MICROBIAL ECOLOGY
BIOS 4410A/BIOL 6410A
EAS 4803JK/EAS 8803JK
Syllabus – Spring, 2027

Course Description:
Microorganisms produce much of the air we breathe, influence the food we eat and the water we drink, sustain plant and human health, regulate Earth's climate, and drive the cycling of essential elements. Yet most of the microbial world remains undiscovered.
Microbial Ecology explores the remarkable diversity of microorganisms and the fundamental roles they play in natural, engineered, plant-associated, and human-associated ecosystems. The course connects microbial community structure with ecosystem processes, asking questions such as:

- Which microorganisms are present in an ecosystem, and how are they distributed?
- What ecological functions do they perform?
- How do microbial communities respond to environmental change?
- How can genomic and computational tools reveal the diversity and activity of microbes in nature?

The course provides an in-depth examination of microbial evolution, phylogeny, physiology, metabolism, community ecology, and biogeochemical cycling. Applications extend from plant and human microbiomes to wetlands, soils, food systems, biofuels, bioproducts and environmental bioremediation.

Instructor:
Joel E. Kostka, Ph.D., School of Biological Sciences and Earth & Atmospheric Sciences
Email: joel.kostka@biology.gatech.edu

Class Schedule and Location:
Lecture: MW 9:30am-10:45am, Clough Undergraduate Learning Commons 129

Required Course Reading Material:
Required text:
Processes in Microbial Ecology, Third Edition
David L. Kirchman and Ashley Shade
Paperback
ISBN: 9780197831618
Publisher: Oxford University Press
Published: 01 October 2026

Required additional supplemental reading:

- Review articles, book chapters
- Primary literature
- Websites

Additional reading material will be announced and added to the course website on Canvas. You are responsible for checking Canvas daily for updates to the schedule and reading material throughout the semester.

Course Learning Outcomes:

By the end of this course, you will be able to…

a. Comprehend the phylogenetic and metabolic diversity, ubiquitous distribution, and services provided by microorganisms in global ecosystems.
b. Describe the origins of microbial life on the planet and how microbes contributed to the chemical evolution of Earth.
c. Understand the evolutionary adaptations and environmental controls that determine the success of microorganisms in past and present ecosystems.
d. Be able to explain the key processes and mechanisms by which microbes mediate the functioning of past and present ecosystems.
e. Describe the latest methods employed for determination of the abundance, distribution, diversity, and activity of microbes in nature. Interpret datasets that quantify microbial diversity and function at the ecosystem scale.
f. Effectively interpret, synthesize, and present information from primary research papers in the field.
g. Reflect on peer presentation of scientific material.
h. Design an investigation using cutting-edge methodologies to characterize structure and functioning of microbial communities in nature.

Grading:

Undergraduate section:
Research paper discussion questions- 20 %
Two take-home exams- 40 %
Amplicon Workshop Assignment- 15 %
Paper presentation- 15 %
Class participation (attendance, reading, discussion)- 10 %

Graduate section:
Research paper discussion questions- 15 %
Two take-home exams- 25 %
Amplicon Workshop Assignment- 15 %
Paper presentation/ discussion - 15 %
Class participation (attendance, reading, discussion)- 10 %
Field lab and report- 20 %

Description of Course Content

Class meetings will involve a combination of lectures (1/3), group discussions (1/3), and student presentations (1/3) focused on the primary literature. Course material will be based on weekly readings of recent research articles from the primary literature, review articles, and the Kirchman (2018) text. Primary literature readings and review papers will be made available as pdfs and posted on Canvas.

Take-home exams
Exams will each count toward 25-40 % of your final course grade. The two exams are take-home home exams which you will have about 1 week to complete. The exams will include mainly short answer and essay questions. The exams are designed so that the answers will not be ones you can simply find in a textbook, but may very well be based on simulated laboratory or field data that I provide. You are expected to work on each exam alone but you may use the textbook, Powerpoints, your lecture notes, and research papers to aid in the completion of your exams. The first exam, a midterm exam, will cover material up to the exam, and the final exam will cover material from the latter half of the course. However, since the topics discussed after the midterm exam will rely on your knowledge of the earlier material, a comprehensive understanding of the course material will be required for the final exam. Exams will be distributed 1 week prior to the scheduled due date (see schedule below). Exams can only be missed if proper documentation is presented. Make-up exams will be different from the original exams. There is NOT a comprehensive final exam.

