University of CINCINNATI

COURSE OVERVIEW
Microbial Genomics (2 credits)
BIOL 8053
Spring 2023
Class Meeting Times: Tuesdays and Thursdays, Rieveschl 713
Due to Faculty Meetings, we will meet in 734D on Jan. 12, Feb. 2, March 2, and April 6.

CONTACT INFORMATION
Instructor: Dr. Joshua Sackett
Office Location: Rieveschl 731
Email: Joshua.sackett@uc.edu
Office Hours: By appointment

Students are expected to review and adhere to all policies outlined in the University of Cincinnati Student Code of Conduct and Graduate Handbook. Please take a moment to re-familiarize yourself with these topics:

- Attendance
- Class Cancellation
- Academic Integrity
- Accessibility
- Title IX (Sex-Based Discrimination/Harassment & Sexual Violence)
- Counseling Services

COURSE WEBSITE, RESOURCES, AND MATERIALS

- Course materials will be provided by Dr. Sackett and distributed via email.

COURSE DESCRIPTION

Advances and decreasing costs of high-throughput DNA sequencing technologies have revolutionized the field of Biology. Not only do genomics analyses permit investigations into the metabolic potential, ecology, and evolutionary history; these techniques can be leveraged in microbiology to identify essential genes, to identify genes involved in cryptic metabolic pathways, and to evaluate directed evolution studies, among many other applications. Because of the ease of access and speed at which we can analyze a microbial genome, this course will use microbial genome annotation and assembly to provide an in-depth study on the methods of genome reconstruction, sequence annotation and analysis, and comparative genomics, including: the science behind next-generation DNA sequencing technologies, the use of repeat graphs and de Bruijn graphs for genome assembly, methods to assess quality of genome assemblies, methods and applications of genome annotation pipelines, and comparative genomic analysis among related species or organisms of interest. This knowledge will be applied to semester-long group microbial genomics research project from genomes (including student-provided samples) sequenced during the first few weeks of class. Students will be expected to reconstruct these genomes from raw sequencing data, evaluate the organisms' metabolic potentials, evaluate the evolutionary history of the organism, and interpret these data within an ecological context. These investigations will culminate in the drafting of a manuscript fit for submission to the American Society for Microbiology's Microbiology Resource Announcements journal (mra.asm.org) or similar journal as mutually agreed upon. All software used in this course is open source and students will be expected to bring and utilize their own computing resources (e.g. laptop) to

each class, though computing resources through the Ohio Supercomputing Center will be made available. Accommodations can be made for students without access to computing resources (see Dr. Sackett). All required reading materials are freely available at the hyperlinks noted in the course schedule and PDFs/printed copies can be made available upon request. The course will be graded on participation (37.5%), individual journal article presentations (12.5%), mid-semester group topic presentation (12.5%), final group project presentations (12.5%) and final group project manuscripts (25%).

COURSE LEARNING OUTCOMES

Students will:

- Develop critical thinking skills and apply those skills to appraise recent microbial genomics literature.
- Develop and evaluate scientific communication skills through oral presentations and drafting of a scientific manuscript.
- Describe the methods, scientific underpinnings/theories, and strengths/limitations of genome sequencing, assembly, and annotation technologies and pipelines.
- Discuss the challenges and limitations associated with microbial genomic analyses.
- Analyze microbial genomes via genome assembly and annotations.
- Evaluate metabolic potential of an organism by inferring metabolic pathways from genomic data.
- Compare microbial genomes and/or specific genes to other closely related species.
- Formulate ideas for future research.

