2025 UNDERGRADUATE RESEARCH CONFERENCE

NSERC CRSNG

science | YORK U

Acknowledgements

The Faculties of Science and Environmental & Urban Change 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 also wishes to extend its gratitude to the individual donors – who wish to remain anonymous – who have supported additional summer research placements for students through the Professor John Goodings Undergraduate Research Award and the Professor Diethard Bohme Undergraduate Research Award.

We also wish to acknowledge York University's Office of the Vice-President Research & Innovation for their support of this important conference.

Last but not least, thank you to all of our faculty members and research staff for supporting, training, and supervising undergraduate research students in your labs this summer.

Table of Contents

Message from the Dean 4

Message from the Director 5

Biology 6

Chemistry 22

Mathematics & Statistics 31

Physics & Astronomy 37

Environmental & Urban Change 43

Robert Tsushima

Dean of the Faculty of Science

Dear Students,

Welcome to our 2025 Summer Undergraduate Research Conference, proudly hosted by York University's Faculty of Science, in collaboration with the Faculty of Environmental and Urban Change.

Congratulations on earning competitive summer research awards that have enabled you to collaborate with leading researchers across our campus. Many of you have been awarded prestigious Undergraduate Summer Research Awards (USRAs) from the Natural Sciences and Engineering Research Council of Canada (NSERC). Additionally, we recognize our Faculty of Science recipients of the York Science Scholars Award (YSSA), the John Goodings Undergraduate Research Award, and the Diethard Bohme Undergraduate Research Award for their outstanding achievements.

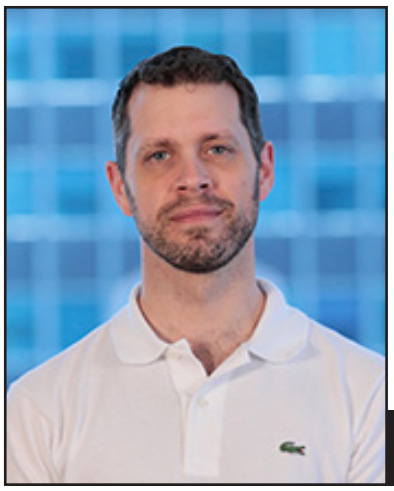
Your projects, which delve into subjects ranging from CRISPR gene editing, to investigating PFAS pollutants, advancing neural interfaces, and furthering our understanding of supermassive black holes, exemplify the curiosity and innovation driving our university community. Your research not only addresses some of the most urgent challenges facing society and the environment but also contributes valuable insights that advance knowledge and inspire positive change.

This conference is a platform for you to present your findings, exchange ideas, and connect with peers and faculty members who share your passion for discovery. Please take some time to explore the research summaries in this booklet, which offers a snapshot of your collective accomplishments and serves as a record of your dedication and hard work.

I trust that your summer research experience has been enriching and has provided valuable growth opportunities, guidance, and a deeper appreciation for scientific inquiry. Thank you for your commitment and contributions—you play a vital role in elevating York University's research excellence and generating knowledge that shapes our world's future.

Best wishes for an engaging and rewarding conference experience!
Sincerely,

Dr. Robert Tsushima
Interim Dean, Faculty of Science
York University



Matthew Vincelli

Director of NSERC

Congratulations to all students whose research is highlighted in this booklet.

The Undergraduate Student Research Awards (USRA) program, offered through the Natural Sciences and Engineering Research Council of Canada (NSERC), is an initiative we are immensely proud of. It provides funding to facilitate research experience opportunities for undergraduate students that hopefully spark a lifelong interest in scientific discovery. Through these training opportunities people can build critical skills in Canada's natural sciences and engineering fields.

To all USRA recipients: thank you for your willingness to step into the world of research. Whether you plan to continue into graduate studies or are exploring where your journey will take you next, we hope this program has helped you to achieve your goals, or perhaps just to set them.

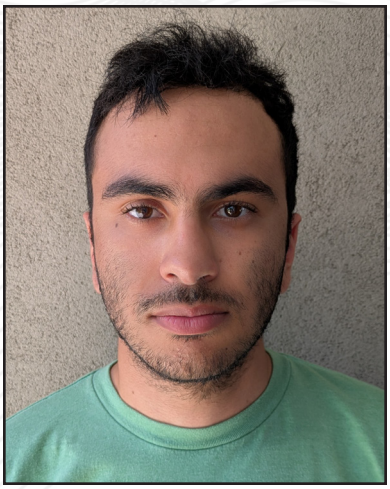
We hope you will continue in research—and should you choose to pursue graduate studies in the natural sciences or engineering, I encourage you to explore the full range of NSERC scholarships available. You can find more details in the Students and fellows section of NSERC's website.

We would like to express our sincere appreciation to the faculty members who hosted and supervised students, as well as the graduate students, postdoctoral fellows, and research staff at York University who provided mentorship and support. Special thanks also go to the university staff who coordinate the program and ensure its continued success.

Thank you to all who make the USRA program a vital part of Canada's research ecosystem.
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



Christian Nakla

NSERC Undergraduate Student Research Award

PROJECT

Nutritionally-mediated Bee-flower Interactions Across an Urban-rural Gradient

PROGRAM

Environmental Biology (Hons.)

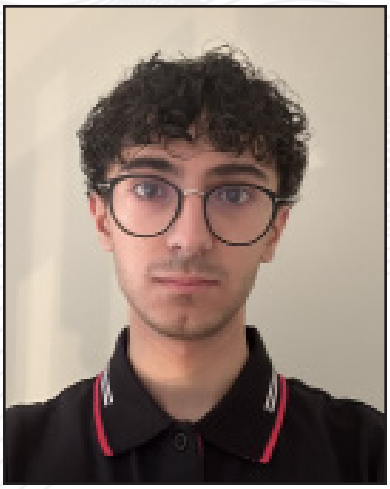
SUPERVISOR

Sandra Rehan

Bees are responsible for plant pollination in many habitat types, yet the ability of these habitats to provide sufficient nutrition for wild bees is understudied, especially under urban influences. My research investigates the interactions between wild bees and flowers, focusing on how pollen nutrition and floral functional traits influence bee visitation across an urban-rural gradient.

During the summer of 2025, bees were collected from selected floral species at various sites across Toronto, along with floral and soil samples. These sampling sites vary in their degree of urbanization, defined by the degree of impervious surface cover within a buffer radius. Pollen from each floral sample will be extracted and analyzed for its protein, amino acid, and non-esterified fatty acid content using Liquid Chromatography/Mass Spectrometry methods. Flower and inflorescence dimensions, petal colour, and symmetry were all recorded. The nutritional composition of pollen and floral traits from target flowers will then be examined to identify correlations with bee visitation patterns as influenced by human land use.

