Fundamentals of Biogeochemistry Syllabus

Department of Earth and Environmental Sciences

ERTH/ENVS 3601 Winter 2026

Dalhousie University operates in the unceded territories of the Mi'kmaw, Wolastoqey, and Peskotomuhkati Peoples. These sovereign nations hold inherent rights as the original peoples of these lands, and we each carry collective obligations under the Peace and Friendship Treaties. Section 35 of the Constitution Act, 1982, recognizes and affirms Aboriginal and Treaty rights in Canada.

We recognize that African Nova Scotians are a distinct people whose histories, legacies, and contributions have enriched the part of Mi'kma'ki known as Nova Scotia for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Dr. Shannon Sterling (she/her)	shannon.sterling@dal.ca	Mon 10h-11h30, room 3056, LSC

Course Description

An interdisciplinary course that covers the basic principles of water, carbon, nitrogen, and phosphorus cycling, and human impacts on these cycles, through the biosphere, atmosphere, hydrosphere, and geosphere. This course involves discussion of the latest developments in this rapidly changing field focusing on climate change and global change.

Course Prerequisites

CHEM 1011.03 / CHEM 1012.03 or equivalent, and one of ENVS 1100.03, SUST 1001.03, ERTH 1080.03, or (SCIE 1506.09 or SCIE 1507.09) and completion of 2 years of an undergraduate degree.

Student Resources

Additional resources available to students in this course include office hours for the professor Sterling and the Teaching Assistant, 1:1 support with TAs during laboratory periods.

Course Structure

Course Delivery

This course will be in-person (lectures and labs), with the exception of lectures during week 3 which will be asynchronous online. Synchronous components will not be recorded.

The take-home Final exam does not require on-campus attendance..

If technology issues occur during quizzes, then extra time will be given to complete the quiz once the technology issue is fixed.

Students connecting to online resources from outside Canada are responsible for ensuring awareness and compliance with any applicable laws in the country from which they are connecting.

Lectures will be held Mondays and Wednesdays from 8h35-9h55 in Studley LSC-COMMON AREA C332.

In -person laboratories will be held Mondays from 11h35-12h55 in Studley LSC-COMMON AREA C332. There will be three laboratories (see schedule below); when there is not a laboratory, the TA's will be available in the room to provide support for student learning.

Course Materials

Required Textbook: *Biogeochemistry: An Analysis of Global Change*, 4th Edition, 2020. W.H. Schlesinger and Emily S. Bernhardt. This book is available in PDF format from the Dalhousie Libraries (Novanet).

Assigned readings will be posted in Brightspace throughout the semester.

The minimum technology required for the course is a laptop that can access Brightspace, and the software MS Excel and MS Word.

Assessment

- 40% quizzes
- 30% lab problem sets
- 30% final exam

Quizzes

There will be 9 quizzes (see the course schedule below). Each quiz will be ~20 minutes long and will be held at the beginning of the Wednesday lecture. Note that Quiz 1 will occur synchronously online on Wednesday January 21st. The quiz will be made available on Brightspace – please bring your laptop to class. Some quiz questions will be given in

class so you will need to attend the class to complete the quiz. Each quiz will focus on the previous ~2 lectures but will build on everything that has already been covered in the course. You can use your notes or the textbook but no other resources.

Lab problem sets

There will be 3 lab problem sets (PS). PSs will be introduced during the lab time, after which you will have 1 week to complete each problem set. You can work collaboratively with other students. Each problem set is worth ~8% of your final grade.

Final exam

There will be a take-home final exam during the exam period. The exam will cover the material from the entire course.

Course Policies on Missed or Late Academic Requirements

Late problems sets will have 3% of the total mark deducted per day that the assignment is late (including weekends). Missed quizzes will receive a zero.

If students are sick and miss a quiz, then they can use the student declaration of absence (SDA). One SDA will be accepted per term. With an SDA, the missed quiz will not count towards the final grade.

Course Policies related to Academic Integrity

For problem sets, students can work together, and must identify who they worked with on the problem set in the submitted problems set. Expectations around generative AI and large language models (e.g., ChatGPT) are that they are not used to generate the problem set or final exam answers themselves, but may be used to help inform the answers. Students must include a statement on how they used generative AI in producing their problem set or final exam.

Learning Objectives

- A foundational overview of biogeochemistry through the Earth system, including the basic principles, processes, movements and interactions of key elements in and among the biosphere, atmosphere, hydrosphere, and geosphere
- An understanding of each major biogeochemical cycle; its key chemical species, stocks, fluxes, and processes; its uniqueness; its importance; its sensitivity; its spatial and temporal variability; and how it has changed throughout Earth's history.
- An understanding of how humans are currently altering each major biogeochemical cycle (climate change and global change), their impacts, and possibilities for mitigation.

