COURSE SYLLABUS

BIOS 4803 SPECIAL TOPICS

**BIOL/EAS 6765 GEOMICROBIOLOGY**

**FALL SEMESTER 2023**

**PROFESSORS DICHRISTINA AND TAILLEFERT**

**Scheduled Time and Room:** TR 12:30 - 1:45 PM, Ford EST Building, room L1118

**Required Class Material:** *Science* and *Nature* papers will be uploaded to class Canvas site.

**Office hours:** By appointment [ES&T Building, rooms 1240 (DiChristina) and 1254 (Taillefert)].

**E-mail addresses:** [thomas.dichristina@biology.gatech.edu](mailto:thomas.dichristina@biology.gatech.edu), mtaillef@eas.gatech.edu

**General Information**

**Course Description: Geomicrobiology** describes the interactions between microorganisms and the geosphere and bridge the gap between geochemistry and environmental microbiology. Fundamental processes such as microbial physiology and genetics, geochemical controls on microbial diversity and activity, microbiological controls on geochemical reaction networks, redox and acid-base geochemistry, biogeochemical cycles, and evolution will be examined.

**Recommended (But Not Required) Textbooks:**

* + M.T. Madigan; J.M. Martinko; J. Parker. 2017. Brock Biology of Microorganisms. 15th edition, Prentice Hall, *On reserve in library*.
  + J. F. Banfield, J. Cervini-Silva, and K. M. Nealson, 2005. Molecular Geomicrobiology. Reviews in Mineralogy Vol. 59. Mineralogical Society of America.

**Grading - BIOL/EAS 6765 Graduate Students**

**Graduate Student Requirements:**

Two paper presentations: 20% each (40% total grade)

Term Paper: 50%

Class Participation: 10%

**Graduate Student Grading scale:**

A: 90-100%

B: 80-90%

C: 70-80%

D: 60-70%

F: <60%

**Grading - BIOS 4803 Undergraduate Students**

**Prerequisite for undergraduate BIOS 4803 (requires a minimum grade of “D”):**

BIOS 3380 or EAS 3620

**Undergraduate Student Requirements:** Undergraduate students enrolled in BIOS 4803 will be graded separately from the graduate students enrolled in BIOL/EAS 6765. Undergraduate students will be required to give draft presentations to Dr. DiChristina one week prior to the scheduled in-class presentations and receive individual advisement on scientific aspects and stylistic skills associated with their presentations.

Two draft presentations: 10% each (20% of final grade)

Two in-class presentations: 20% each (40% of final grade)

Term Paper: 30%

Class Participation: 10% (Graded on a per class basis)

**Undergraduate Student Grading scale:**

A: 90-100%

B: 80-90%

C: 70-80%

D: 60-70%

F: <60%

Geomicrobiology Topic Areas

1. Carbon

Methanogenesis; carbon uptake and fixation; mineralization of organic matter; greenhouse gases; gas hydrates; aerobic and anaerobic methane oxidation.

1. Oxygen

Cyanobacteria and photosynthesis; oxygenation events on Earth; bacterial mats and stromatolites, photosystem I and II.

1. Nitrogen

Nitrogen chemistry; mechanisms and regulation of bacterial N fixation; anaerobic and aerobic ammonium oxidation; ammonium formation; aerobic and anaerobic nitrification; denitrification; dissimilatory nitrate reduction to ammonium.

1. **Sulfur**

Sulfur chemistry; global sulfur cycle; sulfur oxidizers; sulfate reduction; microbial diversity in the sulfur cycle; formation and oxidation of sulfur minerals; anoxygenic photosynthesis.

1. Metals

Metal speciation; Mn and Fe oxidation; metal oxidizers and anoxygenic phototrophs; chemical and bacterial metal reduction; bacterial mechanisms for metal detoxification; uptake of essential elements.

1. Phosphorus

Phosphorus chemistry; global phosphorus cycle, P as a limiting nutrient in marine systems, phosphodiester and phosphonate compounds; bacterial mechanisms for uptake and P-regulated gene expression.

Course Organization: The Geomicrobiology course will consist of a discussion on each topic using recent journal articles from *Science* and *Nature* articles in 2023. Each student will dissect the article by giving a PowerPoint presentation of 45 minutes followed by a 30 minute discussion with the class. The course is designed to be a discussion between participants who will also read each paper assigned by the instructors. Every student is expected to read each paper carefully and ask questions during the discussion period in class. Participation is graded.