Ultimately, this project will provide important insights into the variation in pollen nutrient content and the effects of land use on nutrient values for urban planning, land use restoration, and pollinator health conservation.



Daniel Della Rossa

NSERC Undergraduate Student Research Award

PROJECT

Investigating Diverse Allosteric Effects and Binding Site Dynamics of Proteins Using Zero-scrambling Site Specific HDX-MS Technique

PROGRAM

Biomedical Science

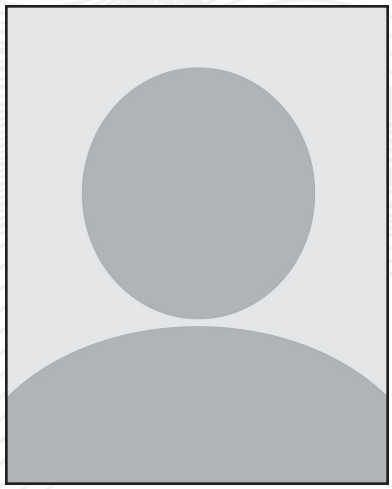
SUPERVISOR

Derek Wilson

Current bottom-up HDX-MS techniques can be used to determine where drugs bind on a protein and the conformational consequences of such binding to a peptide-level resolution. This limited resolution has been bypassed through a novel system that limits deuterium scrambling when paired with EAD fragmentation of peptides.

Our research aims to utilize this system to first measure the different binding affinities of several potential drug candidates for a protein at binding sites proposed by X-ray crystallography. The second goal is to examine regions traditionally silent in activity with current HDX-MS on a peptide level to discover potential secondary or tertiary binding sites of a drug. The third is to use the system to map out differences in allosteric effects due to the unique binding affinities and site binding differences to gain a more comprehensive view of drug-induced protein conformational changes.

This new exciting MS technique can complement X-ray crystal structures, which may miss potential binding interactions and show dynamic changes in protein structure as a consequence of different ligand binding. It is likely to be an essential tool in early drug development by providing higher-quality information earlier in the discovery phase.



Edessa Jajo

York Science Scholars Award

PROJECT

USP-7 Research

PROGRAM

Biochemistry

SUPERVISOR

Vivian Saridakis

The ubiquitin signaling pathway is found in all eukaryotic organisms and plays essential roles in the turnover, localization, or activation of proteins. The best-known process of protein ubiquitination is the covalent attachment of a ubiquitin protein to other proteins to regulate their degradation by the 26S proteasome. An enzyme called Ubiquitin Specific Protease 7 (USP7) catalyzes the deubiquitination of proteins that have been ubiquitinated and thus prevents their degradation. The purpose of my research project is to characterize the motifs used by proteins to interact with USP7 and to look for similar motifs in proteins found across a variety of organisms. My goal is to apply what I am learning about USP7 and the p53 pathway and develop my own research questions: are these motifs conserved, and why? A better understanding of how ubiquitination and deubiquitination pathways work can lead to breakthroughs in cancers and other diseases that are caused by deregulation of the ubiquitin signaling pathway.

Evelyn Trejo

NSERC Undergraduate Student Research Award

PROJECT

Analyzing the Effects of Genetic Variation on Metabolic Rate Using Clonal and Non-clonal Fish (Poeciliids)

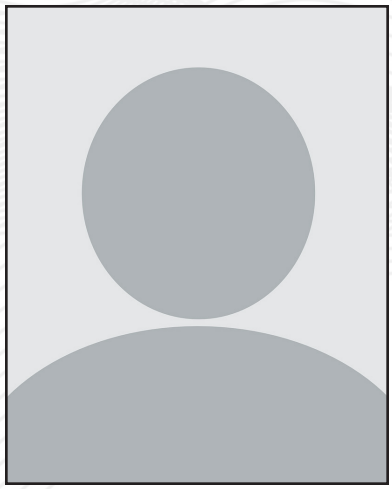
PROGRAM

Biology (Hons.)

SUPERVISOR

Carol Bucking

Within a population, individual phenotypes vary due to the interaction between genetic and environmental factors. It is assumed that genetic composition significantly influences an individual's physiology and is, in turn, a confounding factor in physiology-based experiments. Traditionally, studies have utilized highly inbred populations or F2 populations to control for genetic variability; however, these populations fail to be completely isogenic and present other complications, such as inbreeding depression, that may also impact experimental results. This study aims to evaluate the effects of genomic variation on whole-body physiology by comparing metabolic rates of a naturally occurring clonal species, the Amazon molly (Poecilia formosa), with those of siblings from a neighbouring sexually reproducing species, the Sailfin molly (P. latipinna). Since metabolic rate is a heritable trait that serves as a proxy for whole-body physiology, we measured metabolic rate via oxygen consumption using intermittent-flow respirometry. The results of this study will provide insight into the importance of genetic variation in an animal's physiological phenotype. Further, if the isogenic properties of the Amazon molly prove to limit variation in metabolic rate, this will provide further evidence for our use of this fish as a model to control genetic variation in future physiological studies.



Harry Parmar

NSERC Undergraduate Student Research Award

PROJECT

Examining Functional Properties of Frontal Eye Field in the Macaque Monkey

PROGRAM

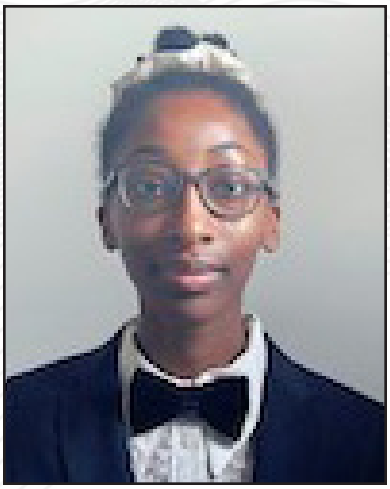
Health Sciences - Queen's University

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, magnetic resonance imaging, power spectral density, current source density, and the presence of spiking discharges will be utilized to pinpoint the laminar positions of each electrode contact within the FEF. This multimodal approach will allow us to quantify the proportions of visual and movement cells across cortical layers, revealing layer-specific functional properties and an improved understanding of the microcircuitry that generates voluntary saccades.



