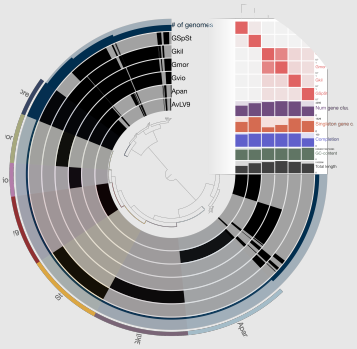

Microbial Genomics Lab

BISC 4234/6234
(3 credits)

Spring 2026

Course Info

- Prerequisites: BISC2336 and basic understanding of Unix/Linux commands OR approval from the instructor.
- Mondays/Wednesdays
- 2:20-3:35 PM
- MPA 309

Instructor Info

- Jimmy Saw
- Office hours: Tue/Thur (11:00AM-12:00PM)
- On Zoom (please use Calendly to schedule)
- https://calendly.com/jsaw/30min
- jsaw@gwu.edu

Course Description

What do you see when you look at the figure below? An eye staring at you? Some sort of sand mandala?

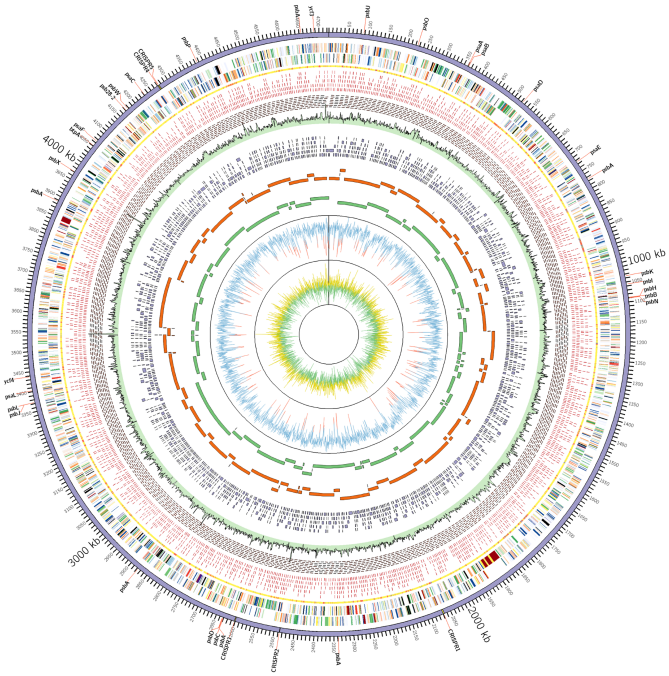

Figure 1: What is this?

This is a circular representation of a bacterial genome! It is just one way of visualizing genomic information. Did you know that most of microbial genomes are circular? Microbial genomics is becoming one of the fastest-growing fields of research, thanks to the advances in sequencing technology and the number of microbial genomes being sequenced are rapidly expanding. Currently, microbial (bacterial and archaeal) genomes outnumber eukaryotic genomes and will continue to do so in coming years.

Consequently, the ability to analyze massive number of microbial genomes will become a crucial skill for anyone who is working in academia, biotechnology, and government labs. This laboratory course will prepare you to gain hands-on computational skills needed to analyze microbial genomes and metagenomes with ease. You will become familiar with techniques such as genome assembly, annotation, metagenome binning, phylogenetic and phylogenomic, and learn how to write simple scripts to help you analyze genomic data.

By becoming proficient at biological sequence data analysis and specifically becoming an expert in microbial genomics, you will have various career options not only in basic research but in other sectors such as biotechnology companies, clinical or diagnostic labs, government agencies (such as FBI, CDC, and more!), or even independent consultants.

This course will also allow you to not only work on pre-existing data but also your own data if available. In addition, the instructor will be providing **unpublished data generated from his research lab** for students to work with. So this course provides an opportunity for students to work with primary research data from a real research lab at GW and provides **course-based undergraduate research experiences (CURE)** to students enrolled in the course. You will be able to be co-authors of manuscripts if your semester-long project(s) ended up discovering something new and the findings can be published in peer-reviewed journals.

This is a **cross-listed** course designed for seniors and graduate students.

Materials

Required Text

No textbook required! Instructional materials and required reading will be provided through **Blackboard** and/or **Slack**. Computational exercises will be provided on this web page:

https://microbialgenomicslab-spring2026.readthedocs.io/. (the course website will become available at the beginning of Spring 2026)

Instructions for lab activities will be updated on a weekly basis on this page and will be available at the beginning of each week.

Required Materials

A **laptop computer** and reliable access to the internet. You should bring your laptop computer to class each lab period and also bring a charger in case your laptop battery is running low. The classroom has power outlets for you to plug in your computer. Please make sure you can log on to GW wireless network during classes.

