Earle Nestmann Undergraduate Research Award

PROJECT

KWC-Changepoint: User-friendly functional and multivariate changepoint detection

PROGRAM

Statistics

SUPERVISOR

Kelly Ramsay

This project aims to introduce newer, more robust changepoint detection methods for multivariate functional data and multivariate data. The current methodology lacks the robustness to deal with outliers, which often exist in real data. This is apparent when dealing with f-MRI (functional magnetic resonance imaging) data, where ensuring changepoints are detected can be computationally challenging but crucial. This project is thus inspired to develop methods that could detect such changepoints and compare them to the current methods.The practical end product of this project is in the form of an open-source R package, which would allow scientists and statisticians to use these changepoint detection methods with their own data. These methods that we propose are not limited to f-MRI data and could be used in any setting that relies on multivariate or functional data, whether that be in environmental sciences or speech recognition.

PHYSICS & ASTRONOMY

Karan Alavi

NSERC Undergraduate Summer Research Award

PROJECT

Dark Matter Halo Dynamics Simulation

PROGRAM

Physics

SUPERVISOR

Sean Tulin

This project has multiple components that need to be merged together at the end. My task with my groupmates is to extend the classical model of our dark matter simulation to one consistent with the general theory of relativity and relativistic fluid dynamics, which enables setting instability conditions for black hole formation, after which we consider the object as a point mass. We will generalize the ideal gas model currently used to have a different equation of state, which can possibly give rise to compact objects named “dark stars.”. Finally, we will make these changes to the Python SPH (smoothed particle hydrodynamics) code and run the simulations. The importance of these adjustments lies in the existing problems with contemporary dark matter models, one of which is called the core-cusp problem. Research has shown that some observation problems can be solved by including details such as star feedback in the simulations. Correcting the code to a relativistic one may not only overcome some of these problems and make better predictions, but can potentially find further application in other related fields of dark matter research.

Adam Cherti

NSERC Undergraduate Summer Research Award

PROJECT

The morphology of extreme mixing events in stratified turbulence

PROGRAM

Applied Physics

SUPERVISOR

Miles Couchman

Turbulence, the chaotic motion of a fluid, is a phenomenon of direct importance to multiple facets of everyday life. However, turbulent processes remain poorly understood due to their inhomogeneous and stochastic nature over a vast range of spatial and temporal scales. In this study, we consider how turbulence leads to the mixing of density in a fluid with a variable background density gradient, known as a stratified fluid. Stratified turbulence arises in a variety of geophysical settings, including the ocean where turbulent mixing is a key area of uncertainty in climate modelling.

We here analyze direct numerical simulations of the evolution of a stratified turbulent flow initialized using a periodic array of Taylor-Green vortices. To characterize the resulting turbulence, we use image-processing techniques including thresholding and connected component analyses to identify local mixing hotspots within the flow. By analyzing the structural evolution of these three-dimensional mixing hotspots over time, and relating their formation and evolution to the underlying velocity field (through consideration of properties such as shear, strain, and vorticity), we are able to gain an improved understanding of the mechanisms driving mixing in stratified environments.

Joseph Cuzzupoli

NSERC Undergraduate Summer Research Award

PROJECT

Feedback System for Laser Intensity Stabilization*

PROGRAM

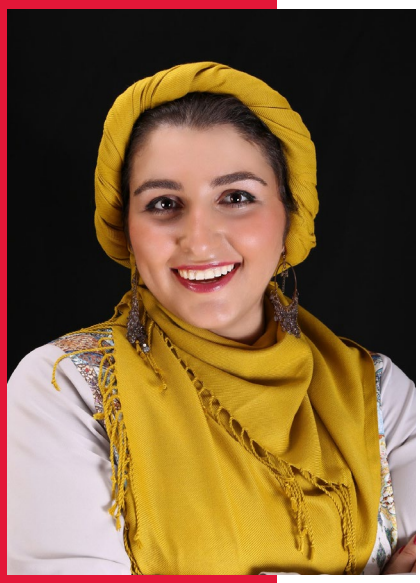
Physics

SUPERVISOR

Anantharman Kumarakrishnan

My research group uses low cost, homebuilt laser systems for experiments in precision metrology, such as measurements of gravitational acceleration using laser cooled atoms, confined in a magneto-optical trap (MOT). We have constructed a feedback system for stabilizing the laser intensity in this experiment that uses an analog circuit and an acousto-optic modulator (AOM). A portion of the light diffracted by the AOM is incident on a photodetector. The signal from the photodetector is compared to a setpoint voltage using a subtractor in the first stage of the analog circuit. In the second stage, the subtractor output is amplified and integrated with a time constant that can be as small as 100 µs. In the final stage, the integrated signal is added to a stable offset voltage, and the resulting signal controls a radio frequency (RF) attenuator that modulates a voltage controlled oscillator driving the AOM. In this scheme, if the laser power fluctuates, the RF signal to the AOM changes so as to stabilize the laser intensity. We investigate the suitability of this feedback loop for stabilizing the fluorescence from the MOT and the impact of stabilizing the atom number on a variety of experiments.