Iman Alleyne

York Science Scholars Award

PROJECT

Do Genetic Diversity and Chemodiversity Influence Powdery Mildew Infection in Monarda Fistulosa?

PROGRAM

Environmental Biology

SUPERVISOR

Gordon Fitch

Previous studies have shown that increased species and genetic diversity correlate to increased biomass and ecosystem productivity. Some research also suggests that diversity can protect against disease spread, though the evidence is mixed. Despite this, the most common method of growing crops, monoculture, involves growing the same crop over a large area. This system creates areas with very low biodiversity, and, as the Panama fungus that wiped out Gros Jean bananas showed the world, it can lead to spectacular impacts from disease. Using replicated diversity plots where the chemical and genetic diversity of the plant Monarda fistulosa (wild bergamot) are varied in a fully factorial design, this project will study the effect of these two components of diversity on mildew infection. It is hypothesized that when plots affected with mildew have high levels of diversity, mildew infection is less severe than affected plots with low diversity, and that genetic diversity has a stronger effect on severity than chemical diversity. As plant biodiversity worldwide continues to decrease, investigating how biodiversity affects plant ecosystems becomes more important.

Isabella Mokabel

York Science Scholars Award

PROJECT

Patterns of Molecular Evolution in the Phototransduction Genes of Turtles

PROGRAM

Biology

SUPERVISOR

Ryan Schott

The phototransduction cascade is a critical biochemical pathway representing the initial stages of vision involving over 35 proteins, but little attention has been paid to the evolutionary and functional variation in these proteins across taxa. Most work in this area focused instead on visual pigments, which are responsible for the initial detection of light. Functional differences in the downstream proteins can also greatly affect visual ability, so studying these genes is essential for understanding the initial steps of vision. Turtles provide an ideal system to test for potential functional differences in phototransduction across a deep evolutionary divide because they have two suborders that diverged approximately 200 million years ago, Pleurodira and Cryptodira. Turtles also inhabit a wide range of light environments, including marine, freshwater, and terrestrial habitats. This project aims to investigate variation in turtle phototransduction genes to better understand their patterns of evolution. I will be focusing on a smaller subset of these extracted genes and using codon-based models to analyze their main drivers of evolution. This work will contribute to our understanding of how visual systems evolve across deep evolutionary divides and in distinct light conditions.

Karoleen Youkhana

NSERC Undergraduate Student Research Award

PROJECT

Investigating Novel Diuretic Regulators of the Malpighian ‘renal’ Tubules in the Fruit Fly, Drosophila Melanogaster

PROGRAM

Biomedical Science

SUPERVISOR

Jean-Paul Paluzzi

Insects must tightly regulate their internal water and ion balance to survive in fluctuating environments. This challenge is met by a highly regulated osmoregulatory system, including in species like Drosophila melanogaster, where the Malpighian ‘renal’ tubules (MTs) serve as the primary excretory organs. Functionally similar to mammalian kidneys, these blind-ended tubules float in hemolymph and are hormonally regulated by various neuropeptides and biogenic amines. While prior studies have highlighted the roles of various antidiuretic and diuretic hormones in Drosophila, recent transcriptomic studies have revealed that there are other potential regulators, including serotonin, which is a well-known biogenic amine found in vertebrate and invertebrate organisms. This project explores whether serotonin modulates fluid secretion in the MTs of adult female Drosophila. To do so, the MTs are isolated in vitro, and Ramsay assays are employed to quantify secretion rates following exposure to varying serotonin concentrations. By expanding our understanding of neuroendocrine control in insect renal physiology, this research sheds light on the potential regulatory role of this biogenic amine in Drosophila and offers broader insight into conserved mechanisms of hormonal signaling that could inform strategies for controlling disease vectors and agricultural pests.

Meghan Lam

York Science Scholars Award

PROJECT

Fossorial Vision Project

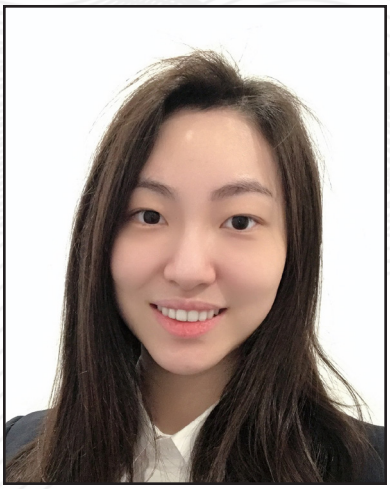
Many animals rely on vision for their survival. However, in low-light environments where fossorial species dwell, many organisms have experienced reduced or lost vision. This project aims to uncover the genes that are causing this effect in caecilians and squamates. My portion of the project focuses on the latter. I will extract genes from newly assembled genomes, as well as produce Multiple Sequence Alignments (MSA) and phylogenetic trees. Additionally, I will perform selection analyses to test for evidence of relaxed and positive selection.

PROGRAM

Biomedical Science

SUPERVISOR

Ryan Schott



Mu Ran Zheng

NSERC Undergraduate Student Research Award

PROJECT

Investigating Nodal Expression in Post-embryonic Zebrafish Stages

PROGRAM

Medical Sciences - Western University

SUPERVISOR

Chun Peng

Nodal is a part of the TGF-β family, and it has critical roles during the early development of the embryo. In zebrafish, the proteins responsible for the regulation of essential processes during embryogenesis are the homologs of Nodal, Nodal-related (ndr) ndr1, ndr2 and ndr3. Although the roles and functions of ndr1 and ndr2 during embryogenesis have been determined, their functions in the post-embryonic as well as adult stages require further understanding.

Recent data from our lab shows that ndr1 is expressed in both the testes and ovaries and that ndr2 is expressed only in the ovaries. Furthermore, there are components of the Nodal signaling pathway that are present in adult gonads, and this suggests active signaling following the embryonic stages.

The goal of the project is to understand ndr1 and ndr2 expression patterns in zebrafish at different time points, from 0 to 90 days post-fertilization, in order to determine when Nodal signaling emerges again following embryogenesis. These findings suggest that ndr1 and ndr2 may have important roles in zebrafish gonad function and reproductive processes. Understanding the functions of Nodal may provide more insights on zebrafish development and elucidate the roles of the Nodal pathway post-embryogenesis and in the adult stages.

