CHEM 4305 (5606) – A
Environmental Chemistry & Toxicology
Winter, 2026
Course Outline

Contact Information
Dr. Amy Rand, amy.rand@carleton.ca

LAND ACKNOWLEDGMENT
At Carleton University, it is important that we acknowledge that the land on which we gather is the traditional and unceded territory of the Algonquin nation.

OFFICE HOURS*
Office hours are held on lecture days to allow time for students to reflect on material before asking questions. They are best used for questions about course concepts, assessments, and feedback. I will respond to student emails and Brightspace messages regarding lecture material during scheduled office hours. For administrative issues (e.g., academic accommodation, missed course work) please email. Questions related to administrative issues will receive a response within one business day.

Monday and Wednesday, 1:30 – 2:30 pm

*In the event that I will cancel an office hour due to an infrequent scheduling conflict, the make-up office hours that week will be posted on *Brightspace.*

COURSE DESCRIPTION
Overview of environmental chemistry and toxicology principles including chemical sources, fate, and effects in the environment. Examining organic reactions occurring in abiotic environments and biological systems and studying aspects of toxicant disposition and biotransformation. Emphasis on contemporary problems in human health and the environment. Prerequisite(s): CHEM 2203 (or CHEM 2207), and CHEM 2800 or CHEM2103, or BIOC 3101 or permission of the department. Also offered at the graduate level, with different requirements, as CHEM 5606, for which additional credit is precluded. Lectures: three hours a week.

It is the **students' responsibility** to ensure they come to class prepared. Partial notes will be available on *Brightspace* and will consist largely of figures and reactions. If you print the slides ahead of time, and take note of what is said in class, you will be in a strong position for success. In-class time will also be dedicated to formative assessment. This type of assessment does not count for marks. Rather, it is an opportunity for you to work with the material when it is fresh in your mind and obtain feedback on areas of improvement.

This course will be supported by *Brightspace* and is the primary method of electronic communication with students outside of class. It will be used to post announcements, lecture material, assignments, and marks. This is an in-person course: lecture material will uploaded to *Brightspace* within 24 h prior to each designated lecture. It is your responsibility to attend class, take notes, keep up to date, and be familiar with ALL dates and deadlines listed in this course outline. If this class will be online due to public health guidelines (e.g., illness), lectures will be recorded and posted within 24 h after the designated lecture. There are no Teaching Assistants assigned to this course.

INCLUSIVE TEACHING STATEMENT
I am committed to providing an inclusive learning environment where all students feel respected and supported. Diverse perspectives and experiences enrich learning in environmental chemistry and toxicology, and students are encouraged to engage respectfully with one another. If aspects of the course create barriers to your learning, please contact me so that we can discuss appropriate support or accommodation.

COURSE LEARNING OBJECTIVES

Environmental chemistry and toxicology applies chemical and biological theories and techniques to tackle several global health challenges such as environmental pollution, public health, and global climate change. Education in environmental chemistry and toxicology is necessary to increase students' awareness of these challenges, and their engagement in facing these challenges. Upon completion of CHEM 4305 (5606), you will be able to apply principles drawn from foundational biochemistry, organic, and physical chemistry to assess the abiotic and biological fate of an environmental pollutant and the response from the organism. Students will also learn to critique and discuss current topics in environmental chemistry and toxicology.

Unit 1: Organic reactions in the abiotic environment – Explain the environmental fate of organic chemicals we use in our everyday lives.
Unit 2: Partitioning and distribution – Use fundamental chemical principles to predict where we can find a chemical (e.g. the air, water, soil, humans/animals).
Unit 3: Organic reactions in biological systems – Describe the defense mechanisms used by an organism to protect itself from foreign chemical exposure.
Unit 4: Toxicant mechanisms of action – Explain fundamental mechanisms by which foreign chemicals disturb biological processes.

SCHEDULE

Lectures Mondays, Wednesdays from 10:05 – 11:25 am, SA 409
Important academic dates, including class suspensions and statutory holidays, are available on the Registrar's website.

