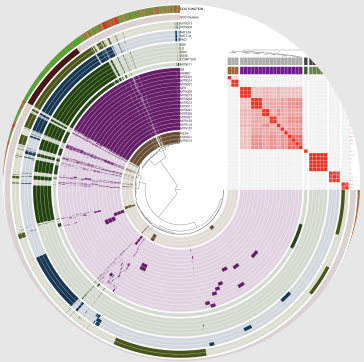

Microbial Genomics Lab

BISC 4234
(3 credits)

Fall 2020
(August 31 - December 12)

Course Info

Prerequisites: BISC2336 and basic understanding of Unix/Linux commands OR approval from the instructor.

Wednesdays

12:45-15:45

SEH 1800

Instructor Info

Jimmy Saw

Office Hrs: Thur (10:00-12:00)

Lisner Hall 413

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?

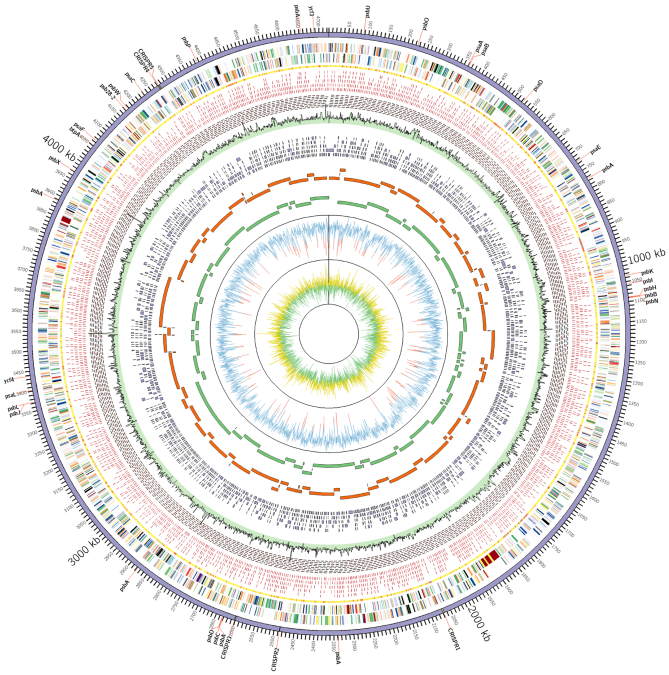

Figure 1: What is this?

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 field 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 scripts to help you analyze genomic data. This course will also allow you to not only work on preexisting data but also your own data if available.

This is a course designed for seniors and graduate students. A cross-listed course for graduate students is available (BISC 6234). The enrollment cap is limited to only 28 students for both courses.

Course Objectives

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

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

- use command line environment
- use Unix/Linux commands
- process raw NGS data into usable forms
- assemble microbial genomes and metagenomes
- annotate, analyze, and compare microbial genomes
- 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
- use git for version control

Materials

Required Text

None. Instructional materials and required reading will be provided through Blackboard or through a Wiki page. Computational exercises will be provided through online Wiki documentation system and Jupyter Lab notebooks.

Required Materials

A laptop computer. A user account on GW's Colonial One high-performance computing clusters. You need to apply for a user account through this website: https://colonialone.gwu.edu/getting-access/.

Additional materials

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

Course Platforms

We will make use of several technologies and platforms available that will facilitate online learning during the time of COVID-19 pandemic. Lectures will be carried out on either **Blackboard Collaborate** or **WebEx**. We will also use **Slack** to communicate and you will receive an invitation to join the course Slack group before class starts.

You will also need to create a **Github** account in order to download some course contents and also to get credit for some assignments. I will invite you to the course Github repository after you have created an account there.

Assessment of Learning

Attendance/In-class Participation

Attendance will be taken and will count towards the final grade. You will get points for attending live sessions during class hours on Wednesdays. Although I would prefer that you turn on your web cam during class hours, I will not force everyone to turn it on if you prefer not to. Everyone is already stressed due to the pandemic and it is fine if you prefer not to turn on your web cam throughout the class. However, for the first time we are meeting, I would like to see everyone face-to-face, at least for a short while.

Assignments

In addition to in-class computer exercises, students will have computer assignments to complete before the next class period. There may also be assigned readings and materials from the assigned readings may be on the midterm or the final examinations.

Documentation using Jupyter Lab

We will make extensive use of Jupyer Lab to document computer exercises and also to keep track of class progress. This Jupyter electronic notebook will need to be turned in at the very end of the semester and will be graded and the scores will count towards the final grade.

