

PSCB90H3 Physical Sciences Research Experience – Winter 2022



This course provides an opportunity for students to work with a faculty member and carry out original research. Students will provide assistance with one of the faculty member's research projects, while also earning credit. Students will gain first-hand exposure to current research methods, and share in the excitement of discovery of knowledge acquisition. Progress will be monitored by regular meetings with the faculty member and through a reflective journal. Final results will be presented in a written report and/or a presentation at the end of the term. Approximately 120 hours of work is expected for the course.

Prerequisite: Varies by project (see below)

Recommended Preparation: Completion of at least 4.0 credits in a relevant discipline.

Breadth Requirements: Natural Sciences

Link to UTSC Timetable: <https://utsc.calendar.utoronto.ca/section/physical-sciences>

Note: Students must reach out to supervisors (listed below) directly to express their interest in working on specific projects. Once students have confirmed a project with a supervisor, they must inform the course coordinator (Dr. Kris Kim, kris.kim@utoronto.ca) for admission into this course and to complete a supervised study form. Students must email Dr. Kim that they have confirmed a supervisor by **December 17th for Winter 2022 enrolment**. Typically, students enrolled in a program offered by the Department of Physical and Environmental Sciences and have a CGPA of at least 2.5 or higher are granted admission. Students are strongly encouraged to reach out to potential supervisors in advance of the deadline above to discuss and confirm their involvement on projects.

When reaching out to supervisors, students should include:

- 1) A letter or email indicating the student's interest in conducting research and enrolling in PSCB90
- 2) An updated copy of your CV and transcript (can be informal)
- 3) A list of relevant courses successfully completed by the student, as well as any relevant courses to be taken during the upcoming semester

Please see below for list of projects.

Environmental Sciences Projects

Project 1 (Environmental Science)

Supervisor: Prof. William Gough (william.gough@utoronto.ca)

Title: Ozone weekend effect during the pandemic

Number of Positions: 2

Project Description: In many urban areas around the world tropospheric ozone, a secondary pollutant, peaks during weekends due to some interesting atmospheric chemistry. This effect has been documented for the Toronto area in past research (Beaney and Gough, 2002; Huryn and Gough, 2014). Preliminary results from the first wave (April to June 2020) indicate a substantial reduction in NO, NO₂, likely the result of reduction in vehicular traffic (Gough and Anderson, 2021) and an increase in ozone on weekdays. The 2020 data was compared to a climatology based on the period 2010-2019. The relevant data is available publicly through the Ontario Ministry of the Environment, Conservation, and Parks. Two follow projects are proposed. The first is to do a similar analysis during the second wave (October to December) for the GTA. The second is to compare Toronto to other urban areas in Ontario (as was done in Huryn and Gough, 2014) in order to test if other less extensive urban areas responded in a similar fashion to pandemic societal measures.

Qualifications: Completion of either EESA09, EESB03; proficiency in Excel. Knowledge of Python would be an asset, but not required.

Chemistry Projects

Project 1 (Chemistry)

Supervisor: Prof. Shadi Dalili (sh.dalili@utoronto.ca)

Title: Developing New Lab Material for CHMB41H

Number of positions: 1-2

Project Description: Students involved in this project will be able to develop and modify new laboratory experiments for Introductory Organic Chemistry I (CHMB41H). Students will work with the course instructor to select new experiments from the chemistry education literature, test the experiments, and prepare accompanying lab manual instructions and demonstrator notes. Students will learn skills such as literature searching and analysis, and utilize essential lab techniques such as extraction, distillation, recrystallization, reflux, etc. to develop new labs for the course. Students will also develop written scientific and communication skills through preparing lab manual writeups, quizzes, and TA documents for each experiment developed.

Qualifications: Completion of CHMB42 with a minimum course grade of B+ and lab grade of A; must be available for lab work 2 full days during the week between 9am-5pm, ideally Tues, Wed and/or Thurs. Please include an up-to-date CV & transcript with your application.

Project 2 (Chemistry)

Supervisor: Prof. Shadi Dalili (sh.dalili@utoronto.ca)

Title: Developing New Tutorial Material for CHMB41H

Number of positions: 1-2

Project Description: Students involved in this project will be expected to develop new tutorial worksheets and quizzes based on current CHMB41H course content, using reputable scientific resources and textbooks. Students in this placement will work with the course instructor to select and develop appropriate questions and exercises from the chemistry education literature, textbooks, and online resources to prepare tutorial materials and quizzes, along with demonstrator notes. Students will learn skills such as literature searching and analysis, and proper design of problem sets and questionnaires. Students will also develop written scientific and communication skills through developing problem sets, quizzes, and TA documents for each tutorial section.

Qualifications: Completion of CHMB42 with a minimum course grade of B+. Please include an up-to-date CV & transcript with your application.