COURSE FORMAT

This course will meet 2 times per week for 50 minutes per meeting. Students will be asked to complete short **pre- and post-course assessments** to evaluate course effectiveness and student learning. These assessments are anonymous, voluntary and do not count toward the final course grade. Students are expected to come to class having read the required readings and prepared to **participate** in lecture and article discussions. Students are expected to participate in discussions, ask questions, provide relevant examples, etc. during each class period. Participation will count toward 37.5% of the course grade. Each student will give a **journal club style presentation** on a recently published microbial genomics paper once during the semester (12.5% of course grade). Students will work individually on the mid-semester topic presentation and the semester-long microbial genomics project. Individual topic presentations will be during Week 5 where students will present on various microbial genome annotation pipelines. This **mid-semester topic presentation** will count toward 12.5% of the course grade. Working individually or in groups, students will conduct a microbial genomics project where they analyze bacterial genomes sequenced as part of the course. For each project, **a 20-minute presentation** (12.5% of course grade) and **manuscript draft** ready for submission to ASM's Microbiology Resource Announcements journal (25% of course grade) will be due in April. There are no formal examinations in this course. Failure to meet assignment deadlines as outlined in the course schedule will result in a 20-point deduction (5%) in overall course grade per instance.

COURSE MATERIALS

Required readings, equipment, and technology

All required reading for the course will be provided in PDF format through the Canvas course website, through email, or through hyperlinks in the course schedule. Please contact me if you need access to printed material.

Students are expected to bring a laptop to class and will be expected to download and install the appropriate software for specific class activities.

ASSESSMENTS, ACTIVITIES, AND GRADING POLICY

Grading

- Participation (150 points) – 5 points per class.
- Individual Journal Article Presentation (50 points)

- Mid-semester Group Topic Presentation (50 points)
- Microbial Genomics Group Project Presentation (50 points)
- Final Group Project Manuscript (100 points)

Total: 400 points.

Letter grades will be awarded as follows: 360-400 A, 320-359 B, 280-319 C, 240-279 D, 0-239 F

Individual Journal Article Presentations

Each student will select a recently published microbial genomics journal article (2018-present) for individual presentation and group discussion. The article should relate in some way to the presenter's broader scientific interests. Short/brief communications, such as Microbiology Resource Announcements or similar, are not acceptable for this assignment. If you have questions regarding the appropriateness of an article for this assignment, email Dr. Sackett. The presenter will email the chosen article to the class no later than 1 week prior to the scheduled presentation as indicated in the course schedule. Effective presentations will present a brief background comprised of 3 or more outside references, identify the scientific question asked in the paper including any hypotheses posed, discuss the approach and any important methodology of the paper, critically analyze the major figures in the paper that support/refute the major findings, and posit logical next steps or additional experiments for the presented study. Presentations should be highly discussion driven and the presenter should aim to guide discussion. Notes may be used during the presentation.

Individual Mid-Semester Topic Presentations

Students will work individually to research and prepare a 20-minute presentation on the assigned topic. The presenter should be prepared to answer questions in the 5 minutes following the presentation. Effective presentations will introduce and provide background on the chosen topic and present and critically evaluate the methodology, results, and conclusions (if applicable).

Microbial Genomics Individual/Group Project Presentations

Students will work individually or in groups of their choice to sequence, assemble, and analyze a microbial genome. Inclusion of personal data is strongly encouraged; however, genome sequences of an organism(s) investigated in the Rowe lab will be provided. Students will not be penalized if they are unable or choose not to use personal data for this project. Students will have approximately 8 weeks to work on the data analysis portion of their project. At the end of this period, each group will be expected to give a 20-minute research talk which should include an introduction, overview of the methods used, results, and discussion. Individuals/groups should be prepared to answer questions in the 5 minutes following the presentation. Effective presentations will frame the research findings within an environmental and/or phylogenetic context.

Microbial Genomics Group Project Manuscripts

Students will work individually or in groups (same groups as above) to draft a manuscript based on the results of their microbial genomics project. At minimum, students will draft a manuscript suitable for publication in the American Society for Microbiology's Microbiology Resource Announcement journal. Students will follow the MRA Author Checklist when drafting their manuscript. Although not permitted in MRA articles, students must include a thorough evaluation of the physiologic potential of their organism in their write up that will not count toward the 500-word limit. Depending on the depth of analyses and upon consultation with Dr. Sackett, students may choose to draft a primary research article for submission to a different journal. In this case, the evaluation criteria will remain the same as for the MRA but the article word limit will not apply.