Final Project

Students will need to work in groups of 4 students and work on a project assigned by the instructor. Findings from the project will need to be reported in a form of research manuscript. This project will count towards the final grade.

Final Presentation

Students will present their final group projects in the form of a Powerpoint presentation. Each of the group members will need to take turn to present their project in order to get points.

Exams

There will be two exams: a midterm and a final. These exams will test students' comprehension of lectures, computer exercises, and assigned readings. The exams may consist of questions to be answered through Blackboard and computational exercises to be answered using a Jupyter notebook.

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

On-campus course - 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 or through email if necessary.

Evaluation and Grading

20%	**Attendance/in-class participation**
20%	**Assignments**
10%	**Documentation using Jupyter Lab**
10%	**Midterm**
10%	**Final Exam**
20%	**Final Project**
10%	**Final Presentation**

Grades will follow the following scale:

92 - 100%	=	A
89 - 91.99%	=	A-
86 - 88.99%	=	B+
83 - 85.99%	=	B
80 - 82.99%	=	B-
77 - 79.99%	=	C+
74 - 76.99%	=	C
71 - 73.99%	=	C-
68 - 70.99%	=	D+
65 - 67.99%	=	D
60 - 64.99%	=	D-
<60%	=	F

Course Policies

Exams

Exams will mostly consist of multiple-choice and short answers. Make-up exams will only be considered for emergencies or university-approved absences, both of which will require appropriate documentation. In the case of university-approved activities, documentation will need to be presented to the instructor well in advance of scheduled exam date so that an alternative date before the actual exam date can be scheduled. No exceptions will be made for the final exam.

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.

Class Schedule

Week	Dates	Topic	Assignments
1	09/02/20	**Lecture:** Introduction to the course **Lab:** Setting up computer environment, basic Unix commands, install git, Jupyter Lab, install bioinformatics tools to use in subsequent weeks. Test some tools. **Assignments:** Lab assignment 1, reading assignment	
2	09/09/20	**Lecture:** Sequencing technologies **Lab:** Processing and analyzing NGS data, download example data sets, learn to use fastqc and bbduk, learn to use Jupyter-lab to document notes and run tests. **Assignment 2**	**Assignment 1 due**
3	09/16/20	**Lecture:** Microbial genome assembly **Lab:** Microbial genome assembly using SPAdes, checking assembly metrics using Quast, learn to use job scheduler on GW's HPC clusters. Prepare for the next lab (prepare sequences for metagenome assembly). **Assignment 3**	**Assignment 2 due**
4	09/23/20	**Lecture:** Metagenomics and uncovering the hidden microbial majority **Lab:** Metagenome assemblies using metaSPAdes and Megahit, binning metagenome with Metabat2, assessment of bin qualities using CheckM, binning refinement using RefineM. **Assignment 4**	**Assignment 3 due**

Week	Dates	Topic	Assignments
5	09/30/20	**Lecture:** Inferring evolutionary relationships among *Bacteria* and *Archaea* **Lab:** Using the 16S rRNA gene to build phylogenetic trees, using GTDB-TK to identify unknown microbes. **Assignment 5**	**Assignment 4 due**
6	10/07/20	**Lecture:** Predicting gene function and understanding microbial metabolism **Lab:** Genome annotation using Prokka and Interproscan. KAAS and GhostKoala to identify metabolic pathways and investigate microbial metabolism. **Assignment 6**	**Assignment 5 due**
7	10/14/20	**Midterm**	**Assignment 6 due**
8	10/21/20	**Lecture:** Microbial Diversity in various habitats **Lab:** Assessment of microbial diversity and population structure using DADA2 and Phyloseq in R **Assignment 7**	**Assignment 6 due**
9	10/28/20	**Midterm**	**Assignment 7 due**
10	11/04/20	**Lecture:** Comparative genomics **Lab:** Learn to compare microbial genomes, pangenomics analyses **Assignment 8**	
11	11/11/20	**Lecture:** Basic Python programming and using Git for version control **Lab:** Learning Python and Biopython to analyze sequence data **Assignment 9**	**Assignment 8 due**
12	11/18/20	**Lab:** Data visualization techniques using Python and R, learn to make publication-quality figures, consult with instructor to decide individual or group projects, start working on group projects **Assignment 10**	**Assignment 9 due**
13	12/02/20	**Thanksgiving Break - No classes**	
14	12/02/20	**Lecture:** Microbial genome evolution, HGT, recombination **Lab:** Work on projects	**Assignment 10 due**
15	12/09/20	**Final Project presentations**	**Final projects due**
16	12/16/20	**Final Exam**	

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