*Work supported by CFI, OIT, NSERC, OCE, Helen Freedhoff Memorial Fund, and York University



Zeinab Imani

NSERC Undergraduate Summer Research Award

PROJECT

Cosmological Formation of Dark Matter Halos

PROGRAM

Physics

SUPERVISOR

Sean Tulin

This project explores the cosmological formation of dark matter halos originating from primordial overdensities, which are key to understanding the Universe's large-scale structure. We use the Secondary/Spherical Infall Model (SIM) to describe halo formation through spherical gravitational collapse. The research involves two main tasks: (1) studying the SIM framework to understand the evolution of dark matter halos, and (2) implementing this model using Smoothed Particle Hydrodynamics (SPH) and SPHerical code. This implementation will model the initial collapse of dark matter halos, focusing on scenarios involving interacting dark matter models. By developing a simulation model and comparing it with high-resolution N-body simulations, we aim to validate the SIM's effectiveness in describing halo formation. The SPHerical code, an advanced tool for simulating spherically symmetric systems, is particularly suited for modeling the gravitational collapse and subsequent evolution of dark matter halos. It provides detailed insights into the dynamics of interacting dark matter, enhancing the accuracy of our halo formation models.

Maria Belen Llaguno Real

Earle Nestmann Undergraduate Research Award

PROJECT

Development of a Modulation-Free Laser Source for Atomic Physics Experiments

PROGRAM

Physics and Astronomy

SUPERVISOR

Anantharaman Kumarakrishnan

The most common technique to stabilize the frequency of a laser is to use a lock-in amplifier, which imposes a frequency modulation on the light source. My research project uses a technique called “Doppler-free Dichroic Atomic Vapor Laser Lock” (DF-DAVLL) to achieve this goal without the need for frequency modulation. The technique involves setting up a saturated absorption spectrometer that includes a rubidium vapor cell in a uniform magnetic field of approximately 20 G. We monitor the absorption of a weak linearly polarized probe laser in the presence of a strong counterpropagating pump laser aligned through the cell. Differences in the indices of refraction for two orthogonal circularly polarized components of the probe laser produce a dispersion shaped error signal that can be used to stabilize the laser frequency. We characterize the lock stability using measurements of the Allan deviation. We present DF- DAVLL sources operating at both 780 nm and 795 nm corresponding to the Rb 5S 1/2 - 5P 3/2 and Rb 5S 1/2 - 5P 1/2 transitions respectively. The frequency stabilized laser sources are used in three ongoing experiments, namely, atom interferometry with laser cooled atoms, measurements of diffusion and magnetic fields using optical latices, and determination of excited state lifetime.

Author List: Maria Belen Llaguno, Leith Arnold, Eduardo Ramos, Jaskaran Randhawa, Joseph Cuzzopoli, Gehrig Carlse, Thomas Vacheresse, Alexander Pouliot, and A. Kumarakrishnan

Aida Shahabi

Earle Nestmann Undergraduate Research Award

PROJECT

Investigating the molecular regulation of trans-delta-9-tetrahydrocannabinol (THC) cannabinoid biosynthesis in Cannabis sativa

PROGRAM

Biophysics

SUPERVISOR

Nikola Kovinich

Cannabis sativa produces over 120 cannabinoids within its trichomes, which are little, hair-like structures located on the surface of several parts of the cannabis plant, such as the flowers. Several of these bioactive cannabinoids are in high demand due to their pharmacological properties. Trans-delta-9-tetrahydrocannabinol (THC) is a psychoactive cannabinoid that alleviates pain, nausea, and vomiting associated with cancer chemotherapy and suppresses spasms. Despite its extensive use, there is limited knowledge of the genes that regulate THC biosynthesis. Our team's yeast two-hybrid analysis has identified 16 transcription factors that physically interact with the putative cannabis transcription factor, CsAP2L1. To uncover the factors contributing to the synthesis of THC, my objective is to investigate the interaction between CsAP2L1 and another transcription factor that serves a vital role in the development and formation of trichomes. I am studying the protein-DNA interactions between the two transcription factors and the regulatory elements of THC synthesis genes, along with the protein-protein interactions among those transcription factors. Our aim is to understand cannabinoid gene regulation to facilitate breeding and engineering efforts aimed at enhancing cannabinoid production.