DATE	DAY	TOPIC	GUEST LECTURER	UNIT	DUE DATES
Jan 5	M	Introduction & syllabus			
Jan 7	W	Photolysis		1	
Jan 12	M	Atmospheric oxidation		1	
Jan 14	W	Aqueous oxidation		1	
Jan 19	M	Substitution and elimination		1	
Jan 21	W	Ester reactivity		1	
Jan 26	M	Reduction		1	Assignment 1
Jan 28	W	Partition coefficients		2	
Feb 2	M	Environmental distribution		2	
Feb 4	W	CLASS CANCELLED			
Feb 9	M	Bioaccumulation/absorption		2	Assignment 2
Feb 11	W	Biological distribution		2	
Feb 16	M	**WINTER BREAK**			
Feb 18	W	**WINTER BREAK**			
Feb 23	M	Reductive and oxidative strategies		3	Assignment 3
Feb 25	W	Elimination, substitution, hydrolysis		3	
Mar 2	M	Chemical bioactivation		3	
Mar 4	W	Organ selective toxicity I (liver)	T. Harris, Carleton	4	Assignment 4
Mar 9	M	Integrative Decision Assessment – In-class component			Part A

Mar 11	W	Organ selective toxicity II (lung)		4	
Mar 16	M	Organ selective toxicity III (kidney)		4	
Mar 18	W	Case study: guest lecture	TBA		
Mar 23	M	Oxidative stress			
Mar 25	W	Involvement with cell signaling		4	Assignment 5
Mar 27	**F**	**Draft Integrative Decision Assessment Due (Brightspace)**			
Mar 30	M	Peer-review 2			Peer review
Apr 1	W	Receptor toxicity		4	
Apr 6	M	Review AND/OR catch-up class			Final Decision Artifact + reflection

Note: Some classes might be moved online pending unforeseen illness, etc.

TEXTBOOKS AND RESOURCES

No textbook is mandatory, although these may be useful resources as some of the lecture material is obtained from these texts, along with additional resources. Students are not required to purchase textbooks or other learning materials for this course.

1. T. Soderberg. *Libretexts: Organic chemistry with a biological emphasis* https://chem.libretexts.org/Textbook_Maps/Organic_Chemistry_Textbook_Maps/Map%3A_Organic_Chemistry_with_a_Biological_Emphasis_(Soderberg)/Chapter_08%3A_Nucleophilic_substitution_reactions_I Chapter 8: Nucleophilic substitution reactions part 1
    - 8.1: Introduction to the nucleophilic substitution reaction
    - 8.2: Two mechanistic models for a nucleophilic substitution reaction
    - 8.3: More about nucleophiles
    - 8.4: Electrophiles and carbocation stability
    - 8.5: Leaving groups and solvent effect
2. T. Soderberg. *Libretexts: Organic chemistry with a biological emphasis* https://chem.libretexts.org/Textbook_Maps/Organic_Chemistry_Textbook_Maps/Map%3A_Organic_Chemistry_with_a_Biological_Emphasis_(Soderberg)/12%3A_Acyl_substitution_reactions Chapter 12: Acyl substitution reactions
3. Additional resources of use will be indicated within each lecture.

GRADING

Assessment in this course emphasizes integrative decision-making and professional scientific skills, with major synthesis evaluated prior to the final weeks of term in accordance with university policy.

Component	Weight
Assignments (5 x 5%)	25%
Peer Review	10%
Integrative Decision Assessment – Pt A	15%
Integrative Decision Assessment – Pt B	20%
Final Exam (Integrative)	30%
Total	100%

ASSIGNMENTS (25%)

Five short application-based assignments are to be completed during the term. These assignments are designed to provide regular practice by applying course concepts (e.g., chemical fate, transformation, bioaccumulation,

and toxicity mechanisms) to realistic environmental scenarios. The completed assignments must be submitted through *Brightspace* by **11:59 pm of the due date.** Assignments are low-stakes, concise, and graded using streamlined rubric emphasizing conceptual understanding and appropriate use of course material.

INTEGRATIVE DECISION ASSESSMENT (35%)
The Integrative Decision Assessment evaluates students' ability to synthesize chemical mechanisms, environmental fate, toxicology, and societal trade-offs into a policy-relevant context. This assessment is conducted in **multiple linked stages**, which together form a single integrated assessment.

Part A: In-class decision analysis (midterm) – 15%
Students will complete an in-class, case-based decision analysis focused on a real-world environmental chemistry problem. This component emphasizes:

- identification and prioritization of relevant criteria,
- application of course concepts under time constraints, and
- justification of a preliminary policy recommendation.

This in-class component establishes the student's original reasoning and decision framework.

Part B: Structured decision artifact – 20%
Following the in-class component, students will submit a structured written decision artifact that builds upon (but does not replace) their in-class analysis. The artifact requires students to clearly articulate their reasoning, integrate supporting evidence, and communicate their decision in a professional, policy-relevant format. Students are expected to remain consistent with the priorities and recommendation established during the in-class component; revisions are intended to clarify and support reasoning, not to fundamentally change conclusions.

