Summer Session 2021

BIOE 400 Aquatic Microbial Ecology
Syllabus

3 credits: Lectures, Labs, Field Work
Course dates: Jun 21– Jul 2, 2021
Instructor: Dr. Matthew Church
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Prerequisites: BIOB 170N (Principles Biological Diversity), CHMY 121N (Introduction to General Chemistry), one year college math, or consent of instructor.

Level: U/G offered for undergraduate and graduate credit (see graduate increment page 3)

Course Description:
Aquatic Microbial Ecology (BIOE 400) is an immersive (2 week) summer course offered to undergraduate and graduate students with interests in microbiology and aquatic ecology. The course includes lectures, laboratories, and several field-based sampling trips. The course provides a conceptual foundation and hands-on field and laboratory training in modern methods in aquatic microbial ecology. Lectures, laboratories, field trips, and in-class discussions will be used to explore topics such as physiology and metabolism of aquatic microbes; methods and tools for assessing microbial diversity, biomass, and growth; and the role of microbes in bioelemental cycles. Students will gain hands-on experience with both cultivation-based approaches and cultivation-independent methods for studying environmental microorganisms. The heavy field-based emphasis of the course is intended to provide an experiential learning environment.

Students will work in small groups (2–3 students per group) to oversee a mutually agreeable field-based project. The goals of these group projects are: 1) Elucidate similarities or differences in the types and activities of microorganisms inhabiting diverse aquatic environments, 2) Gain understanding of how microorganisms are influenced by and influence these environments, and 3) Obtain hands-on experience with field sampling, experimental design, and laboratory methods utilized for assessing the role of aquatic microorganisms in ecosystem processes. Course includes 4–5 field trips to sample diverse aquatic habitats (lakes, streams, glacial melt waters, etc.). Samples will be collected for subsequent analyses of microbial abundance, metabolic activity, and diversity.

Student Learning Goals:
1) Define the major forms of aquatic microbial life and describe characteristics that distinguish these forms.
2) Describe the microbial loop and methods for quantifying fluxes of material through the ecological pathways that characterize the loop.
3) Define processes controlling microbial abundances, growth, and diversity in aquatic environments.
4) Be able to explain ways that microorganisms influence nutrient cycling in aquatic ecosystems.

Student Learning Outcomes:

1) Plan an experiment to identify specific processes controlling microbial productivity and biomass in aquatic environments.
2) Be able to describe and demonstrate proficiency in laboratory methods commonly used for measuring microbial biomass, productivity, and diversity.
3) Be able to calculate microbial biomass and productivity, and use of these data to compare and contrast microbial communities across aquatic habitats.
4) Be able to graphically depict field and laboratory data related to concentrations and activities of microorganisms.
5) Present results of a field and laboratory research project to peers and colleagues.

Required Text: There are no required text books for the course; however, students will be assigned readings that include both primary literature and textbook chapters pertinent to the topics covered in class.

Course and Field Supplies/Equipment

(*available for purchase at the FLBS Bookstore)

- Waterproof field notebook (Rite in the Rain 8.5" by 11")*	- Sleeping bag
- Lab notebook*; binder or clipboard (optional)*	- Tent
- Pencils*	- Rain gear
- Laptop Computer	- Water bottle*
- Plastic, resealable containers for lunch pack-up*	- Water purifier
- Warm jacket	- Clothes that can get muddy
- Mess kit	- Flashlight or headlamp with batteries

Evaluation and Grading for Undergraduate Credit:

Grades will be earned based on three criteria:

1) Regular attendance and participation in course activities;
2) Performance on an oral (15 min total: 12-minute talk with 3 minutes for questions) presentation summarizing the group project/experiment; and
3) Completion and quality of final exam testing students' familiarity with concepts and methodologies covered during lectures, reading discussions, labs, and field sampling trips.

Students completing the course for undergraduate credit will be graded as follows:

1) Attendance and participation in class lectures, discussions, and labs (20%),
2) Performance on oral presentation summarizing group projects (40%), and
3) Performance on final exam (40%)

Oral Presentations:

Each student will deliver a 10-minute oral presentation that summarizes a relevant aspect of course material (i.e., covering concepts and/or methods related to aquatic microbial ecology), drawing on pertinent published literature. My hope is that you will identify a topic of interest, ideally one deriving from a lecture or our field/lab activities, and want to investigate it further. You will need to search the primary literature, read a few papers, and identify a topic to present. For your talk, briefly summarize the topic (why it is important, what advances have been made, what remains to be known) and include related measurements from our sampling and lab activities. Please discuss the selected topic with the instructor sometime during the first week of the course.