Nazanin Marfou

NSERC Undergraduate Student Research Award

PROJECT

Role of AMPK Regulation of TOR (Target of Rapamycin) in Circadian Rhythmicity

PROGRAM

Biomedical Science

SUPERVISOR

Patricia Lakin-Thomas

The goal of our research is to describe the molecular mechanisms that produce circadian (24-hour) rhythmicity in eukaryotes. Circadian clocks are found in almost all eukaryotic cells, but the mechanisms are not yet completely described. Our model organism is the fungus Neurospora crassa. We have found that rhythmicity depends on proteins that are components of the TOR (Target of Rapamycin) pathway, which is a nutrition-sensing pathway that activates growth in all eukaryotes. TOR activity is rhythmic, and we are testing the hypothesis that TOR could function as an oscillator, driven by negative feedback loops that regulate its activity. Regulation of TOR in yeast and mammals includes inhibition by AMPK, an energy sensor that responds to ADP/ATP ratios and inhibits TOR when energy supplies are low. The presence of this feedback in Neurospora has not been determined, and this will be the focus of this NSERC project. Questions we will address include: Will AMPK activators/ inhibitors affect TOR activity and circadian rhythmicity? How does an AMPK knockout mutant affect TOR activity and rhythmicity? We will assay TOR activity using immunoblotting (Westerns) to quantitate the phosphorylation of a downstream target of TOR, S6 ribosomal protein. We will assay rhythmicity by fungal spore formation.

Nevadha Murugarajan

York Science Scholars Award

PROJECT

Investigating the Correlation Between Increased Contaminants in Roadside Soils, Plant Diversity, and Pollinator Visits Within Urban Roadside “pollinator-friendly” Sites

PROGRAM

Environmental Biology

SUPERVISOR

Gordon Fitch

Urban roadside green infrastructure sites serve as an eco-friendly alternative to monoculture grass lawns and may increase local biodiversity. Nevertheless, roadside soils accumulate high concentrations of contaminants, including Na+, Zn, Pb, and Cu, due to road salt usage, vehicle exhaust, and tire wear. This project investigates the impacts of an increased concentration of contaminants in roadside soils on plant diversity and pollinator abundance and diversity. We hypothesize that a higher level of soil contamination will cause decreased plant diversity, with a dominance of tolerant species in highly contaminated sites. Since pollinators rely on a variety of flowering plants for nectar and pollen, we also hypothesize that this decreased plant diversity will adversely affect pollinator visits. At each of the 20 sites, we will evaluate soil contaminants once and, on a biweekly basis, monitor flowering plant abundance and diversity, bee abundance and diversity, and bee-plant interactions. Vehicle exhaust emissions and tire wear will be inferred from a collection of roadside traffic data. Exploring the correlation between these factors can help determine the viability of these sites for pollinator conservation. Conclusions drawn from roadsides can also be applied to other “pollinator-friendly” sites to determine if soil contamination significantly impacts pollinator attraction.

Rafia Nadeem

NSERC Undergraduate Student Research Award

PROJECT

Role of ZTF-22 in Regulating the Er-unfolded Protein Response

PROGRAM

Biology

SUPERVISOR

Terrance Kubiseski

The accumulation of misfolded proteins is a hallmark of many neurodegenerative diseases, including Parkinson's disease. In Caenorhabditis elegans, expression of human alpha-synuclein in body wall muscle leads to progressive aggregation and motor impairment, making it a valuable model for studying proteotoxic stress. ZTF-22 is a zinc finger transcription factor previously linked to stress resistance, particularly in response to ER stress, though its role in regulating misfolded protein toxicity is not well understood.

This project investigates how ZTF-22 influences the response to protein misfolding by crossing alpha-synuclein::YFP-expressing worms with ztf-22 mutants. The resulting strain will then be assessed using thrashing and paralysis assays to monitor neuromuscular function over time. In addition, confocal microscopy will be used to visualize and quantify alpha-synuclein aggregates in muscle cells, providing a cellular-level view of proteotoxic burden.

Together, these experiments will help determine whether loss of ZTF-22 alters the severity of alpha-synuclein-induced stress and dysfunction. Understanding this interaction could reveal new insights into how transcriptional regulators modulate proteostasis and contribute to the progression or mitigation of neurodegenerative diseases.

Stewart Pim

NSERC Undergraduate Student Research Award

PROJECT

Determination of Early Adulthood Gut Microbiota in Ceratina Calcarata and Its Dependence on Social Interaction

PROGRAM

Biology (Hons.)

SUPERVISOR

Sandra Rehan

The composition and diversity of the microbiome have been shown to vary across different developmental life stages of the small carpenter bee, Ceratina calcarata. This has included the microbiota of the one-day-old adult, or callow life stage, as well as the mature late-season adult, but not in between. As is typical of insects, when C. calcarata moult the lining of the foregut and hindgut is shed, disturbing the microbiome and potentially necessitating its reestablishment. Low microbial diversity in the early adult life stages has piqued interest towards when and how the microbiome becomes diversified. This is concerning, as a diverse microbial community with beneficial symbionts is instrumental in maintaining wild pollinator health. This project aims to characterize and quantify the microbiota of early adults from callow to ten days old using 16S rRNA and ITS amplicon sequencing as well as qPCR. Additionally, the dependence of microbiome composition on social interaction will be examined using one group of individuals reared separately on sterile plates while the other group of individuals will be allowed to grow in the nest and interact. This work seeks to find the critical time points in which the microbiome may be most vulnerable to pathogens, while also determining when the microbiota stabilize into healthy communities.

Umael Qudrat

NSERC Undergraduate Student Research Award

PROJECT

Sketch Recognition as a Tool to Infer Mechanisms of Primate Visual Processing

PROGRAM

Neuroscience

SUPERVISOR

Kohitij Kar

The human brain has a remarkable capacity to extract meaningful information from abstract representations such as sketches. To investigate the neural mechanisms that support this visual abstraction, we are developing a non-human primate model that allows us to directly test the hypotheses generated from artificial neural network (ANN) models of the primate visual system. Leveraging the close evolutionary relationship between macaque monkeys and humans, particularly in the inferior temporal (IT) cortex—a brain region crucial to object recognition—this animal model enables controlled, invasive recordings and experimental manipulations not feasible in human subjects.

In this project, we use sketch recognition as a tool to better understand how visual generalization emerges across biological and artificial model systems. We assess how well both macaques and brain-inspired ANNs perform on sketch recognition tasks, allowing us to identify parallels and differences in their ability to generalize to abstract stimuli. Additionally, we record neural activity from the macaque IT cortex to probe the neural representations involved in this process. Ultimately, this project aims to advance our understanding of primate visual processing, guide the development of more biologically plausible AI models, and inform broader applications in neuroscience, education, and clinical interventions for visual and cognitive disorders.

