

Fundamentals of Biogeochemistry Syllabus

Department of Earth and Environmental Sciences
ERTH/ENVS 3601 Winter 2025

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Dr. Sian Kou-Giesbrecht (she/her)	sian.kougiesbrecht@dal.ca	Tuesday 1:30pm-2:30pm
Dr. Shannon Sterling (she/her)	shannon.sterling@dal.ca	Thursday 10am-12pm

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, EARTH 1080.03, or (SCIE 1506.09 or SCIE 1507.09) and completion of 2 years of an undergraduate degree.

Course Structure

Course Delivery

This course will be in-person (lectures and labs). Lectures are 8:35am-9:55am in the Studley LSC-COMMON AREA C332 on Tuesday and Thursdays. Labs are 10:05am-11:25am in the Studley LSC-COMMON AREA C332 on Tuesdays.

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 \(Novanet\)](#).

Assessment

- 25% quizzes
- 15% lab problem sets
- 20% lab project
- 40% 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 Thursday lecture. The quiz will be made available on Brightspace – please bring your laptop to class. You must be present in class to take the quiz and some questions will be given in the class. 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. The best 8 out of 9 quizzes will be counted towards your final grade; each quiz is worth ~3% of your final grade.

Lab problem sets

There will be 2 lab problem sets (PS). The lab problem sets will be introduced during the lab. You will have 1.5 weeks to complete each lab problem set (they will be due on the following Sunday at 11:59pm). You can work collaboratively with other students. Each problem set is worth 7.5% of your final grade.

Lab project

The lab project will be focused on a carbon dioxide removal approach. You will explain the method, the underlying biogeochemical cycle and mechanism, and an organisation applying the approach. This project will be completed as a group (5 people). Groups will be finalized in the 2nd lab. You must attend this lab, and your entire group must check in

with an instructor. Groups will give a 20-minute presentation on their lab project. There will be 5 minutes for questions after the presentation. All students will provide constructive peer feedback on all other presentations, and you must attend all presentations. Groups will submit a 3-page report that incorporates this feedback (due 1 week after the presentation at 11:59pm). Each group member will also submit an author contribution statement which outlines the contribution of each group member.

Final exam

There will be an in-person final exam during the exam period. The exam will cover the material from the entire course. You can bring your written notes and the textbook to the 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

Date	Lecture topic	Lab	Quizzes	Textbook	Instructor
Jan 7	Introduction - What is biogeochemistry?				SKG
Jan 9	Fundamentals - Biosphere, atmosphere, hydrosphere, geosphere - Understanding the Earth as a chemical system	Project introduction	No quiz	Chap 1	SKG
Jan 14	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	SMS
Jan 16	Origins cont'd	Project group formation	Quiz 1		SMS
Jan 21	Atmosphere - Structure and circulation - Atmospheric composition - Biogeochemical reactions in the troposphere and stratosphere - Atmospheric deposition - Earth's energy budget and climate change			Chap 3	SKG
Jan 23	Atmosphere cont'd	PS1	Quiz 2		SKG
Jan 28	Atmosphere cont'd				SKG
Jan 30	Hydrosphere - The global water cycle - Impacts of global change	Optional PS1 time	Quiz 3	Chap 10	SMS
Feb 4	Hydrosphere cont'd				SMS
Feb 6	Geosphere - Rock weathering - Soil development - Soil chemical reactions	Optional project time	Quiz 4	Chap 4	SMS
Feb 11	Carbon cycling overview - Photosynthesis and respiration - Carbon fluxes (GPP, NPP, NEP, NBP, etc.)				SKG
Feb 13	Land - Structure of terrestrial ecosystems (vegetation biomass and soil organic matter) - Methodologies (eddy covariance, remote sensing, etc.) - Impacts of global change	Optional project time	Quiz 5	Chap 5/6	SKG
Feb 18					
Feb 20					



Feb 25	Wetlands - Types of wetlands - Productivity and storage in wetlands - Anaerobic metabolic pathways and the redox ladder Impacts of global change			Chap 7	SMS
Feb 27	Inland waters - Structure of aquatic ecosystems - Properties of water - Watersheds - Lakes, rivers, and estuaries Impacts of global change	PS2	Quiz 6	Chap 8	SMS
Mar 4	Land cont'd				SKG
Mar 6	Land cont'd	Optional PS2 time	Quiz 7		SKG
Mar 11	Inland waters cont'd				SMS
Mar 13	Oceans - Ocean circulation - Composition of seawater - Surface ocean biogeochemistry - Deep ocean biogeochemistry - Impacts of global change	Project check in	Quiz 8	Chap 9	SMS
Mar 18	Oceans cont'd				SMS
Mar 20	Global carbon cycle - Global pools and fluxes - Temporal variations Global nitrogen/phosphorus cycle - Global pools and fluxes - Temporal variations - Nitrous oxide Linking global biogeochemical cycles	Optional project time	Quiz 9	Chap 11/12	SKG
Mar 25	GUEST LECTURE – Dr. Owen Sherwood				
Mar 27	Review	Review	No quiz		
Apr 1	Project presentations				SMS/SKG
Apr 3	Project presentations	Project presentations			SMS/SKG

Conversion of numerical grades to final letter grades follows the

[Dalhousie Grade Scale](#)

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Policies on Missed or Late Academic Requirements

If you miss a class, you are responsible for finding out what you missed that day from your peers and/or the TA.

Student Declaration of Absence Forms (SDAs) can be used for short-term absences that are no longer than three consecutive days. Students must notify the TA prior to the deadline and email the SDA to the TA within 3 days following their last day of absence. Students can submit a maximum of one SDA. After the SDA is submitted, the student will have 3 extra days to submit the assignment. Late assignments without notifying the TA will receive a deduction of 10% per day the assignment is late.

SDAs do not apply to quizzes because only the best 8 out of 9 quizzes will be counted towards your final grade.

SDAs do not apply to the final exam. An alternative final exam time will only be granted for exceptional circumstances. Students must email the instructors before the exam to schedule an alternative final exam time if these apply.

Course Policies related to Academic Integrity

Students can work collaboratively on the lab problem sets and the lab project. All other work must be completed individually. You should note that AI tools don't understand biogeochemistry very well – they produce inaccurate and incomplete information. They also may stifle your own independent thinking and creativity. You can use AI tools to assist your learning but note the aforementioned warnings. You may not submit any work generated by an AI tool as your own in this course. This is considered an academic integrity offence. Other forms of cheating will be dealt with under relevant Dalhousie University policies.

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 the Indigenous Student Centre can be found at:

https://www.dal.ca/campus_life/communities/indigenous.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-dal/internationalization.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/about-dal/agricultural-campus/student-success-centre.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: <http://www.dal.ca/cultureofrespect.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/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

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/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: <https://www.dal.ca/about/leadership-governance/academic-integrity/faculty-resources/ouroriginal-plagiarism-detection.html>

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.