Student oral presentations will be graded using the following metrics:

Excellent:	*Satisfactory*:	*Needs improvement*:
• Engaging eye contact, proper enunciation of words, creativity of presentation (e.g., interactive elements and/or visual imagery). • Topic has a clear focus and contains at least two scholarly sources. Finishes precisely on time.	• Decent eye contact, most words are properly enunciated. • Has basic requirements of a visual presentation. • Topic is rather clear, and contains one scholarly source. Stays within reasonable time limit.	• Lacking eye contact, many words were not properly enunciated. Presentation lacks visual flair, and may have errors. • Topic is not clear, and contains no scholarly sources. • Presentation time was either too long or too short.

Evaluation and Grading for Graduate Credit:
In addition to completing all requirements specified above, graduate students seeking graduate-level credits for the course will be expected to develop a proposal outlining a research project to test one or more hypotheses specific to the biogeochemical and ecological role of aquatic microbes. Students will use data gathered as part of the class field trips to support their proposal idea. Students will write a 4–6 page research proposal to be submitted at the end of the class.

Grades for graduate credit will be earned based on student performance on the following four criteria:
1) Regular attendance and participation in course activities;
2) Performance on an oral (15 min total: 12-minute talk with 3 minutes for questions) presentation summarizing the group project/experiment;
3) Submission and quality of research proposal (4–6 pages) outlining methods and approaches to address specific questions and hypotheses related to the ecological and biogeochemical role of aquatic microbes.
4) Completion and quality of final exam testing students' familiarity with concepts and methodologies covered during lectures, reading discussions, labs, and field sampling trips.

Graduate student grades will be weighted as follows:
1) Attendance and participation in class lectures, discussions, and labs (20%),
2) Quality of oral presentation summarizing group project (20%)
3) Quality of written proposal (20%)
4) Performance on final exam (40%)

Grading of research proposal (for graduate credits only)
Graduate students will write a 4-6 page (excluding references, table, figures) research proposal addressing a question focused on better understanding the role of aquatic microorganisms in the various habitats studied as part of the class. Early in the class, students and instructor will select a mutually agreeable research question; students will formulate one or more testable hypotheses related to the question. At the end of the class, graduate students will submit a proposal outlining a plan for addressing the question and testing the hypotheses. The research plan should build on field sampling approaches, laboratory methodologies, and data generated as part of the class. The research proposal should include:

1) Statement of the research question
2) Articulation of a testable hypothesis based on the research question
3) Experimental design and field sampling approach
4) Description of laboratory methodologies to be used as part of the research
5) Presentation of preliminary data to help justify the proposal hypothesis and research plan

Grading Assignment Criteria:
Letter grades for the course will be assigned based on earned percentage of points (out of **100 points** total):
A: 90–100%
B: 80–89%
C: 70–79%
D: 60–69%
F: <60 points

Absences: Students are expected to attend all classes and actively participate in discussions and ask questions. Unexcused absences will impact the grade you receive in the course.

Disabilities:
Any student who feels s/he may need an accommodation based on the impact of a disability is invited to contact the course instructor privately. The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you have a disability that adversely affects your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or 406.243.2243. The instructors will work with you and Disability Services to provide an appropriate modification.

Course Policies:
Students will adhere to University of Montana Student Conduct Code and Discrimination, Harassment, Sexual Misconduct, Stalking, and Retaliation Policy (UM policy website: http://www.umt.edu/safety/policies/).
Students must also adhere to the FLBS Code of Conduct and FLBS Rules and Regulations, as well as abide by the Safety Orientation Checklist.

FLBS students are required to complete University of Montana Prevention Education Program courses: AlcoholEdu and Sexual Assault Prevention for Adult Learners after coursework begins and prior to completion of coursework.

Class Schedule: See pages 5 and 6 for details.

Class Schedule 2021 (Updates Pending): The schedule may change subject prior to first day of class and while class is in session due to location availability and field conditions.

Note: Make sure you pack your brown bag lunch each day at breakfast!

