FLATHEAD LAKE BIO STATION
UNIVERSITY OF MONTANA

Summer Session 2022

BIOE 400 Aquatic Microbial Ecology
Syllabus

3 credits: Lectures, Labs, Field Work
Course dates: June 20-July 1, 2022
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

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.

Using immersive field experiences coupled with classroom and laboratory activities, students will: 1) Identify similarities and 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 field trips and experiments conducted in local aquatic habitats.

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 and conduct 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")* - Lab notebook*; binder or clipboard (optional)* - Pencils* - Laptop Computer - Plastic, resealable containers for lunch pack-up* - Warm jacket	- Rain gear - Water bottle* - Water purifier - Clothes that can get muddy - 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:

Students will deliver a 12-minute oral presentation that relies on concepts and datasets developed as part of this field and lab class. These can be part of a group presentation, or you can work independently; regardless, each student should give a presentation. My hope is that you will identify a topic of interest, ideally one deriving from our field/lab activities, and want to investigate it using data we collect from the field. You will likely need to search the primary literature and read a few papers for context on what is known about your topic. 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. These presentations can be in many different forms; for example, a mix of a video that you and your group record, together with

presentation of more traditional Powerpoint slides, and maybe something more creative (an animation, a poem, a song, drawing/painting, etc.). Be creative! The important thing is to communicate the key findings in a way that is informative and educational.

Presentations will be evaluated based on the following metrics:

Excellent: • 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.	*Satisfactory*: • Decent eye contact, most words are properly enunciated. • Has basic requirements of a visual presentation. • Topic is mostly clear, and contains one scholarly source. Stays within reasonable time limit.	*Needs improvement*: • 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 can 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 4-6 pages (excluding references) research proposal addressing a question whose answer might help us better understand 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. Students with disabilities may request reasonable modifications by contacting the instructor. The University of Montana assures equal access to instruction for students with disabilities in collaboration with instructors and the Office for Disability Equity. The University does not permit fundamental alterations of academic standards or retroactive modifications. If you have a disability that adversely affects your academic activities, please let us know at summersession@flbs.umt.edu so we can discuss an accommodation.

Course Policies:
Students are expected to review and adhere to the University of Montana Student Code of Conduct at this link: https://www.umt.edu/student-affairs/community-standards/um_student_code_of_conduct_2021-2020.pdf and adhere to the Flathead Lake Biological Station Code of Conduct form signed during student registration. Students must also abide by the FLBS Rules and Regulations and the Safety Orientation Checklist. Students who have not already completed the University of Montana online Prevention Education Programs: AlcoholEdu and Sexual Assault Prevention for Adult Learners must complete these programs at this link: https://www.umt.edu/student-affairs/programs/ (NetID and password required).

Class Schedule: See pages 5 and 6 for details.

Schedule: The schedule may change 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
20 June 2022 (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 11:00-13:00 **Getting familiar with field sampling equipment on Flathead Lake** Lunch (in the field) 13:00-16:00 Getting familiar with laboratory processing of samples at FLBS Equipment and supplies needed for field sampling: Hydrolab; downwelling PAR meter; VanDorn bottle, line, and messenger; sample bottles and carboys (125 mL, 500 mL, and 1 L) Lunch (in the field) 16:00-17:00 Lecture on by FLBS Associate Director Tom Bansak 17:30-18:30 Dinner (FLBS)
21 June 2022 (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** Lunch (in the field) Equipment and supplies needed for field sampling: Canoes (x5) and canoe trailer; Hydrolab; downwelling PAR meter; VanDorn bottle, line, and messenger; sample bottles and carboys (125 mL, 500 mL, 1 L, and 20 L carboy) Lunch (in the field) 15:00-17:00 Laboratory processing of samples at FLBS; Set up Exp. #1 17:30-18:30 Dinner (FLBS)
22 June 2022 (W)	07:30-08:30 Breakfast (FLBS), pack lunch 08:30-09:30 Lecture: Microbial biomass – methods and patterns (Church) 10:00-14:30 **Field sampling: Swan Lake** Lunch (in the field) Equipment and supplies needed for field sampling: Canoes (x5) and canoe trailer; Hydrolab; downwelling PAR meter; VanDorn bottle, line, and messenger; sample bottles (125 mL, 500 mL, 1 L) Lunch (in the field) 15:00-17:00 Laboratory processing of samples at FLBS 17:30-18:30 Dinner (FLBS)
23 June 2022 (Th)	07:30-08:30 Breakfast (FLBS), pack lunch 08:30-17:00 Raft trip: Middle Fork of Flathead River (Cascadilla to West Glacier) Equipment and supplies needed: Lifejackets, rafts (x2), paddles, helmets, raft pumps, sample bottles Lunch (in the field) 17:30-18:30 Dinner (in the field)

Date	Lectures/Lab/Field Work	
24 June 2022 (F)	07:30-08:30	Breakfast (FLBS), pack lunch
	08:30-09:30	Lecture: Nutrient cycling
	10:00-14:00	**Field sampling: Flathead Lake aboard the *Jessie B***
		Lunch (in the field)
		Equipment and supplies needed for field sampling:
		Hydrolab; downwelling PAR meter; VanDorn bottle, line, and messenger; sample bottles and carboys (125 mL, 500 mL, 1 L, and 20 L)
	14:00-1700	Laboratory processing of field samples; sample Experiment #1; set-up Experiment #2
	17:30-18:30	Dinner (FLBS)
27 June 2022 (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	**Laboratory processing of samples** (nutrient analyses, microscopy, flow cytometry, DNA extraction); sample Exp. #2
	17:30-18:30	Dinner (FLBS)
	18:00-20:00	Laboratory processing of samples
28 June 2022 (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 extractions, ddPCR)
	17:30-18:30	Dinner (FLBS)
29 June 2022 (W)	07:00-08:00	Breakfast (FLBS), pack lunch
	08:30-09:30	Lecture: Application of molecular approaches to microbial ecology
	09:30-12:00	**Laboratory processing of samples** (PCR and ddPCR)
	13:00-17:00	**Bioinformatic analyses (Dr. Logan Peoples)**
	17:30-18:00	Dinner (FLBS)
30 June 2022 (Th)	07:30-08:00	Breakfast (FLBS), pack lunch
	09:00-12:00	**Bioinformatic analyses (Dr. Logan Peoples)**
	13:00-19:00	Work on oral presentations (proposals for graduate students)
	17:30-18:30	Dinner (FLBS)
1 July 2022 (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, classroom and lab clean up**
	17:30-18:30	Dinner