You will also need to access a GW **high-performance computing (HPC) cluster** known as **Cerberus**. I will let you know how to get access to the cluster.

Additional materials

Additional reading materials and media will be provided on Blackboard and/or Slack. These may include research journal articles, news articles, YouTube videos, etc.

Course Platforms

This computational genomics lab is run fully in-person and you are expected to be present in person each lab period. We will meet from 2:20 PM to 3:35 PM Mondays and Wednesdays in MPA 309 unless there are emergencies. Zoom may be used if needed due to various circumstances. We will also use Slack messaging tool to communicate.

Course Objectives

The overall goals of this course are to: (1) develop basic understanding of computational methods used to analyze microbial genomes, (2) become familiar with common bioinformatics tools used to (assemble, annotate, analyze, compare) microbial genomes and metagenomes, (3) learn how to compare microbiome samples, (4) learn basic techniques to construct phylogenetic trees, (5) learn how to visualize microbial genomic data using Python and/or R, (6) learn basic Python programming, (7) learn how to write a research manuscript.

Specifically, at the end of this course, you should be able to:

- use command line environment
- use basic Unix/Linux commands to process biological data
- process raw biological sequence data into usable forms
- assemble, annotate, analyze, and compare microbial genomes and metagenomes
- use various bioinformatic tools to compare microbiome samples
- construct phylogenetic trees to assess relationships between different microbes
- identify any given gene(s) of interest and use it for further downstream processes
- learn to write simple Bash, Python, and R scripts
- use Jupyter Lab to document computer exercises
- learn Markdown syntax and write simple Markdown documents
- use git for version control
- learn to use a citation manager
- learn to write a publishable research manuscript to be submitted to a peer-reviewed journal

Assessment of Learning

Attendance/In-class Participation

Please make an effort to show up to all lab sessions as important discussions or demonstrations on how to use certain tools will be done in class and missing a class could mean you might be a bit behind your peers. I will do my best to record class sessions using Echo 360 but the goal is to only use this option as a last resort. Therefore, please inform your instructor if you anticipate missing a class due to emergencies or for important reasons. It is expected that you attend classes in person on Mondays and Wednesdays unless you are sick or you have emergencies. Please inform me ahead of time if you needed to be excused from class due to various reasons.

You will lose attendance points for each unexcused absence (for example, if you miss 2 labs out of 25, you will score only 13.8 points out of 15 possible points for attendance). We will not have a remote option for you to participate at this time unless there are emergencies.

We will also use **Slack** software platform to communicate and you will receive an invitation to join the course Slack group before the class begins.

Assignments

These are computational exercises to help you gain practical skills in bioinformatics and genomics. Using the course instructional website, you will first learn how to use certain computational tools. After that, you will work on problem sets that are designed to be completed within a relatively short amount of time (perhaps a few hours). These assignments have hard deadlines as shown in the tentative schedule below but don't worry about not getting things right at the first instance. As this course is mainly to help you learn skills in genomics and bioinformatics, you will be given chances to correct mistakes made in your assignments to gain points back. You will work with the instructor (and classmates) to find out where you got certain things wrong and to correct the mistakes to get right answers on the assignments.

Documentation of your work/project using Jupyter Lab

You will use Jupyter-lab notebook to document your final project and workflows and it is worth 15% towards your final grade. Detailed instructions will be given at the beginning of the semester. Briefly, your Jupyter-lab notebook should document everything that you have done from start to finish. It should be documented in such a way that if I were to take this notebook and rerun the analyses you have done, I should be able to produce the same results you have obtained (This include details of the commands you ran, the tools you used, and any **bash** or **sbatch** scripts used in the process, for example). You should explain in detail some steps you have performed and why you did these steps. You will submit your notebooks individually.

Final Project Report/Manuscript

BISC 4234 students will need to work in groups or in pairs, depending on the number of students enrolled in the course (I will assign and the number of students in each group later in the semester) and work on a project assigned by the instructor or design their own project of choosing after consulting with the instructor. **BISC 6234** students will work individually. If you are an undergraduate student and wish to work on the project individually, please let me know and we can discuss the scope of the project before moving forward.

Findings from the project will need to be reported in a form of a written report. This project will count towards the final grade. There may be opportunities for you to work on original unpublished data that I generated in my lab, use publicly available data, or to use your own data (if you happen to be in a lab and want to use your lab-specific data but the data need to be related to some aspects of microbiology). Depending on how novel the data and findings are, there may be opportunities for publications in peer-reviewed journals. Detailed instructions will be given for the final projects.

Final Presentation

BISC 4234 students will present their final group projects in the form of a Powerpoint presentation or something similar (other acceptable formats can be Google Slides, Keynote, Canva, etc). Each of the group members will need to take turn to present their project in order to get points. **BISC 6234** students will present their final projects individually. Separate instructions will be given for final presentations.