Date	Lectures/Lab/Field Work	
21-Jun-21 (M)	07:30-08:30	Breakfast (FLBS), pack lunch
	08:30-09:30	Welcome, orientation, and introduction to aquatic microbial ecology (Church)
	10:00-11:00	Data and Donuts FLBS seminar
	11:00-17:00	**Field sampling on Flathead Lake aboard the *Jessie B***
		Processing of samples at FLBS
		Samples to be collected/properties measured: Physical structure of lake (Hydrolab), light attenuation (PAR meter), size fractionated Chl *a,* bacterial abundance (flow cytometry and microscopy), nutrients (DIN, SRP, TN, TP), & DNA. **Collect water for experiment; sample experiment**
		Lunch (in the field)
	17:00-18:00	Dinner (FLBS)
22-Jun-21 (T)	07:30-08:30	Breakfast (FLBS), pack lunch
	08:30-09:30	Lecture: Bioenergetics and the microbial loop (Church)
	09:30-14:30	**Field sampling: Echo Lake**
		Samples to be collected/properties measured: Physical structure of lake (Hydrolab), light attenuation (PAR meter), size fractionated Chl *a,* bacterial abundance (flow cytometry and microscopy), nutrients (DIN, SRP, TN, TP), & DNA
		Lunch (in the field)
	15:00-17:00	Laboratory processing of samples at FLBS; Sample experiment
	17:00-18:00	Dinner (FLBS)
23-Jun-21 (W)	07:30-08:30	Breakfast (FLBS), pack lunch
	08:30-09:30	Lecture: Microbial biomass – methods and patterns (Church)
	09:30-11:00	Process samples from Lost Lake experiments
	11:00-14:30	**Field sampling: Swan Lake**
		Samples to be collected/properties measured: Physical structure of lake (Hydrolab), light attenuation (PAR meter), size fractionated Chl *a,* bacterial abundance (flow cytometry and microscopy), nutrients (DIN, SRP, TN, TP), & DNA; **sample experiment**
		Lunch (in the field)
	15:00-17:00	Laboratory processing of samples at FLBS; Sample experiment
	17:00-18:00	Dinner (FLBS)

Date	Lectures/Lab/Field Work	
24-Jun-21 (Th)	07:30-08:30	Breakfast (FLBS), pack lunch
	08:00-09:00	Lecture: The ecology of the Nyack floodplain (Tom Bansak, Assistant Director FLBS)
	09:30-	**Field Sampling: Groundwater well sampling in the Nyack floodplain with Phil Matson**
		Lunch (in the field)
		Sampling: bacterial abundance, nutrients (DIN, SRP, TN, TP), & DNA
	17:30-18:30	Dinner (in the field)
	Overnight at Nyack floodplain	
25-Jun-21 (F)	07:00-09:00	Breakfast (FLBS), pack lunch
	10:00-17:00	**Field Sampling: Raft trip, sampling from Cascadia to West Glacier**
		Lunch (in the field)
	18:00	Dinner (FLBS)
28-Jun-21 (M)	07:30-08:30	Breakfast (FLBS)
	08:30-09:30	Lecture: Microbial production and respiration (Church)
	10:00-11:00	Data and Donuts FLBS seminar
	11:00- 17:00	**Sample experiment; laboratory processing of samples**
	17:00-18:00	Dinner (FLBS)
	18:00-20:00	Laboratory processing of samples
29-Jun-21 (T)	07:30-09:30	Breakfast
	08:30-09:30	Lecture: Microbial control of nutrient biogeochemistry (Church)
	09:30-17:00	**Laboratory processing of samples** (nutrient analyses, microscopy, flow cytometry, DNA extraction and PCR)
	17:00-18:00	Dinner (FLBS)
	18:00-20:00	Laboratory processing of samples
30-Jun-21 (W)	07:00-08:00	Breakfast (FLBS), pack lunch
	08:30-09:30	Lecture: Application of molecular approaches to microbial ecology
	09:30-17:00	**Sample experiment; laboratory processing of samples** (nutrient analyses, microscopy, flow cytometry, DNA extraction and PCR)
	17:00-18:00	Dinner (FLBS)
1-Jul-21 (Th)	07:30-08:00	Breakfast (FLBS), pack lunch
	09:00-16:00	Data analyses; work on oral presentations (proposals for graduate students)
	17:00-18:00	Dinner (FLBS)
2-Jul-21 (F)	07:30-08:30	Breakfast (FLBS), pack lunch
	09:00-11:00	**Oral presentations**
	11:00-13:00	Break
	13:00-17:00	**Final exam, course evaluations, clean up**
	17:00-18:00	Dinner