Project 3 (Chemistry)

Supervisor: Prof. Ruby Sullan (ruby.sullan@utoronto.ca)

Title: Evaluating synthetic route of a bioinspired nanomaterial

Number of positions: 1

Project Description: The student will help elucidate the formation mechanism of a bioinspired nanomaterial, polyserotonin nanoparticles (PSeNP), generated via different synthetic routes, particularly using heat and light as triggers for initiating nanoparticle formation. Throughout the semester, the student will be involved in the synthesis and characterization of PSeNP using a suite of analytical and surface characterization techniques. For mechanism elucidation, the student will primarily use solid state NMR as well as electrospray ionization mass spectrometer. Training will be provided across all relevant instrumentation for the project. At the end of the semester, the student will present the research results in an informal group meeting.

Qualifications: Completion of CHMA10, CHMA11, CHMB16, CHMC31 with minimum grade of B+.

Project 4 (Chemistry)

Supervisor: Prof. Kris Kim (kris.kim@utoronto.ca)

Title: Developing New Experiments for Analytical Chemistry (CHMB16)

Number of Positions: 1

Project Description: Students in this placement will work with the course instructor to design and test experiments and build resources towards creating in-person lab experiments for second-year analytical chemistry (CHMB16). Through this process, students will develop their ability to reflect on prior first- and second-year chemistry learning outcomes, search the literature for relevant experiments, design, test, and modify experimental procedures, and learn to apply principles of instructional design and best practices for effectively engaging learners through online platforms. This project will require in-person laboratory work. By the end of the semester, students will have developed at least one experiment to completion, which includes designing and testing a procedure to writing up the experimental protocol with supporting resources (e.g., lab manual and quizzes).

Qualifications: Completion of CHMB16 with a minimum course grade of B+. Please send updated resume and transcript to kris.kim@utoronto.ca.

Project 5 (Chemistry)

Co-Supervisors: Prof. Kris Kim (kris.kim@utoronto.ca) & Prof. Ruby Sullan (ruby.sullan@utoronto.ca)

Title: Developing interfacial chemistry experiments

Number of Positions: 2-3

Project Description: Students will help design experiments that probe phenomena at interfaces. The projects will involve searching literature for existing experiments and adapting them as experimental modules that can be completed by undergraduate students. Students will gain experience operating a variety of surface sensitive analytical instruments as well as preparing polymer thin films and nanomaterials. Throughout the course of the semester, students will develop a wide range of research skills (e.g., conducting literature searches, analyzing and reporting results, regularly communicating findings with supervisor and peers through PowerPoint presentations, writing a formal report, etc.). By the end of the semester, students will have developed at least one experimental module to completion, which includes designing and testing a procedure to writing up the experimental protocol with supporting resources (e.g., lab manual and quizzes).

Qualifications: Completion of CHMB16, CHMB31, and CHMB23 with a minimum course grades of B+, lab grades of A-. Please send updated resume, transcript, and expression of interest to kris.kim@utoronto.ca.

Project 6 (Chemistry)

Supervisor: Prof. Oleksandr Voznyy (o.voznyy@utoronto.ca)

Title: Simulations and educational videos on classical and quantum chemistry concepts

Project Description: Students are sought to write small programs that simulate some interesting but difficult chemistry concept (for example, why atomic radius decreases across a period and increases down a group, or how a classical electron would behave in a magnetic field vs. a quantum electron in Stern-Gerlach experiment, or what is the meaning of a wavefunction, etc.) and then make a video explaining the process and the results, which can be used in Chemistry courses or uploaded to Youtube.

Qualifications: Knowledge of some programming language is required (Unity is preferred), Basic video editing skills are required, Knowledge of quantum chemistry is desirable but not mandatory.

Project 7 (Chemistry)

Supervisor: Prof. Nirusha Thavarajah (nirusha.thavarajah@utoronto.ca)

Title: Developing a Culturally Relevant Public Health Communication Strategy to Promote COVID-19 Vaccination

Number of Positions: 2

Project Description: Students will work with the faculty member and collaborate with students from the department of management at UTSC, from a South Asian University and a STEM leadership community group in Toronto to create a scientific infographic to convey the importance of COVID-19 vaccination. Students will collect data on a targeted population to understand the reasons behind resistance to vaccinating and will design their infographics as a countermeasure to the COVID-19 "Infodemic" ("Infodemic" is an overwhelming amount of false information in the form of a digital or physical form). The domestic and international student collaborations will give exposure to an *Interdisciplinary and Global Classroom* learning experience that will help students cultivate their research skills and scientific communication skills. (Learning Skills: Literature search, critical thinking, problem-solving & scientific writing skills.)

Qualifications: Completion of CHMB42H3 with a minimum grade of B+. Please send updated CV & transcript to nirusha.thavarajah@utoronto.ca.