Class Attendance and Participation
Attendance and active participation are **required**. As outlined in the course requirements section of this syllabus, 10 % of your course grade will be determined by your active participation in class. I will use a "cold-calling" mode of questioning in class. Using index cards you fill out during our first class, I will randomly call on students during each class period to promote discussion. I will grade your response based on the scheme below. Therefore, you are expected to read the required material for each class and come ready to participate and contribute. Participation in the discussions and questioning during student presentations is also expected and will be included in your participation grade. Much of the information needed to succeed on the exams will be provided orally in class, but will not be present in the Powerpoint presentations. **If you do not attend class and rely solely on the textbook and the Powerpoint presentations available on Canvas following each class, you will most likely do very poorly in this course.**

Index-card class participation grading:
0 - no attempt given to answer question, absent
1 - a poor attempt is given to answer the question, unclear on many points
2 - a good answer with some of the essential features addressed
3 - an excellent answer with most or all of the essential features addressed

Student Presentations and Research Paper Discussions
Research articles will be chosen by Dr. Kostka to complement the lectures and to reflect the latest developments in the field. Students will be assigned and responsible for one of the research papers. Groups will be developed in the first few weeks of class depending on enrollment. Students will design and present a graded Powerpoint presentation on the research paper and relevant background information. Their oral presentation will be given during class on the date assigned. Plan the presentation for 45 minutes, allowing 30 minutes for questions and discussion. The format for the presentations is flexible, but should be designed to both summarize the content of the paper and also

present ideas for discussion. Dr. Kostka will provide guidelines for what to include in the presentation, and will give an example presentation. You will be graded on the presentation, on the Powerpoint slides that you submit to me, and your formulation and written answers to discussion questions. The discussion questions/ answers are due one week before your presentation in order to leave time for me to distribute the discussion questions to the class.

All students that are not presenting that day will fill out a "presentation assessment form" at the end of the presentation and turn it in. The presentation grade for each student or group will be derived from the average of the assessment grade from your peers (50%) and from the instructor (50%). The independent critical review by undergraduate students will be graded by the instructor using the critique rubric. The grade from your presentation or critique represents 10% of your course grade.

Students are required to read each research paper carefully (prior to class) and to answer a set of questions relating to the content of each study. These questions are designed to encourage reflection and to prepare students to discuss the goals, methods, and outcomes of the research, and also to become critical reviewers of scientific research articles. Answers (~1-2 pages) to paper questions will be handed in (hard copy) by the BEGINNING of class on the day the paper is discussed. These answers will be graded. Late assignments will NOT be accepted.

Course expectations and policies:

Consideration: Appropriate classroom behavior is expected at all times. Turn off all cell phones. The only electronic device used can be a laptop if you would like, although this is not required. If you use a laptop, it is for note-taking for this course only, and not for web-surfing, social networking… Students are also expected to be proactive, meeting with their instructor should they encounter difficulties in the class, require assistance or have any unanswered questions. **I encourage you to ask questions!**

Academic Integrity:

All students in this course must follow the Georgia Tech Academic Honor Code (https://policylibrary.gatech.edu/student-life/academic-honor-code). Trust is essential to learning, and any dishonesty harms the whole Georgia Tech community. I expect you to meet the highest ethical standards in all of your work. Under the Honor Code, academic misconduct is any act that does or could improperly distort grades or other academic records. Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity in the Office of the Dean of Students, who will investigate the incident and identify the appropriate penalty for violations. If you are unsure whether something is allowed, ask me before you submit the work. Penalties may include a zero on the assignment, a failing grade in the course, or other sanctions under Institute policy.

Accommodations for Students with Disabilities:

Georgia Institute of Technology is committed to creating a learning environment that meets the needs of its diverse student body. If you anticipate or experience

any barriers to learning in this course, please feel welcome to discuss your concerns with me. Students with a disability or who think they may have a disability should contact the Office of Disability Services to inquire about services or request a meeting with a Coordinator. Students can find more information about the Office of Disability Services, including contact information, at disabilityservices.gatech.edu, or call ODS at 404.894.2563 or in person at Smithgall Student Services Building, 353 Ferst Drive, Suite 221. Students who have already been approved for accommodations through the Office of Disability Services, please also e-mail me as soon as possible in order to set up a time to discuss your academic accomodations.

Statement about Acceptable Student Conduct (Student-Faculty Expectations Agreement)
This course is committed to an atmosphere of mutual respect, acknowledgement, and responsibility between faculty and students. Expectations are outlined in the current Georgia Tech Catalog, Rules and Regulations, Section XXI (https://catalog.gatech.edu/rules/21/).

Core IMPACTS Statement- STEM.
Core IMPACTS refers to the core curriculum, which provides students with essential knowledge in foundational academic areas. This course will help master course content, and support students' broad academic and career goals. This course should direct students toward a broad Orienting Question:

- How do I ask scientific questions or use data, mathematics or technology to understand the universe?

Completion of this course should enable students to meet the following Learning Outcomes:

- Students will use the scientific method and laboratory procedures or mathematical and computational methods to analyze data, solve problems and explain natural phenomena.

Course content, activities and exercises in this course should help students develop the following Career-Ready Competencies:

- Inquiry and Analysis
- Problem-Solving
- Teamwork