CHEMISTRY

Alessia D'Addario

NSERC Undergraduate Student Research Award

PROJECT

Disrupting Crispr Prime Editing via Small Molecule Inhibitors

PROGRAM

Biomedical Science

SUPERVISOR

Brian Kim

CRISPR gene editing has shown great promise in treating genetic disorders; thus, it is key to optimize the control we have over the editing system. This summer, an assay is being developed to test potential inhibitors of a state-of-the-art RNA-based editing system, Prime editing. The Prime Editor is a fusion protein of a catalytically impaired Cas9 enzyme and a reverse transcriptase. These enzymes work in conjunction with a highly specific guide RNA to insert an edit into the target strand of DNA. Inhibiting this editing system is incredibly important to ensure we are able to control and halt gene editing whenever necessary, especially once Prime editing is used in mainstream medical treatments. The initial phases of this project depend on developing a bacterial green fluorescence protein reporter and an in vitro assay to test prime editing. Both assays rely on the introduction of a change in the target gene by the Prime Editor. Following the development of these assays, inhibition will take place with various reverse transcriptase-targeted small molecule inhibitors. With these molecules, we aim to disrupt the editing potential of the Prime Editor, allowing us to view the unmutated genes.

Danton Duong

The Professor John Goodings Undergraduate Research Award

PROJECT

Synthesis of Redox-active Phosphines and Their Reactivity in Frustrated Lewis Pair Chemistry

PROGRAM

Chemistry

SUPERVISOR

Christopher Caputo

From pharmaceutical manufacturing to agrochemical production, transition metal complexes have been widely used as catalysts in many important industrial chemical transformations. While these catalysts are very efficient, they contain precious and expensive metals, which raise concerns about the economic and environmental sustainability of these processes. Hence, alternative metal-free catalytic systems should be explored. One option is to exploit main-group elements in the form of frustrated Lewis pairs (FLPs) to achieve this target. The discovery of FLPs revolutionized main-group chemistry, as transition metal-specific reactivity can now be achieved with main-group elements. This project aims to synthesize various sterically encumbered phosphines appended with a redox-active phenothiazine motif. The introduction of the redox-active motif provides additional electrons, which may facilitate transformations not currently achievable with traditional FLP chemistry. The reactivity of these species towards carbon-carbon double bonds, carbon-carbon triple bonds, carbon-oxygen double bonds, etc. will be investigated in the presence of sterically hindered Lewis acids B(C6F5)3 and B(OC6F5)3.

Harish Ramesh

NSERC Undergraduate Student Research Award

PROJECT

Quantum-dot Driven Photocatalytic Degradation of Fluorinated Alkyl and Aromatic Environmental Contaminants

PROGRAM

Chemistry (Hons.)

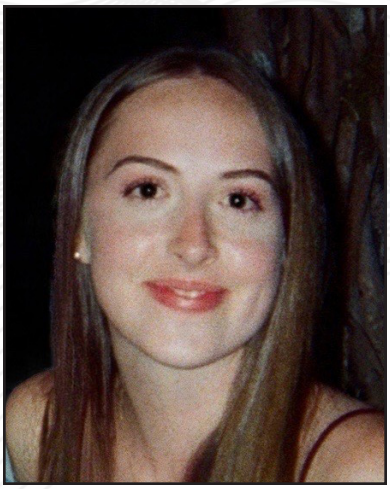
SUPERVISOR

Jennifer Chen

This project explores innovative ways to break the carbon-fluorine bond in pollutants using light-driven catalysis. Fluorinated compounds, commonly known as PFAS (per- and polyfluoroalkyl substances), are pollutants generated from the chemical manufacturing and pharmaceutical industry. However, these fluorine-containing compounds are difficult to degrade naturally in the environment. This project utilizes manganese-doped cadmium sulfide quantum dots with zinc sulfide capping as photocatalysts to generate reactive radicals under light exposure, aiming to break down these polyfluorinated pollutants into safer, non-environmentally toxic fragments.

The goal is to optimize conditions, including radical generation, hole scavengers, and solvent systems, to make the degradation process fast, efficient, and potentially scalable. While much of the existing work focuses on one pollutant at a time, this project takes a broader view by targeting both aliphatic and aromatic fluorinated wastes.

The long-term vision is to contribute to cleaner technologies for managing industrial and pharmaceutical waste that would otherwise persist for decades.



Madeline Barbaro

The Professor Diethard Bohme Undergraduate Research Award

PROJECT

Development of Small-molecule Inhibitors of YTHDF1 Protein

PROGRAM

Biochemistry

SUPERVISOR

Ryan Hili

Epitranscriptomics is a growing field that focuses on the post-transcriptional modifications of RNA. Of these RNA modifications, the most abundant in mRNA is N6-methyladenosine (m6A), which is dynamically written, erased, and read by various proteins. One of the many “reader” proteins is YTHDF1, which plays a critical role in regulating the fate of RNA. It has been shown to selectively increase the translation of specific m6A-modified mRNAs. When this process becomes dysregulated, aberrant translation of mRNA follows, often resulting in the development of human cancers such as liver, lung, and prostate cancers, as well as glioblastoma and acute myeloid leukemia. Thus, YTHDF1 is a promising therapeutic target.

To address this, small-molecule inhibitors of YTHDF1 will be identified through a DNA-encoded library (DEL) selection. Additionally, a counterselection will be done against paralogs, YTHDF2 and YTHDF3, to ensure selectivity of inhibitors. Upon completion of the DEL selection, sequencing will be done to determine up to 5 promising derivatives that will then be synthesized and subsequently evaluated for inhibition of YTHDF1 using a fluorescence polarization assay. For binding assays, YTHDF1 will be expressed in BL21(DE3) E.coli cells. Finally, the inhibitors will be optimized by analyzing structure-activity relationships to further enhance binding capabilities.

Parmeetpal Dhillon

NSERC Undergraduate Student Research Award

PROJECT

Fundamental Accuracy Constraints in Surface Kinetic Assays for Kd Determination

PROGRAM

Biochemistry

SUPERVISOR

Sergey Krylov

The inaccuracy of the equilibrium dissociation constant (Kd) determined from surface-based kinetic assays such as surface plasmon resonance (SPR) and biolayer interferometry (BLI) is often attributed to technical issues, including mass transport limitations, non-specific binding, and limited detection sensitivity. However, retrospective analyses have revealed that even under optimized conditions, the same assay can produce Kd values that differ by orders of magnitude for the same binding pair, indicating the presence of fundamental, not just technical, sources of inaccuracy. In this study, we perform an analytical error-propagation analysis to derive closed-form expressions describing how systematic errors in experimental variables, such as analyte concentration and signal intensity, influence the accuracy of kinetic assay-derived Kd values. Our findings offer practical guidance for high-throughput ligand ranking assays in pharmaceutical research, where an arbitrary single target concentration is often used. Theoretical predictions are supported by numerical simulations and BLI experiments, demonstrating that this strategy can significantly improve the reliability of high-throughput affinity measurements and reduce the risk of mis-ranking candidate compounds, offering both scientific and economic advantages in early drug discovery.

