# Freshwater Biogeochemistry: Processes and Human Impacts

**Spring 2026**


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**Office Hours: by appointment**

## Course Description

Biogeochemistry is the study of biological, geological, and chemical processes that together control the state of the environment. The natural environment is full of unique biogeochemical processes that sustain ecosystems. Yet, we live in a world with increasing occurrences of freshwater issues that affect society (e.g., water scarcity) and the natural biota (e.g., reduced biodiversity). This course is designed to provide students with an introductory understanding of biogeochemistry as pertains to natural waters and changes to these systems caused by natural and anthropogenic (anthropo- meaning “having to do with humans” and -genic meaning “creation”) influences. Students will gain an understanding of the mechanisms of freshwater processes and specific tools and markers to (1) characterize and quantify the magnitude of biogeochemical changes and (2) determine the causes of these changes. The course will culminate in the application of these tools and principles in original research. Students will each select a research question and receive guidance in navigating the path from hypothesis to fieldwork to a final report and presentation. Through this process, skills in critical analysis, academic literacy, and data analysis will be developed and strengthened.

## Pre-requisites

Required: CHM 101
Recommended: CHM 210, ECS 220

## Course Materials

There is no textbook for this course. Any required readings will be assigned ahead of class and will comprise of peer-reviewed journal articles, popular science articles, scanned book sections, or published reports. These materials will be posted on the course CANVAS at least one week prior to the class meeting for which the reading is required.

## Student Learning Outcomes

By the end of this course, students will…

- be able to synthesize mechanisms depicting the effects of scavenging, advection/ diffusion, and sediment-water interactions on elemental cycling in freshwater environments.
- be able to describe current and projected human and geological impacts on freshwater geochemical fluxes.
- develop skills to be able to assess, synthesize, and discuss peer-reviewed scientific literature.
- build scientific literacy and communication skills through writing assignments targeted for pop science publications as well as scientific journals in turn.
- have demonstrated the scientific method by designing and completing rigorous experimentation targeted at understanding a hypothesis-driven scientific question.

**Assessment**

| | |
|---|---|
| Class Participation | 15% |
| Literature Presentation | 10% |
| Literature Discussions | 20% |
| Proposal Writing Assignment | 10% |
| Workshops | 10% |
| Final Project | 35% |

**Class Participaction (15%)**
*Attendance (5%):* Attendance at every class session is expected. Please contact the instructor ahead of time or as soon as possible following an emergency if you cannot attend class.

*Active Participation (10%):* Short exercises will be presented during class to help facilitate students' understanding of the material.

*Valid absences will not affect your course grade; a make-up assignment will be assigned for missed activities.*

**Literature Presentation (10%)**
Throughout the course, each student will facilitate a discussion on an assigned peer-reviewed scientific article that they will be the "expert" on while their peers will be assigned a reading of a popular science article of the same topic to serve as a broad introduction. As the "expert", the student will present key takeaways of the study and help their peers understand the nuances of the presented research. Literature discussions will begin on January 27th with, on average, one student presenting each week.

**Literature Discussions (20%)**
In preparation for active discussion with the above-mentioned presentation, students will prepare a short 1-2 paragraph reflection of their assigned popular science article onto to be submitted on CANVAS. Students who submit reflections and actively engage in discussion will receive full credit.

**Funding Proposal Assignment (10%)**
Following the selection of a research question for the final project, students will be responsible for researching the topic and developing their own 2-3-page mock-funding proposal explaining what they will be examining and why it is important.

**Data Analysis Workshop (10%)**
This workshop will provide students with hands-on experience in data collection and analysis and aid in strengthening research skills. This is a collaborative class session. Following the workshop, students will be responsible for submitting a graded deliverable.

**Final Project (35%)**
Students will select an independent research question they are interested in investigating. Through periodic class activities and workshops, students will investigate their hypothesis and be guided through conducting a literature review, creating a methodology, conducting field/lab work, analyzing and visualizing data, and formulating their results into a comprehensive final report. This report will also include a 1-page pop-science article sharing their findings with a lay audience. Additionally, the class will end with each group presenting their findings and facilitating a discussion on their topic.