A term paper is required from each student in the class. This paper should be a critical review of a geomicrobiology topic. The term paper should be 10 pages in length (Font: Times New Roman 12; Lines: double-spaced), not including figures and references. Term paper topics should be approved by the instructors by **Thursday, November 16, 2023**. PDF files of term papers should be submitted via email to the instructors by **Monday, December 14, 2023.**

**Expectations:** Students are responsible for knowing the material covered during the course. Students are required to read the assigned papers prior to class to aid in their understanding and participation during presentations. It is the responsibility of the students to obtain any information, instructions or materials that was provided during a missed class. Students are also expected to be proactive, meeting with either Dr. DiChristina or Dr. Taillefert if they encounter difficulties in the class, require assistance or have any unanswered questions.

**Learning Outcomes:** By the end of this course, students will be proficient at:

* recalling fundamental geomicrobial processes across a wide range of disciplines
* understanding biogeochemical cycling of elements in natural and engineered systems
* analyzing and evaluating the scientific background behind each topic covered
* communicating with a broad scientific and engineering audience that is not always well-versed in their own discipline
* applying their knowledge during career development activities

**Sample course schedule:** Beginning in week two, each class will begin with lecture material on the topic, which will be followed by a student presentation. The course schedule is below:

week dates topic

1 Aug. 22 Syllabus and Class Topics

Aug. 24 Lecture on Presentation Style

2 Aug. 29 Mechanosensitive K ion channels

Aug. 31 Bacterial nitrification in groundwater

3 Sep. 5 Deep branching of themophilic clade

Sep. 7 Reactive oxygen species mineralization

4 Sep. 12 Cable bacteria

Sep. 14 Lightning as fixed N source for bacteria on Early Earth

5 Sep. 19 Carbon catabolic preferences

Sep. 21 Iron hydrothermal fertilization of diazotrophy

6 Sep. 26 Biofilm degradation of oil

Sep. 28 Motility in Trichodesmium regulates aggregates

7 Oct. 3 Bacterial catabolism of membrane phospholipids

Oct. 5 Saltmarsh O2 priming on carbon emissions

8 Oct. 10 Fall Break

Oct. 12 Phytoplankton chlorophyll c synthase

9 Oct. 17 Sulfide and methane oxidation by an extremophile

Oct. 19 Soil respiration CO2 pulse dominates Australia

10 Oct. 24 Sediment gene response to hydrothermal stress

Oct. 26 Metabolomic response to Antarctic salt changes

11 Oct. 31 Respiration and abundance of prokaryoplankton

Nov. 2 Pathogens deliver water and solutes to plant cells

12 Nov. 7 Phosphorous availability in paddy soils under high CO2

Nov. 9 Hydrogenotrophy abundance in hydrothermal plumes

13 Nov. 14 Biochemistry and structure of mercuric reductase

Nov. 16 Bacteriophages suppress CRISPR-Cas immunity

14 Nov. 21 Ecology in organohalide-degrading consortia

Nov. 25 Thanksgiving

15 Nov. 28 Light-independent microbial oxidation of Mn(II)

Nov. 30 Aerobic respiration by a sulfate reducer

Term paper due: to be determined

**Classroom policies:**

**Class structure**

Lectures will be delivered in person as the best way for you to learn and interact is face-to-face. However, we will accommodate anyone who is isolating or in quarantine as a result of testing positive for Covid-19 by providing online lectures synchronously. Please let Dr. DiChristina and Taillefert know as soon as possible, should you test positive during the semester.

**Covid-19 Guidelines and Expectations**

Students are expected to be familiar with and abide by the Institute guidelines, information, and updates related to Covid-19. Find campus operational updates, FAQs, and details on campus surveillance testing and vaccine appointments on the [**Stamps Health Services site**](https://health.gatech.edu/tech-moving-forward)**.**

Our expectation is that everyone should be respectful of others and isolate or quarantine if they know they have been exposed to Covid.

**Consideration to classmates:** Silence all cell phones. Remove headphones and headsets. No talking unless asking or answering questions relevant to the course.

**Lateness:** Please be on time.

**Missed Classes:** If you have a valid excuse to miss class (e.g., illness, conference, field trip, etc.), please contact Dr. DiChristina or Dr. Taillefert before the missed class. You will be required to submit in writing a short synopsis of the papers discussed in class as well as at least one comment on the science described in the paper within a week of the missed class period. You will also be able to make up the missed class during the instructor’s office hours (or at another pre-arranged time) within the same time frame.