Savreet Sangha

NSERC Undergraduate Student Research Award

PROJECT

In-vitro Targeted Protein Degradation Using a Bifunctional Aptamer Protease System

PROGRAM

Chemistry

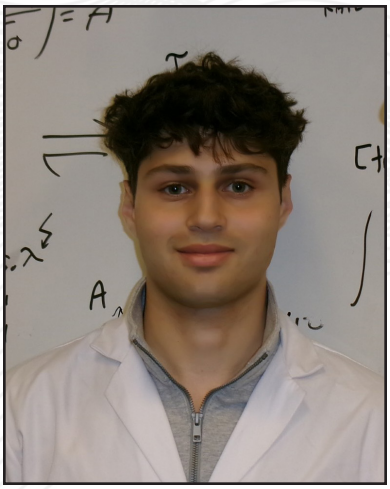
SUPERVISOR

Ryan Hili

Targeted protein degradation (TPD) is an emerging therapeutic strategy that enables the selective degradation of disease-associated proteins. One promising method within this framework uses bispecific aptamers, which are oligonucleotides that bind both a target protein and a protease noncovalently to facilitate direct proteolytic degradation.

Our research focuses on degrading tumor necrosis factor-alpha (TNF-α), a pro-inflammatory cytokine involved in the pathogenesis of autoimmune diseases such as rheumatoid arthritis, inflammatory bowel disease, and cancer. In this system, a bispecific aptamer is designed to bind both TNF-α and human neutrophil elastase (hNE), a protease with broad substrate specificity. The aptamer binds hNE with high affinity while preserving its enzymatic activity, making it ideal for targeted protein degradation. By bringing hNE into proximity with TNF-α, we hypothesize the bifunctional aptamer will facilitate extracellular proteolytic cleavage of the cytokine.

To assess the efficiency of this system, TNF-α levels will be measured using SDS-PAGE followed by densitometric analysis, comparing treated and untreated samples. In conclusion, our research aims to validate bispecific aptamers as a platform for extracellular protein degradation, highlighting their therapeutic potential for targeting membrane-bound and soluble plasma proteins.



Sebastian Marmorato

NSERC Undergraduate Student Research Award

PROJECT

Exploring Protonation and Metalation of a Novel Molecular Photoswitch

PROGRAM

Biochemistry

SUPERVISOR

William J. Pietro

Azobenzene photoswitches are molecular machines that can undergo trans-cis isomerization when irradiated with photons of an appropriate wavelength. These molecular devices show great promise in biomedical science research and biomaterials engineering, being widely applicable and exploitable for their broad dynamic range in kinetic timescales for the cis-trans thermal relaxation. This research focuses on one such photoswitch with environmentally responsive relaxation timescales, namely 5-(8-hydroxyquinolinyl)-phenylazo-4-sulphonic acid (abbreviated as HPAS). The relatively short thermal relaxation rate of HPAS makes it particularly well-suited for applications requiring exquisite temporal control, such as regulating ion transport through transmembrane proteins. The rapid thermal relaxation process of HPAS is primarily attributed to its push-pull electronic characteristic, formed by electron-donating (p-hydroxyl) and electron-withdrawing (p-sulfonate) substituents, which weaken the central azo bond. Under acidic conditions, HPAS undergoes azo-hydrazone tautomerization, introducing sensitive pH-dependent behaviour to its switching dynamics, providing flexibility. We investigate the thermal relaxation kinetics of HPAS and the dependence of its photoswitching behaviour on protonation. Additionally, we experimentally study the effects of metal binding to HPAS, supported by quantum mechanical modeling. We show that metal coordination has the potential to alter the thermal relaxation rates of cis-HPAS, possibly stabilizing specific isomeric forms for targeted applications.

Sofia Mittelstedt

York Science Scholars Award

PROJECT

Quinine Binding MN4 Variants Using Differential Scanning Calorimetry

PROGRAM

Biochemistry

SUPERVISOR

Philip E. Johnson

Aptamers are single-stranded oligonucleotides that can bind specifically and with high affinity to a ligand. They are selected by the SELEX process, which screens through many random DNA sequences and enriches the selection pool with sequences that bind the ligand. DNA aptamers can act as molecular recognition modalities in biosensors, aiding in the detection of diseases or for other medical purposes. Quinine is used to treat malaria caused by the parasite Plasmodium falciparum; therefore, finding DNA aptamers that only bind quinine is significant for the development of quinine biosensors. In this study, I investigated six MN4 aptamer variants, both free and bound with quinine, using Differential Scanning Calorimetry (DSC). The results allow us to show how differences in the stability and binding affinity correlate between the different aptamers in the free state compared to the bound state.

MATHEMATICS & STATISTICS

Aliya Kelimu

NSERC Undergraduate Student Research Award

PROJECT

A Bayesian and Behavioural Analysis of Bonus-malus Systems

PROGRAM

Actuarial Science

SUPERVISOR

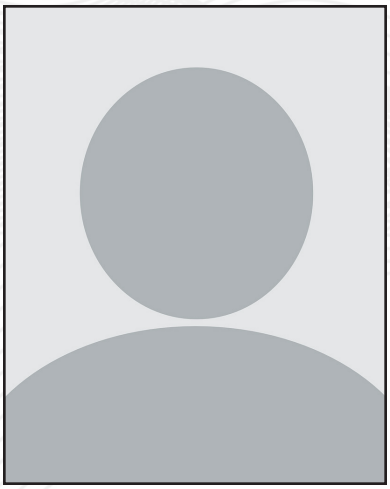
Jingyi Cao

The Bonus-Malus System (BMS)is a premium adjustment mechanism used by insurers to reflect an individual's claim history. Policyholders earn discounts (bonuses) for claim-free periods and incur surcharges (maluses) after filing claims. While traditionally applied to auto insurance, BMS is increasingly explored for broader applications in property and casualty (P&C) insurance. This project aims to model BMS structures, assess their efficiency, and evaluate their actuarial relevance.