**Course Schedule**

| Date | | Topics | Assignments |
|---|---|---|---|
| Thur Jan 8 | | Course Introduction | |
| Tues Jan 13 | | Freshwater as a Chemical System | |
| Thur Jan 15 | | New Perspectives in Biogeochemical Cycling | |
| Tues Jan 20 | | Synthesizing Scientific Literature | **Literature Discussion Dates Assigned** |
| Thur Jan 22 | | Research Funding Tips and Acquisition | **Proposal Assignment Assigned** |
| Tues Jan 27 | | Biological Processes I: Organization and Reactions | |
| Thur Jan 29 | | Biological Processes II: Nutrient Cycling | |
| Tues Feb 3 | | Physical Processes I: Hydrology and Nutrients | |
| Thur Feb 5 | | Physical Processes II: Groundwater Dynamics | |
| Tues Feb 10 | | Physical Processes III: Weathering and Sediment Transport | |
| Thur Feb 12 | | Research Methods and Design | |
| Tues Feb 17 | | Tools and Techniques in Biogeochemistry I | |
| Thur Feb 19 | | Tools and Techniques in Biogeochemistry II | **Proposal Assignment Due** |
| Tues Feb 24 | | Freshwater Management and Climate | |
| Thur Feb 26 | | Methodology Peer Review | |
| Tues Mar 3 | | Biogeochemical Data Analysis Workshop I | **Final Project Methodology Due** |
| Thur Mar 5 | | Biogeochemical Data Analysis Workshop II | |
| Tues Mar 17 | | Anthropogenic Influences I | |
| Thur Mar 19 | | **No Class** | |
| Tues Mar 24 | | Anthropogenic Influences II | |
| Thur Mar 26 | | Background Peer Review | |
| Tues Mar 31 | | Expanding to the Ocean | |
| Thur Apr 2 | | Data Analysis Peer Review | |
| Tues Apr 7 | | Research Seminar: Ocean Alkalinity Enhancement | |
| Thur Apr 9 | | Presentation Tips and Preparation | |
| Tues Apr 14 | | Research Seminar: Isotope Geochemistry | |
| Thur Apr 16 | | Presentations and Discussion | |
| Tues Apr 21 | | Review and Synthesis | |
| Mon Apr 27 | | -- | **Final Project Report Due** |

***Color code:*** *content-based class sessions*, *research skills-based class sessions*, *final project checkpoints*

**:** Denotes dates that students will present literature and lead a discussion

**Late Policy and Attendance**
Attendance is expected at all classes. Please email both instructors ahead of time if you are sick or cannot otherwise attend class (valid absences will not affect your credit for participation). Barring exceptional circumstances, submission extensions will not exceed 5 calendar days.

**Use of AI Tools Such as ChatGPT**
AI-powered language models such as ChatGPT may be used for research purposes, such as gathering information, exploring ideas, or generating preliminary drafts of assignments. When using AI models for research, you must ensure that the information or ideas derived from the AI model are properly cited and attributed.

**Use of TWP Writing Studio**
The Thompson Writing Program (TWP) at Duke University supports students in developing their writing skills through consultations, workshops, and events. Its Writing Studio offers collaborative and non-evaluative sessions with experienced consultants who assist at all stages of the writing process, from brainstorming to final revisions. As writing assignments constitute a considerable portion of the assignments of this course, we encourage students to utilize the TWP Writing Studio as needed. Students can book an appointment using their online scheduling platform at https://twp.duke.edu/twp-writing-studio/appointments/appointment.

**Duke Access and Accommodations**
Duke University is committed to providing equal access to students with documented disabilities. Students with disabilities may contact the Student Disability Access Office (SDAO) to ensure your access to this course and to the program. There you can engage in a confidential conversation about the process of requesting reasonable accommodations both in the classroom and in clinical settings. Students are encouraged to register with the SDAO as soon as they begin the program. Please note that accommodations are not provided retroactively. More information can be found online at access.duke.edu or by contacting SDAO at 919-668-1267, SDAO@duke.edu.

**Diversity, Equity, and Inclusion**
Because diversity is essential to fulfilling the university's mission, Duke is committed to building an inclusive and diverse university community. In our class, we strive to create an atmosphere that is inclusive and welcoming to all participants, including BIPOC, LGBTQ+, different socioeconomic backgrounds, different political preferences, and different learning styles. Please speak with us or write to us at any point with any comments, questions, or concerns related to diversity, inclusion, equity, or other topics.

**Duke Community Standard**

We expect all students to adhere to the Duke Community Standard:

*Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity.*

*To uphold the Duke Community Standard:*

*· I will not lie, cheat, or steal in my academic endeavors;*

*· I will conduct myself responsibly in all my endeavors; and*

*· I will act if the Standard is compromised.*

Violations will not be tolerated, and any infractions will be dealt with by respective deans immediately. More information can be found here: https://studentaffairs.duke.edu/conduct/about-us/duke-community-standard.

**Mental Health and Wellness Resources**

If your mental health concerns and/or stressful events negatively affect your daily emotional state, academic performance, or ability to participate in your daily activities, many resources are available to you, including the ones listed below. Duke encourages all students to access these resources, particularly as we navigate the transition and emotions associated with this time. Duke Student Government has worked with DukeReach and student advocates to create the "Two-Click to Connect" Support Form.

- DukeReach provides comprehensive outreach services to identify and support students in managing all aspects of wellbeing. If you have concerns about your own or another student's behavior or health, please visit the website for resources and assistance.
- Counseling and Psychological Services (CAPS) provides individual, group, and couples counseling services, health coaching, psychiatric services, and workshops and discussions.
- Blue Devils Care is a convenient and cost-effective way for Duke students to receive 24/7 mental health support online through TalkNow.

Managing daily stress and self-care are also important to well-being. Duke offers several resources for students to both seek assistance on coursework and improve overall wellness, some of which are listed below. Please visit https://studentaffairs.duke.edu/duwell/holistic-wellness to learn more about:

- The Academic Resource Center: (919) 684-5917
- DuWell: (919) 681-8421
- WellTrack