Part C: Peer review and revision
Students will participate in a structured peer-review exercise, providing analytical feedback on a classmate's decision artifact. Peer review is assessed on the quality and usefulness of the critique, not on agreement with the author's position. Students will then submit a lightly revised final version of their decision artifact, accompanied by a brief reflection describing how peer feedback was addressed.

PEER REVIEW (10%)
Peer review is treated as a core professional skill in environmental chemistry. Students will be assessed on their ability to critically evaluate scientific arguments, identify missing or weak components, and provide constructive, criteria-based feedback. Students will peer-review each other using provided peer-review guidance sheets. Students must participate in the peer-review by submitting a draft of the structured decision artifact and by providing their peers with feedback. Peer-reviews must be submitted through *Brightspace* by **11:59 pm of the due date**. **Failure to submit either a draft of the structured decision artifact or the peer-review will result in a 0/10.**

FINAL EXAM (30%)
The final examination will be scheduled during the official university exam period. The exam will assess integrative understanding of course material, with an emphasis on synthesis, application, and reasoning rather than memorization. The final exam will include short-answer and integrative problem-based questions.

ACCOMMODATIONS FOR MISSED WORK
Notify me within 24 hours of the missed work. Carleton recognizes that students may experience unexpected, temporary incapacitation (i.e., illness, injury, or extraordinary circumstances outside of a student's control). As a result, Carleton has put into place a protocol for students to apply for accommodation using a self-declaration form in the event of missed work. The form can be found at: https://carleton.ca/registrar/wp-content/uploads/self-declaration.pdf. Note that these forms should be used for short-term concerns related to missed work; if you are experiencing chronic, ongoing challenges which necessitate a broader solution, I recommend reaching out to the Paul Menton Centre and/or the Care Support team.

FEELING SICK?
If you feel unwell (e.g., fever, chills, stomach upset), please do not come to campus. Where possible, a lecture recording may be made available on Brightspace to support short-term absences. Recordings are intended as a supplementary resource and do not replace in-person participation, which includes discussion and formative activities that are not captured in recordings.

MENTAL HEALTH
If you are struggling, please know that support is available. While I can help with course-related questions and academic concerns, Carleton provides dedicated mental health and well-being services that are better equipped to support students experiencing distress. Information about these resources can be found here.

PLAGIARISM AND CHEATING
The University Senate defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This can include:

- reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source;
- submitting a take-home examination, essay, laboratory report or other assignment written, in whole or in part, by someone else;
- using ideas or direct, verbatim quotations, or paraphrased material, concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another's data or research findings;
- failing to acknowledge sources using proper citations when using another's works and/or failing to use quotation marks;
- handing in "substantially the same piece of work for academic credit more than once without prior written permission of the course instructor in which the submission occurs."

Plagiarism is a serious offence that cannot be resolved directly by the course's instructor. The Associate Dean of the Faculty conducts a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized. Penalties are not trivial. They can include a final grade of "F" for the course."

GENERATIVE AI / CHAT GPT
The use of generative artificial intelligence tools (e.g., ChatGPT) is not permitted for assessments in this course unless explicitly stated in the assignment instructions. Where AI use is permitted, students are responsible for ensuring that their work reflects their own understanding and reasoning and for complying with all academic integrity requirements. If you are unsure whether AI tools may be used for a particular assessment, you must consult the instructor in advance.

COURSE SHARING WEBSITES
Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copy protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s).

My lectures and course materials (including all PowerPoint presentations, outlines, and similar materials) are protected by copyright. I am the exclusive owner of copyright and intellectual property of all course materials. You may take notes and make copies of course materials for your own educational use. You may not allow others to reproduce or distribute lecture notes and course materials publicly for commercial purposes without my express written consent.

STUDENT RIGHTS AND RESPONSIBILITIES
Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See the 7 Rights and Responsibilities Policy for details regarding the

expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

STUDENT CONCERNS
If a concern arises regarding this course, **your first point of contact is me**: Email or drop in during office hours and I will do my best to address your concern. If I am unable to address your concern, the next points of contact are (in this order):

Note: You can also bring your concerns to Ombuds services.

ACADEMIC ACCOMODATIONS
You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation –
Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website.

Religious obligation –
Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website.

Student activities –
Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the Senate Policy on Accommodation for Student Activities (PDF, 25KB).

Students with disabilities requiring academic accommodations -
The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally scheduled exam (if applicable)."