The first component focuses on modeling BMS and computing Bayesian relativities. A Markov chain framework is used to represent policyholder transitions between BMS levels. Given specified penalty-reward structures and assumptions about claim frequency, the stationary distribution is derived, and Bayesian relativities are calculated to reflect long-term, risk-adjusted premiums. Efficiency is then evaluated using the Loimaranta and De Pril measures.

The final component investigates behavioural responses to BMS incentives. By incorporating models of bonus hunger and optimal retention, the analysis examines when policyholders choose to report or withhold claims based on anticipated future premiums.

This integrated approach offers both theoretical and practical insights into the BMS, highlighting its implications for fairness, behavioural dynamics, and implementation in P&C insurance.



Cabot Jones-Thomson

NSERC Undergraduate Student Research Award

PROJECT

Outputs of Low-dimensional Quantum Channels

In upcoming work, it will be shown when there exists a quantum channel between two non-commuting n-tuples of quantum states via inequalities involving multi-valued non-commutative functions. The goal of this project is to analyze and simplify said inequalities in low-dimensional matrix algebras.

PROGRAM

Pure Mathematics

SUPERVISOR

Paul Skoufranis

Hien Thao Mai

NSERC Undergraduate Student Research Award

PROJECT

Maternal Health and Birth Weight Prediction Through Statistical and Machine Learning Methods

PROGRAM

Statistics (Hons.)

SUPERVISOR

Tianyu Guan

Low birth weight is a major risk factor for various health complications in newborns and long-term developmental issues. This project aims to develop predictive models for newborn birth weight using maternal characteristics, focusing on how gestational BMI change influences birth weight. Other relevant predictors include gestational age at birth, pre-pregnancy BMI, maternal age, and additional health-related variables. Preliminary analyses indicate that the variance of birth weight differs significantly across gestational ages, suggesting heteroscedasticity in the standard regression model error structure. To address this issue, we incorporate a heteroscedastic modeling approach using weighted least squares, where the weights reflect gestational age–specific variability. We apply sparse regression methods such as Lasso and SCAD for feature selection and consider nonlinear models such as GAM for better interpretability. To enhance predictive performance, we also apply machine learning models, including neural networks, XGBoost, and ensemble methods. Additionally, this project investigates maternal factors linked to neonatal survival, especially in cases of low birth weight. As a practical outcome, we aim to develop an app that enables pregnant individuals to input their health data and receive real-time estimates and projections of birth weight, helping promote informed prenatal care and mitigate risks associated with abnormal birth weight.

Mehedi Hossain Rafi

NSERC Undergraduate Student Research Award

PROJECT

Mathematical Analysis of a Within-host Multistrain Plasmodium Falciparum Dynamics Under Immune Response

PROGRAM

Applied Mathematics

SUPERVISOR

Woldegebriel Assefa Woldegerima

Malaria remains one of the most widespread and life-threatening infectious diseases globally, with a particularly high burden in Sub-Saharan Africa. Its persistence is partly due to the parasite's ability to express multiple strains within a host and evade immune responses. Understanding the interaction between multistrain parasites and the host immune system is therefore crucial for developing effective treatment strategies.

This project integrates mathematical modeling, biological insights, and data-driven approaches to study the within-host dynamics of Plasmodium falciparum (the most prevalent malaria-causing species) under the influence of both innate and adaptive immune responses using systems of nonlinear ordinary differential equations (ODEs). We perform equilibrium, stability, and bifurcation analyses to identify conditions that lead to parasite clearance, chronic infection, immune escape, strain dominance, coexistence, or elimination. Sensitivity and scenario analyses are conducted to assess the impact of key biological parameters on infection outcomes. Numerical simulations and contour plots are used to visualize complex dynamics and explore immune evasion strategies.

By capturing the intricate interplay between immune responses and multistrain infections, this research deepens our understanding of malaria pathogenesis and supports the development of more targeted and effective intervention strategies.

Nicolas Andrews

NSERC Undergraduate Student Research Award

PROJECT

Convergence Properties in Topological Spaces

We consider classes of topological spaces satisfying various convergence properties, which effectively generalize the first axiom of countability. In particular, we ask under which conditions certain topological groups will possess properties equivalent to that of metrizability.

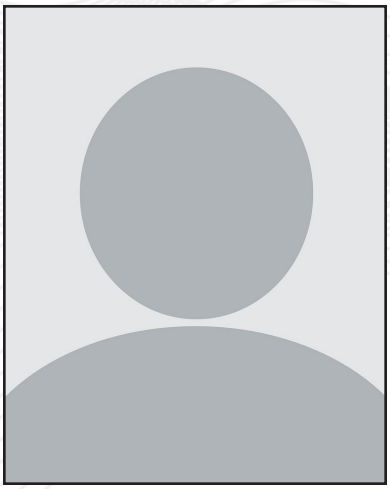
PROGRAM

Pure Mathematics

SUPERVISOR

Paul Szeptycki

PHYSICS & ASTRONOMY



Adam Cherti

NSERC Undergraduate Student Research Award

PROJECT

Measurement of the Electron's Electric Dipole Moment Using the Edm3 Method

PROGRAM

Physics

SUPERVISOR

Eric Hessels

Matrix isolation (of barium fluoride) at cryogenic temperatures provides a unique platform for studying electrons under highly controlled conditions.

The EDMCubed collaboration is developing new techniques to grow and analyze solid Argon matrices at sub-kelvin temperatures. My work focuses on the deposition of CO_2 onto a sapphire substrate cooled to around 4K, which will then serve as a substrate for growing Argon.

This approach seeks to prevent the crystal from cracking after annealing.

Alyssa Lazzer

NSERC Undergraduate Student Research Award

PROJECT

Dissipative Dark Matter: From Galactic Halos to Supermassive Blackholes

PROGRAM

Physics and Astronomy (Astronomy and Astrophysics) (Spec. Hons.)

SUPERVISOR

Sean Tulin

Dark matter is an invisible form of matter that accounts for most of the mass in the universe and plays a critical role in cosmic structure formation. Despite its abundance, dark matter remains poorly understood within current fundamental physics. Its specific particle nature and interaction mechanisms remain unknown. A promising theory is dissipative dark matter, where energy is lost through inelastic collisions. In this model, dark matter particles scatter into excited states and release energy as a light force-carrier particle, carrying energy out of dark matter structures. This research studies a two-state dark matter model, including elastic and inelastic interactions between ground-state and excited-state dark matter particles. We are focused on calculating the rate at which dissipative dark matter interactions occur. These collision rates are then used in an existing simulation to understand how the proposed interaction model affects dark matter halos. This model of dissipative dark matter interactions may result in the formation of compact objects, such as black holes, in the early universe. These interactions may explain the gap between collisionless dark matter simulations and astronomical observations, particularly at large and small halo scales, and explain the mysterious origins of supermassive black holes seen at galaxy centres.