Evaluation

Rubrics for major assignments (oral presentations and final projects) will be provided to students at times indicated in the course schedule.

CLASSROOM PROCEDURES AND POLICIES

Communication

Course communications will be conducted in person during scheduled class time or via email. Please regularly check your email for course announcements, reminders, and changes to the syllabus or course schedule.

Technology Use During Class
Laptops and cell phones are allowable in class for class-related purposes only. Use of technology for playing games, messaging, etc. will not be tolerated and will result in loss of daily participation points.

Attendance Policy
Attendance is **MANDATORY**. Please contact me (Dr. Sackett) if you are unable to attend class. Unexcused absences will result in loss of daily participation points. Beyond two unexcused absences, each subsequent unexcused absence will result in a letter grade reduction.

Faculty Attendance
The instructor will attend and participate in all classes unless otherwise noted or scheduled.

Inclusion Statement
I am committed to fostering an equitable and safe learning environment for students from diverse backgrounds and perspectives. Please contact me if you feel any part of this course is exclusionary or if you have any concerns regarding inclusion of yourself or other students.

The University of Cincinnati does not discriminate on the basis of disability, race, color, religion, national origin, ancestry, medical condition, genetic information, marital status, sex, age, sexual orientation, veteran status or gender identity and expression in its programs and activities.

The university does not tolerate discrimination, harassment, or retaliation on these bases and takes steps to ensure that students, employees, and third parties are not subject to a hostile environment in University programs or activities.

The university responds promptly and effectively to allegations of discrimination, harassment, and retaliation. It promptly conducts investigations and takes appropriate action, including disciplinary action, against individuals found to have violated its policies, as well as provides appropriate remedies to complainants and the campus community. The university takes immediate action to end a hostile environment if one has been created, prevent its recurrence, and remedy the effects of any hostile environment on affected members of the campus community.

UC is committed to the ideal of universal Web accessibility and strives to provide an accessible Web presence that enables all university community members and visitors full access to information provided on its websites. Every effort has been made to make these pages as accessible as possible in accordance with the applicable guidelines.

Accessibility Policy
Please let the instructor know if you foresee any problems with accessibility in this course. I will make every attempt (within my power) to make this course accessible to all students. Feel free to contact me with any comments or concerns.

Academic Integrity
Please be aware of the University's policies on academic integrity. Academic integrity will be enforced in this course and any instance of cheating will be dealt with at the discretion of the instructor. Plagiarism will not be tolerated under any circumstance.

Please see the Student Code of Conduct for more information.

COURSE SCHEDULE

Date	Activity	Reading	Assignments
WEEK 1			
Jan. 10	Introduction and course overview.		*Assign individual journal article presentation dates. *Provide journal article presentation rubric. *OPTIONAL: Pre-course assessment due at the start of class Jan. 12 (hard copy).
Jan. 12	DNA sequencing technologies	Slatko et al., 2018. Overview of next-generation sequencing technologies.	
WEEK 2			
Jan. 17	Genomics – a powerful tool to investigate microbes	Grigoryan et al., 2022. Draft genome sequence of *Polaromonas eurypsychrophila* AER18D-145…	Introduce group microbial genomics projects
Jan. 19	Genomics – a powerful tool to investigate microbes	Peng et al., 2022 Genomic features and pervasive negative selection in Rhodanobacter…	*Assign group presentations on microbial genome annotation pipelines. *Provide mid-semester presentation rubric to students. ***Leah** – send out journal article for Jan. 26 class.
WEEK 3			
Jan. 24	Hybrid genome assembly methods: Repeat graphs and de Bruijn graphs.	Kolmogorov et al., 2019. Assembly of long, error-prone reads using repeat graphs. Walker et al., 2014. Pilon: An integrated tool for comprehensive microbial variant detection… Recommended: Compeau et al., 2011. How to apply de Bruijn graphs to genome assembly.	
Jan. 26	Student Journal Article Presentation #1 - **Leah**	TBD	*OPTIONAL: DNA extracts (minimum of 30 uL at 10 ng/uL for Illumina sequencing AND 400 ng – 1000 ng high molecular weight DNA for Nanopore minION sequencing) due by 5 PM Jan 27.
WEEK 4			
Jan. 31	Assessing genome assembly quality and taxonomy: CheckM, QUAST, and GTDB.	Parks et al., 2015. CheckM: assessing the quality of microbial genomes… Gurevich et al., 2013. QUAST: quality assessment tool for genome assemblies. Parks et al., 2018. A standardized bacterial taxonomy…	
Feb. 2	Instructor-led Journal Article Presentation	Light et al., 2019. EET powers flavinylated extracellular reductases in Gram-positive bacteria.	
WEEK 5			