Exams

Please note that there are **no exams** in this course. I want to reemphasize that I want students to focus on learning important skills that will be useful for a wide variety of career options so that they will be well-prepared to take on roles that require advanced skills in computation or data analysis. Therefore, I will be doing regular check-ins with students to see whether they fully understood how things work rather than focusing on their performance in an exam setting.

Amount of Effort Required

Average amount of direct instruction or guided interaction with the instructor and average minimum amount of independent (out-of-class) learning expected per week

In a traditional 15-week semester (which includes exam week), for each credit, students are expected to spend a minimum of 100 minutes on independent coursework for every 50 minutes of direct instruction for a minimum total of 2.5 hours per week. For this 3-credit course, you will need to spend 3 hours of direction instruction and a minimum of 6 hours of independent learning, totaling a minimum of 9 hours per week or 135 hours per semester. I am available for consultation during office hours (by appointment) or through email if necessary.

Office Hours

Office hours will be on Zoom on Tuesdays and Thursdays from 11:00 AM to 12:00 PM. Please reserve for a meeting slot using Calendly website.

Evaluation and Grading

15%	**Attendance/in-class participation**
20%	**Assignments**
10%	**In-class discussions**
20%	**Final Project in a research manuscript format**
15%	**Documentation of work using Jupyter Lab Notebook**
15%	**Final Presentation**
4%	**Attendance of Final Presentations**
1%	**Course Evaluation**

Grades will follow the following scale:

92.5 - 100%	=	A
88.5 - 92.49%	=	A-
85.5 - 88.49%	=	B+
82.5 - 85.49%	=	B
79.5 - 82.49%	=	B-
76.5 - 79.49%	=	C+
73.5 - 76.49%	=	C
70.5 - 73.49%	=	C-
67.5 - 70.49%	=	D+
64.5 - 67.49%	=	D
60 - 64.49%	=	D-
<60%	=	F

Course Policies

Attendance

We will meet fully in person and remote participation will not be an option for this course unless there are emergencies.

Academic Integrity

The course will be conducted according to established GWU guidelines of academic behavior and integrity (https://studentconduct.gwu.edu/). Academic dishonesty is defined as "cheating of any kind, including misrepresenting one's own work, taking credit for the work of others without crediting them and without appropriate authorization, and fabrication of information." Note that plagiarism covers both words and ideas - be sure to use proper citations for both! The minimum penalty for academic dishonesty is to receive a zero on the assignment. Academic dishonesty on the exam will result in receiving a failing grade on the exam. Major offenses will result in failure of the course or report to disciplinary committees.

Policy on the use of AI (Artificial Intelligence)

The use of AI to accomplish various tasks has become quite common with the rise of generative AI technologies and I am quite aware that you can prompt an AI agent to accomplish certain tasks. Some of the assignments you work on might be easily done by AI. While it is ok to ask AI to solve certain tasks, please make sure you understand how the code actually works. For example, job interviews done by AI companies (such as Anthropic) do encourage candidates to use it in certain context but not all. They definitely want you to demonstrate your understanding of the code in real-time without the assistance from AI. Likewise, you do not want to copy-paste the text ChatGPT or Claude may have regurgitated from somewhere without checking to make sure if some phrases have been plagiarized or not.

Therefore, I would encourage you to ***really*** understand the materials covered in class and make sure you think of this course as a training course that will prepare you well for a future job.

University Policies

University Policy on Religious Holidays

In accordance with University policy, students should notify faculty during the first week of the semester of their intention to be absent from class on their day(s) of religious observance. For details and policy, see: provost.gwu.edu/policies-procedures-and-guidelines.

Academic integrity code

Academic dishonesty is defined as cheating of any kind, including misrepresenting one's own work, taking credit for the work of others without crediting them and without appropriate authorization, and the fabrication of information. For details and complete code, see: studentconduct.gwu.edu/code-academic-integrity.

Support for students outside the classroom

Blackboard

Class announcements, additional readings, lab materials, and assignments will be posted on the course Blackboard site (https://blackboard.gwu.edu/webapps/login/). Any PowerPoint slides/lectures will be made available on Blackboard **after** the corresponding class.

The GW Library system

The library system (https://library.gwu.edu/) will be able to procure almost any book or article that you might need, but some materials may take a few days to arrive so you must plan ahead to avoid last-minute problems.

The GW Writing Center

Need help on a paper or other written assignment? Make an appointment (or drop into) the GW Writing Center (https://writingcenter.gwu.edu/).