ENVIRONMENTAL & URBAN CHANGE

Vesta Tajik

NSERC Undergraduate Summer Research Award

PROJECT

Documenting the impacts of an inter-basin river diversion on Lake Nipigon

PROGRAM

Environmental Biology

SUPERVISOR

Joshua Thienpont

In 1948, the construction of the Ogoki Diversion rerouted the Ogoki River from the Hudson Bay watershed into the Atlantic drainage basin through Lake Nipigon, the largest lake entirely within Ontario's borders located north of Lake Superior. The goal of the Ogoki Diversion was to enhance flow at power generating stations 1000 kilometers downstream in Niagara Falls, highlighting the significance of Lake Nipigon to the Great Lakes system. The Ogoki Diversion caused widespread erosion along the banks of the Little Jackfish River, with eroded sediments being deposited into Ombabika Bay at the north end of Lake Nipigon. HydroOne estimated that up to 9 metres were deposited in Ombabika Bay, and local Indigenous fishermen observed a large sediment plume that extended beyond Ombabika Bay and persisted for many years. There has never been any assessment of the impacts of the Ogoki Diversion on Lake Nipigon, despite its designation as a provincially significant fishery. Biinjitiwaabik Zaaging Anishinaabek (BZA) have raised concerns about a lack of understanding of the cumulative impacts of development in the Lake Nipigon watershed, and the Ogoki Diversion in particular. My research is part of a larger, collaborative initiative between York and BZA to reconstruct environmental change using lake sediment cores (paleolimnology), an approach similar to ice cores. I am conducting chemical analyses on the sediment cores to "fingerprint" the sediment eroded by the Ogoki diversion, so that I can trace the distance it travelled in Lake Nipigon. "Distance travelled" is a proxy for understanding the potential spatial extent of impact to fish spawning areas. Preliminary results support the observations of local fisherman, indicating that the sediment plume had a much wider impact than just Ombabika Bay.

LIBERAL ARTS & PROFESSIONAL STUDIES

Samuel Moore

NSERC Undergraduate Summer Research Award

PROJECT

Developing an AI Fairness Tool for Bias Detection and Mitigation in FinTech Using NLP

PROGRAM

Information Technology

SUPERVISOR

Manar Jammal

The rapid evolution of financial technology (FinTech) has introduced advanced AI models into many aspects of finance, including credit scoring, fraud detection, and customer service. While these innovations offer significant benefits, they also pose risks of perpetuating biases against marginalized groups. We aim to develop an AI fairness tool designed for the FinTech sector, leveraging Natural Language Processing (NLP) to detect, analyze, and mitigate biases in textual data and decision-making processes. The project will employ a mixed-methods approach, starting with a qualitative analysis to understand the types of biases present in FinTech and how they manifest in textual data. Following this, we will develop NLP models to automate the detection of these biases, utilizing machine learning, deep learning, and linguistics. The development of the bias metric system will involve statistical analysis and machine learning algorithms to accurately quantify biases. For mitigation, we will develop a methodology for implementing automated bias mitigation strategies, ensuring FinTech applications adhere to ethical standards and regulatory requirements. By addressing biases at their source and throughout the decision-making process, the project will contribute to the development of more accountable and fair financial technologies. Instilling confidence in AI-driven financial services among consumers and stakeholders.

Yuliya Savvon

NSERC Undergraduate Summer Research Award

PROJECT

Simulating Blockchain Consensus Protocols

PROGRAM

Information Technology

SUPERVISOR

Sotirios Liaskos

This project focuses on developing a simulator for consensus networks, which form the foundation of blockchain technology used in cryptocurrencies, financial services and other industries. These consensus networks involve a set of interconnected nodes participating in a protocol to validate various events, such as economic transactions. Conventional approaches to studying and testing these networks can face difficulties in handling the level of complexity needed for analyses and experimentation.

The event-driven simulator in this project provides a cost-effective option to study and analyze the performance of consensus protocols. Unlike most existing and proposed in literature simulators, the simulator in question is based on a flexible object-oriented framework that allows one to build, maintain, and enhance simulators of any protocol and run them under diverse conditions.

In collaboration with a team of other software developers, we are working towards improving the simulator's functionality, including sampling, reporting, and customization. We are also working towards further deepening our knowledge of cryptocurrencies and blockchain while developing simulations of additional protocols based on published research and improving and testing already implemented protocols.

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