Feb. 7	Student Presentations – Microbial Genome Annotation Pipelines.		*Register for an account at KBase.us prior to class Feb. 9. *Register for RAST account (https://rast.nmpdr.org). *Accept Ohio Supercomputer Center (OSC) invitation to join course if you have not yet done so.
Feb. 9	Introduction to KBase.		**Jin** – send out journal article for Feb. 16 class.
WEEK 6			
Feb. 14	Comparative genomics pipelines and analyses.	TBD based upon class interests. Examples include: core/pangenome, genome synteny, identification of HGT events, dN/dS ratios and fitness effects, etc.	
Feb. 16	Student Journal Article Presentation #2 – **Jin**	TBD	**Mehdi** – send out journal article for Feb. 23 class.
WEEK 7			
Feb. 21	Ethics in Authorship	McNutt et al., 2018. Transparency in authors' contributions and responsibilities to promote integrity in scientific publication.	
Feb. 23	Student Journal Article Presentation #3 – **Mehdi**	TBD	
WEEK 8			
Feb. 28	Workshop: Genome Assembly and Polishing		Provide genomics project final presentation rubric and final manuscript rubric to students.
March 2	Workshop: Genome Assembly and Polishing		
WEEK 9			
March 7	Workshop: Genome assembly quality and taxonomy and sequencing depth approximations.		
March 9	Instructor-led Journal Article Presentation	Martínez et al., 2021. Genomic characterization and proteomic analysis of the halotolerant *Micrococcus luteus* SA211 in response to the presence of lithium.	*Polished genome assemblies (FASTA format), taxonomy, quality information, basic statistics, and a draft of genome assembly methods due by 5 PM March 10 (email). *Submit sequences and assemblies to NCBI (Dr. Sackett)
WEEK 10 – Spring Break			
March 14	No class!		Comments on methods returned (email).
March 16	No class!		*Submit FAA file (provided by Dr. Sackett) to GhostKOALA *at least* 48 hours prior to class start. *Presenter 7 – send out journal article for March 23 class.

WEEK 11			
March 21	Workshop KEGG pathways and metabolic potential. Discuss next steps.		
March 23	Workshop KEGG pathways and metabolic potential. Discuss next steps.		
WEEK 12			
March 28	In-person work on genomics project. Demo pSORTb, Prosite.		
March 30	In-person work on genomics project.		Manuscript Introduction and Methods draft due by 5 PM March 31 (email).
WEEK 13			
April 4	Final project presentation overview. In-person work on genomics project.		
April 6	In-person work on genomics project.		Comments on Intro and Methods drafts returned to students (email).
WEEK 14			
April 11	In-person work on genomics project.		
April 13	In-person work on genomics project.		Completed manuscript draft due by noon April 14 (email). Comments returned by 5 PM.
WEEK 15			
April 18	In-person work on genomics project.		
April 20	Final Genomics Project Presentations		*Final manuscript due by 5 PM April 21 (email). *OPTIONAL: Post-course assessment due by 5 PM April 21 (hard copy).

I reserve the right to make changes to the course schedule as class needs arise. All changes to course schedule, the syllabus, or to course policies will be communicated via email.