Disability Support Services (DSS) 202-994-8250

Any student who may need an accommodation based on the potential impact of a disability should contact Disability Support Services in Rome Hall, 801 22nd Street, NW, Suite 102, to establish eligibility and to coordinate reasonable accommodations. For additional information see: disabilitysupport.gwu.edu

Counseling and Psychological Services 202-994-5300

GW's Colonial Health Center offers counseling and psychological services, supporting mental health and personal development by collaborating directly with students to overcome challenges and difficulties that may interfere with academic, emotional, and personal success. For additional information, see: healthcenter.gwu.edu/counseling-and-psychological-services

University Counseling Center (UCC)

The University Counseling Center (UCC) offers 24/7 assistance and referral to address students' personal, social, career, and study skill problems. Services for students include crisis and emergency mental health consultations and confidential assessment, counseling services (individual and group), and referrals. For additional information please visit https://healthcenter.gwu.edu/.

Safety and security

- In an emergency: call GWPD 202-994-6111 or 911
- For situation-specific actions: review the Emergency Response Handbook: safety.gwu.edu/emergency- response-handbook
- In an active violence situation: Get Out, Hide Out or Take Out: go.gwu.edu/shooterprep
- Stay informed: safety.gwu.edu/stay-informed

Tentative Class Schedule

Week	Dates	Topics/Activities	Assignments
1	12-Jan	Lecture: introduction to the course, a brief history of microbial genomics	
	14-Jan	Lab: setting up computing environment, basic Unix commands, install Miniconda/bioconda, Jupyter lab, other bioinformatic tools for the next lab	
2	19-Jan	**Martin Luther King Day (no classes)**	
	21-Jan	Lecture: introduction to sequencing technologies, bioinformatic tools, and databases	
3	26-Jan	Lab: processing and analysis of NGS data, download example datasets, learn to use fastqc and bbduk, Jupyter-lab to document notes and run tests, prepare for next lab	Assignment 1 (due 2-Feb)
	28-Jan	Lecture: Microbial genomics; brainstorm possible final projects to choose from; formation of groups	
4	2-Feb	Lab: learn to connect to a remote computer, use job scheduler on GW's HPC clusters, prepare for next lab	
	4-Feb	Lecture: Metagenomics and uncovering the hidden microbial majority	Reading assignment 1 (for 18-Feb)
5	9-Feb	Lab: Metagenome assemblies and binning exercises using metaSPAdes, Megahit, and Metabat2.	
	11-Feb	Lab: Assessment of bin qualities and refinement using CheckM and RefineM. Hybrid assembly using Illumina and Nanopore data	Assignment 2 (due 23-Feb)
6	16-Feb	**Presidents' Day (no classes)**	
	18-Feb	Lecture: Infering evolutionary relationships among Bacteria and Archaea; discussion of paper 1	
7	23-Feb	Lab: Using 16S rRNA gene sequences to build phylogenetic trees, using GTDB-Tk to identify unknown microbes	Reading assignment 2 (for 4-Mar)
	25-Feb	Lecture: Predicting gene function and understanding microbial metabolism	
8	2-Mar	Lab: Genome annotation using Prokka and Interproscan, using GhostKoala to identify metabolic pathways	Assignment 3 (due 16-Mar)
	4-Mar	Lecture: Microbial diversity in various habitats; discussion of paper 2	
9	9-Mar	**Spribng break (no classes)**	
	11-Mar	**Spribng break (no classes)**	
10	16-Mar	Lab: Assessment of microbial diversity and population structure using DADA2 and Phyloseq in R	Reading assignment 3 (for 25-Mar)
	18-Mar	Lecture: Microbial genome evolution and comparative genomics	
11	23-Mar	Lab: Learn to compare microbial genomes, pangenomic analysis using Anvi'o	Assignment 4 (due 6-Apr)
	25-Mar	Lecture: Basic Python programming; discussion of paper 3	
12	30-Mar	Lab: Learning Python and Biopython to analyze sequence data	
	1-Apr	Lab: Data visualization using Python and R, learn to make publication-quality figures, consult with instructor about group projects	Reading assignment 4 (for 13-Apr)
13	6-Apr	Work on projects; learn how to write scientific papers and use proper citations	Assignment 5 (due 20-Apr)
	8-Apr	Work on projects	
14	13-Apr	Work on projects; discussion of paper 4	
	15-Apr	Work on projects	
15	20-Apr	Work on projects; final guidelines on manuscript(s) to draft	
	22-Apr	**Final presentations**	
16	27-Apr	Last day of classes (**Final presentations**)	
	28-Apr	Make-up day	
	29-Apr	Designated Monday (**Final presentations**)	

Due Dates

Below is a list of due dates for the semester

- Assignment 1 (due Feb 2)
- Reading assignment 1 (please be ready to discuss on Feb 18)
- Assignment 2 (due Feb 23)
- Reading assignment 2 (please be ready to discuss on Mar 4)
- Assignment 3 (due Mar 16)
- Reading assignment 3 (please be ready to discuss on Mar 25)
- Assignment 4 (due Apr 6)
- Reading assignment 4 (please be ready to discuss on Apr 13)
- Assignment 5 (due Apr 20)