**Regrade requests:** Any request for a reconsideration of the grading of a presentation or term paper must be submitted in writing to Dr. DiChristina or Dr. Taillefert. This request must include a clear explanation of why you think your presentation or term paper should be re-graded.

**Academic Integrity:** Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit <https://www.catalog.gatech.edu/policies/honor-code/>. Any student suspected of cheating or plagiarizing on an assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

AI-based assistance (e.g., ChatGPT, Copilot) is treated the same way as collaboration with other people: you are welcome to talk about your ideas and work with other people, both inside and outside the class, as well as with AI-based assistants. However, all work you submit must be your own. Never include in your assignment anything that was not written directly by you without proper citation (including quotation marks and in-line citation for direct quotes).Anything you did not write without proper citation will be treated as an academic misconduct case. The following heuristics may be useful:

1. Never hit “Copy” within your conversation with an AI assistant. You can copy your own work into your own conversation, but do not copy anything from the conversation back into your assignment. Instead, use your interaction with the AI assistant as a learning experience, then let your assignment reflect your improved understanding.
2. Do not open the assignment and the AI agent at the same time. Use your conversation with the AI as a learning experience, then close the interaction down, open your assignment, and let your assignment reflect your revised knowledge. This heuristic avoids integrating AI directly into your document: just as you should not let a classmate write content or code directly into your submission, you should also avoid using tools that directly add content to your submission.

**Accommodations for Students with Disabilities:** If you are a student with learning needs that require special accommodation, including a student at higher risk for severe illness with Covid-19, contact the Office of Disability Services at 404-894-2563 or <https://disabilityservices.gatech.edu>, as soon as possible, to discuss your special needs and obtain an accommodations letter. Please also e-mail either Dr. DiChristina or Dr. Taillefert as soon as possible in order to set up a time to discuss your learning needs.

**Campus Resources for Students:** In your time at Georgia Tech, you may find yourself in need of support. Below you will find resources to support you both as a student and as a person.

**Academic support**

* Center for Academic Success <http://success.gatech.edu>
  + 1-to-1 tutoring <https://tutoring.gatech.edu/tutoring>
  + Peer-Led Undergraduate Study (PLUS) <https://tutoring.gatech.edu/plus-sessions>
  + Academic coaching <https://advising.gatech.edu/academic-coaching>
* OMED: Educational Services (<https://omed.gatech.edu/academic-support>)
  + Group study sessions and tutoring programs
* Communication Center (<https://communicationcenter.gatech.edu>)
  + Individualized help with writing and multimedia projects

**Personal Support:**

Georgia Tech Resources

* The Office of the Dean of Students: <https://studentlife.gatech.edu>; **404-894-2565**; Smithgall Student Services Building 2nd floor, 353 Ferst Drive
* Counseling Center: <https://counseling.gatech.edu>; **404-894-2575**; Smithgall Student Services Building 2nd floor (suite #238)
  + Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. Their website also includes links to state and national resources.
  + Students in crisis may walk in during business hours (8am-5pm, Monday through Friday) or contact the counselor on call after hours at **404-894-3498**.
* Students’ Temporary Assistance and Resources (STAR): <https://studentlife.gatech.edu/content/star-services>
  + Can assist with interview clothing, food, and housing needs.
* Stamps Health Services: <https://health.gatech.edu>; **404-894-1420**
  + Primary care, pharmacy, women’s health, psychiatry, immunization and allergy, health promotion, and nutrition
* Women’s Resource Center: <https://womenscenter.gatech.edu>; **404-385-0230**
* LGBTQIA Resource Center: <https://lgbtqia.gatech.edu>; **404-385-4780**
* Veteran’s Resource Center: <https://veterans.gatech.edu>; **404-385-2067**
* Georgia Tech Police: **404-894-2500**

**Statement of Intent for Inclusivity:** As a member of the Georgia Tech community, we are committed to creating a learning environment in which all of our students feel safe and included. Because we are individuals with varying needs, we are reliant on your feedback to achieve this goal. To that end, we invite you to enter into dialogue with us about the things we can stop, start, and continue doing to make our classroom an environment in which every student feels valued and can engage actively in our learning community.

**Syllabus change policy:** Syllabus changes substantially affecting the grading of the course will not be made. Other syllabus changes may be made and will be announced.