You should be able to answer the following seven key questions for each major biogeochemical cycle / element:

1. Chemical species: What are the important chemical species of the element in each sector of the Earth system (atmosphere, geosphere, biosphere, and hydrosphere)?
2. Pools and fluxes: What are the important pools? What are the important fluxes between these pools and what controls their rates?
3. Transformations: What are the important transformations among chemical species? What controls their rates?
4. Earth's history: What were the major events and changes throughout Earth's history?
5. Links with other biogeochemical cycles: What are the links between the element and other elements? What are their stoichiometric ratios?
6. Human impact: How are humans currently altering the biogeochemical cycle?
7. Response: How does the biogeochemical cycle respond to human impact?

Course Content 07-JAN-2026 - 09-APR-2026

Week	Date	Lecture topic	Problem Sets	Quizzes	Textbook
1	Wed Jan 7	Introduction - What is biogeochemistry?			
2	Mon Jan 12	Fundamentals - Biosphere, atmosphere, hydrosphere, lithosphere - Understanding the Earth as a chemical system - Scales of endeavour	PS1 assigned	No quiz	Chap 1
2	Wed Jan14	Origins - Origins of the elements - Origin of the solar system and the solid Earth - Origin of the atmosphere and the oceans - Origin of life - Evolution of metabolic pathways			Chap 2
3	Mon Jan 19	ONLINE ASYNCHRONOUS LECTURE Atmosphere - Structure and circulation - Atmospheric composition - Biogeochemical reactions in the troposphere and stratosphere - Atmospheric deposition Earth's energy budget and climate change	Optional PS1 help		Chap 3
3	Wed Jan 21	ONLINE ASYNCHRONOUS LECTURE Atmosphere cont'd		Quiz 1 ONLINE SYNCHRONOUS	PS1 due
4	Mon Jan 26	Geosphere - Rock weather - Soil development Soil chemical reactions	TA help (optional)		Chap 4
4	Wed Jan 28	Geosphere cont.		Quiz 2	
5	Mon Feb 2	Carbon cycling overview - Photosynthesis and respiration Carbon fluxes (GPP, NPP, NEP, NBP, etc.)			Chap 5
5	Wed Feb 4	Carbon cycling cont.	PS2	Quiz 3	
6	Mon Feb 9	Land - Structure of terrestrial ecosystems (vegetation biomass and soil organic matter) - Methodologies (eddy covariance, remote sensing, etc.)			Chap 6

		Impacts of global change			
6	Wed Feb 11	Land cont'd	Optional PS2 time	Quiz 4	
	Feb 16	Reading Week			
	Feb 18	Reading Week			
7	Mon Feb 23	Wetlands - Types of wetlands - Productivity and storage in wetlands - Anaerobic metabolic pathways and the redox ladder Impacts of global change			Chap 7
7	Wed Feb 25	Wetlands cont'd	PS3	Quiz 5	
8	Mon Mar 2	Inland waters - Structure of aquatic ecosystems - Properties of water - Watersheds - Lakes, rivers, and estuaries Impacts of global change			Chap 8
8	Wed Mar 4	Inland waters cont'd	Optional PS3 time	Quiz 6	
9	Mon Mar 16	Oceans - Ocean circulation - Composition of seawater - Surface ocean biogeochemistry - Deep ocean biogeochemistry Impacts of global change			Chap 9
9	Wed Mar 18	Oceans cont'd	TA help (optional)	Quiz 7	
10	Mon Mar 23	Global Water Cycle			Chap 10
10	Wed Mar 25	Global carbon cycle - Global pools and fluxes - Temporal variations Methane	TA help (optional)	Quiz 8	Chap 11
11	Mon Mar 30	Global carbon cycle con't			
11	Wed Apr 1	Global nitrogen/phosphorus cycle - Global pools and fluxes - Temporal variations - Nitrous oxide - Linking global biogeochemical cycles		Quiz 9	Chap 12
12	Mon Apr 6	Applications of biogeochemistry to climate mitigation			
12	Wed Apr 8	Review		No quiz	

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding Mi'kmaq and Indigenous Relations (including the Elders in Residence program, Land Acknowledgements, Understanding Our Roots, and much more) can be found at: https://www.dal.ca/about/mission-vision-values/mikmaq-indigenous-relations.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about/mission-vision-values/global-relations.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/campus_life/ssc.html).

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: https://www.dal.ca/about/mission-vision-values/equity-diversity-inclusion-and-accessibility/about-office-equity-inclusion.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/content/dam/www/about/leadership-and-governance/governing-bodies/code-student-conduct.pdf

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/content/dam/www/about/leadership-and-governance/university-policies/fair-dealing-policy.pdf

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.