Ariana Didiano

NSERC Undergraduate Student Research Award

PROJECT

Investigating an Apparently Episodic Accelerating Quasar Outflow

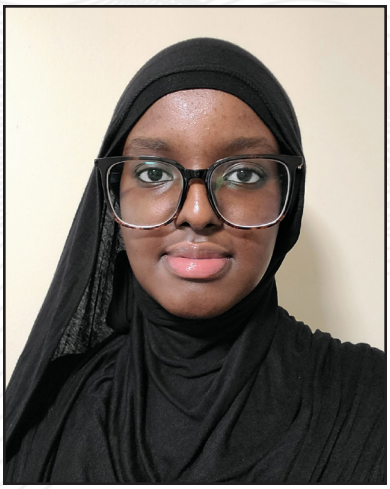
PROGRAM

Physics and Astronomy (Astronomy) (Hons.)

SUPERVISOR

Patrick Hall

Quasars are supermassive black holes located at the centres of galaxies that accrete matter through an accretion disk and simultaneously produce powerful outflows by ejecting matter from the disk's surface. The quasar SDSS J024221.87+004912.6 was reported to have an accelerating outflow in Hall et al. (2007), based on 3 spectra over 1.4 years. The acceleration was confirmed in Byun et al. (2022) using 5 spectra over 5 years. For my project, we extend the study of the quasar using 12 spectra over 6.6 years by measuring the stability of the acceleration and studying two remarkable features in the latest spectra, including a possible reappearance of a component of the outflow at its original velocity and a pronounced drop at near-UV wavelengths. Investigating the reappearance of the outflow at its original velocity and comparing our measurements with predictions of various models to determine which best describes the observed behaviour is significant because, if confirmed, this would be the clearest indication of an episodic outflow yet seen in a quasar. Determining if the drop at near-UV wavelengths is due to dust extinction along the line of sight will be significant in explaining how the outflow is launched.



Halima-Sadia Mohamud

NSERC Undergraduate Student Research Award

PROJECT

Again With the Quasars

PROGRAM

Physics and Astronomy (Astronomy)

SUPERVISOR

Patrick Hall

This project investigates quasars, supermassive black holes at the centre of galaxies that show dramatic changes in brightness and emission lines over time. Working with Dr. Patrick Hall on the Again With The Quasars project, I will analyze data from the Sloan Digital Sky Survey (SDSS) to identify and study over 2000 quasars that have been re-observed after more than a decade. My work includes measuring brightness and colour changes, identifying unusual or “changing-look” quasars, and comparing results across imaging surveys. I will contribute to statistical analyses of quasar variability and assist in interpreting spectral features linked to accretion disk behaviour. This research aims to improve our understanding of quasar evolution, and findings may be submitted for peer-reviewed publication.

Tanya Puri

NSERC Undergraduate Student Research Award

PROJECT

Nature-inspired Brain Probe Biocamouflage for Improved Brain-Machine Interfaces

PROGRAM

Health Science (Hons.) - McMaster University

SUPERVISOR

Ozzy Mermut

Brain-machine interfaces are transforming neuroscience and medicine, offering new possibilities for restoring lost function and treating neurological disorders. However, the long-term effectiveness of these technologies is fundamentally limited by the brain's neuroinflammatory responses, including glial scarring and foreign body rejection. This project, led by the MiBAR Lab (Dr. Ozzy Mermut) at York University in collaboration with the Montreal Neurological Institute (Dr. Christopher J. Barrett) at McGill University, investigates the development of nature-inspired, biomimetic coatings to enhance the biocompatibility of neural probes and support stable, long-term brain integration.

Using Layer-by-Layer (LbL) assembly, we construct nanoscale, multilayered coatings of Dendritic Polyglycerol Amine (dPGA), a non-protein, macromolecular biomimetic of polylysine. These coatings are deposited onto silicon wafers, glass slides, and model neural probes to simulate the surface characteristics of implantable neural interfaces. Designed to replicate the soft, hydrated mechanical environment of brain tissue, the engineered films aim to minimize foreign body response and enhance biocompatibility at the brain–machine interface.

By combining materials science and neuroengineering through the lens of biomimicry, this research supports the advancement of next-generation neural interfaces that are both high-performing and biologically harmonious.

ENVIRONMENTAL & URBAN CHANGE

Jesse Hughes

NSERC Undergraduate Student Research Award

PROJECT

Assessing Tributaries as a Source of Potential Toxic Cyanobacteria Inputs to a Large Subarctic Lake

PROGRAM

Sustainable Environment Management

SUPERVISOR

Jennifer Korosi

Potentially toxic Cyanobacteria blooms have been identified as an emerging water quality concern in subarctic lakes, where they remain largely understudied. My research focuses on Sambaa K'e (Trout Lake), a large cold lake in the southern Northwest Territories where blooms have been documented seasonally since ~2003. My research objective is to analyze phytoplankton communities from Sambaa K'e tributaries to assess if fluvial seeding may be contributing to cyanobacteria blooms. Fluvial seeding refers to the role of tributaries in providing a source of Cyanobacteria propagules to a lake, which can result in a bloom when environmental conditions are ideal. Preliminary findings from four tributaries (one summer sampling event) showed that bloom-forming Cyanobacteria species were abundant, indicating potential for fluvial seeding. Analysis of phytoplankton in weekly samples collected from one tributary (July and August, 2024) is ongoing. Sambaa K'e is a candidate Indigenous Protected and Conserved Area (IPCA), and this research is being done in collaboration with Sambaa K'e First Nation in support of their efforts to establish their IPCA management plan. Sambaa K'e may also be a bellwether for other subarctic lakes, and therefore this research has broader implications for understanding the rise in cyanobacteria in high-latitude lakes.


025 UNDERGRADUATE
UNDERGRADUATE RES
ADUATE RESEARCH CO
ERENCE 2025 UNDERG
E UNDERGRADUATE 2
ARCH RESEARCH 2025
025 CONFERENCE UN
ATE RESEARCH CONFE
ADUATE RESEARCH CO
RESEARCH CONFERENC