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# McMaster Undergraduate Society for the Chemical Sciences Summer Research Symposium 2025 Abstract Booklet

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**Abstract**
The McMaster Undergraduate Society for the Chemical Sciences (MUSCS) Summer Research Symposium is an undergraduate research symposium run for one day annually by undergraduate students. In McMaster University's Department of Chemistry & Chemical Biology (CCB), many undergraduate students participate in research during the spring and summer terms. For example, students contribute to research groups as scholarship recipients, research assistants, cooperative education students, and project course students. Despite the vast amounts of undergraduate research occurring, undergraduate students rarely have opportunities to communicate and display their work. The MUSCS Summer Research Symposium aims to give undergraduate students from McMaster University's CCB Department a platform to share the research they conducted over the previous summer. The 2025 symposium was held on September 21st, 2025, with over 80 attendees, including nine students who presented their work from multiple fields of chemistry (e.g., organic chemistry, chemical biology, theoretical chemistry). The symposium also featured three keynote presentations from professors within McMaster University's CCB Department. This was the second annual MUSCS Summer Research Symposium and the event will operate next year to include feedback from presenters, attendees, and professors. Abstracts within this abstract booklet were submitted by the undergraduate speakers on a voluntary basis.

**Keywords:** chemistry conference; undergraduate research; organic chemistry; inorganic chemistry; chemical biology; analytical chemistry; environmental chemistry

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## Conference Abstracts

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## Presentations in Chemical Biology

### Engineering Chlamydomonas Reinhardtii Via Overexpression of Key Enzymes for Sustainable Sterol Biomanufacturing

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Leveraging metabolic pathways present in photosynthetic microalgae provide an alternative route for sustainable steroid synthesis, modelling biomanufacturing in a circular economy. Current methods of producing key organic compounds required for steroid production rely on resource intensive yeast systems, requiring vast amounts of sugars and releasing excessive carbon waste. Steroid availability is further limited by climate change, damaging organisms essential for precursor production. A carbon neutral production system is required to sustain the rise of pharmaceuticals as demand for steroid medicines increase in Canada. While current models for photobioreactors do not meet investor expectations, engineering strains to be more productive can increase return on investment and financially validate the scaling of microbial photobioreactors as carbon negative biomanufacturing systems. Using synthetic biology strategies in the model microalgae *Chlamydomonas reinhardtii,* we can create a sustainable chemical processing unit that produces ergosterol, a versatile platform molecule for sought after steroids with high economic value. The metabolic engineering strategy includes the expression of both endogenous and non-endogenous enzymes to evaluate the impact of overexpression on the regulatory non-mevalonate and steroid biosynthesis pathways. To evaluate ergosterol's production in the non-mevalonate pathway, kinetic modeling and flux balance analyses predicted the effects of overexpressing heterologous squalene synthase and squalene epoxidase. If key downstream enzymes are overexpressed in the sterol pathway, then ergosterol can be over accumulated in our chassis *C. reinhardtii.* For *C. reinhardtii'*s squalene synthase a Vmax value of 8.37×10−7 mmol/gDW/h was computationally derived using enzyme-constrained metabolic modeling; in comparison to *Thermosynechococcus vestitu*s's squalene synthase (Vmax = 1.8mmol/gDW/h), which we propose as a candidate for heterologous protein introduction for *C. reinhardtii* due to its efficiency. Golden gate assembly was used for pathway engineering whereas Bligh and Dyer will extract our sterol product, quantified after by GC/MS. A growth curve analysis has been conducted to create a baseline for standard biomass*;* providing a benchmark for optimal lipid extraction timings and the microalgae's growth. This approach utilizes microalgae as a platform for sustainable sterol production, creating a basis for metabolic engineering and understanding pathway regulation in *C. reinhardtii.*

## Presentations in Analytical & Environmental Chemistry

### What's the Grime? Analysis of Urban Grime and Polycyclic Aromatic Hydrocarbons in Hamilton, Ontario, Canada

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Hamilton, Ontario, Canada is a mid-sized city known for its extensive steel production industry. Atmospheric pollution around industrial areas in Hamilton remains under monitored, which is a major cause of concern due to the risk of human exposure to harmful atmospheric pollutants. Recently, residents have reported an increased amount of "black soot" around Lower Hamilton, which can contribute to the formation of "urban grime". In this study, we examined urban grime for its polycyclic aromatic hydrocarbon (PAH) profiles, and for its spatial distribution throughout the lower city. We deployed sampling kits across 50 locations in lower Hamilton and collected them after a four-month period. We then quantified 14 high priority PAHs in urban grime samples with gas chromatography-mass spectrometry (GC-MS). Additionally, we visualized each sample for preliminary examination of spatial distribution of urban grime. Visual and quantitative analyses suggest that total PAH concentration is higher near industrial areas. Analysis of PAH diagnostic ratios suggests that industrial processes, particularly coal combustion, contribute to the majority of PAH emissions. Future directions include the elucidation of temporal trends of urban grime and PAH profiles, analysis of PAH derivatives such as alkylated and nitro-PAHs, and analysis of various inorganic species found in urban grime, such as heavy metals.

**Presentations in Inorganic & Materials Chemistry**

**Chemiresistive Peroxide Sensors for Applications in Continuous Sweat Monitoring**

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Chemiresistors are solid state sensor devices that change in resistance upon exposure to a target chemical. Here, we aim to assemble a peroxide sensor with applications in continuous sweat monitoring. Hydrogen peroxide is a typical byproduct of oxidase enzymes, meaning numerous biological analytes found in sweat can be catalyzed into hydrogen peroxide, consequently being sensed by the chemiresistor. Lactate can be catalyzed into hydrogen peroxide by lactate oxidase, and its fluctuation reflects hydration status, athletic performance, and other underlying medical conditions. A particular area of concern with biosensors is the limit of detection (LOD) and the film stability, especially with exposure to moisture; this was addressed by investigating different methods of film preparation and adhesions. Peroxide response was most consistent when the covalent organic framework (COF) material was exfoliated in 40-50% isopropyl alcohol, followed by acidification. Due to the nature of the application of these chemiresistors, the film must be conductive when immersed in aqueous mediums while still maintaining its integrity. Cellulose acetate was added atop the COF film as it was found to improve film stability without compromising conductivity or sensing ability. While achieving a film with sensing ability is one step of the process, it is still important to consider the longevity, reusability, and versatility of sensors used for continuous monitoring. Future work will continue to optimize sensitivity, stability, as well as functionalizing the COF film with the oxidase enzyme of interest. Sweat sensors capable of continuous monitoring can serve as economical, non-invasive medical devices that contribute to preventative and diagnostic medicine.

**Conflicts of Interest**

The authors declare no conflict of interests.

**Authors' Contributions**

AE: Conceptualization, Planning, Funding Acquisition, Resources, Drafted the Conference Abstract Booklet, and Final Approval of Abstract Book to be Published.
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