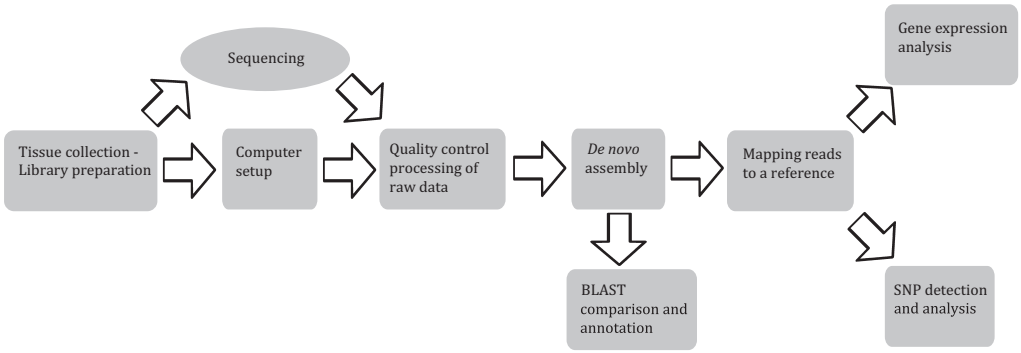

Instructor: Dr. Crista Wadsworth (cwadsworth@hsph.harvard.edu)
Class Meetings: Wednesday 6:00-8:30pm in Anderson Hall, Room 208
Office Hours: Wednesday 4:00-6:00pm in *TBD*

Course Description: This seminar is designed to familiarize graduate students with the theory and analysis of genomic data, within the context of evolution. Students optimize a bioinformatics pipeline in computational labs, work on problem sets, discuss primary literature, and write brief lab reports. This year, we will study how bacteria evolve antimicrobial resistance by working with Illumina RNA-sequencing (RNA-seq) and whole genome sequencing data. Six core topics in computational biology are emphasized: (1) high-performance computing and command-line interface; (2) transcriptome and genome assembly, (3) functional annotation, (4) gene expression analysis, (5) mutation (indel/SNP) discovery, and (6) population genetics and assessment of phylogenetic relationships. Class meetings are coordinated around these six topics, as well as the biology of antimicrobial resistance.

Prerequisites: Graduate student status or permission of instructor. Basic knowledge of biology, plus upper level work in any of the following fields: biology, chemistry, chemical or biomedical engineering, computer science. Access to a computer and some prior background in evolution, statistics, and genetics is assumed. Experience with command-line interface is a plus. ***Please bring your laptop to every class!***

Class Resources and Required Readings: Tufts Canvas (https://canvas.tufts.edu/) will be the main class resource for downloading papers for each week's meetings, as well as for class leaders to post any discussion questions ahead of class.

Course Goals

- To become familiar with command-line interface and high-performance computing
- To be able to reconstruct the genomes and transcriptomes of bacterial species
- To evaluate patterns of differential gene expression
- To assess the biological and molecular functions of sequence data
- To characterize patterns of genetic variation in nature and explore how antimicrobial resistance evolves

Outcomes

- A pipeline for transcriptomic and genomic analysis
- An understanding of how bacteria evolve resistance to antibiotics

Schedule:

Date	Week	Topic	Due
9/5/18	1	Course Mechanics & Overview of Field	
9/12/18	2	Evolution of Antimicrobial Resistance and the Model System	CP
9/19/18	3	Unix and slurm	PS
9/26/18	4	R	PS
10/3/18	5	Descriptive Statistics and Plotting	PS
10/10/18	6	*de novo* Genome Assembly	PS, CP
10/17/18	7	Genetic Variant Detection	PS, CP
10/24/18	8	Natural Selection	PS, CP
10/31/18	9	Phylogenetic Tree Construction and Visualization	PS, CP
11/7/18	10	*de novo* Transcriptome Assembly & Annotation	PS, CP
11/14/18	11	Transcriptome Analysis	PS, CP
11/28/18	12	Pathway Enrichment	PS, CP
12/5/18	13	Group Presentations of Results	

PS: Problem Set; CP: Commentary Paper

Format: Each class session has two components: (1) *A student led discussion* of literature or a *student led interactive session* (TBA); and (2) a bioinformatics workshop to be conducted in small groups.

(1) STUDENT LED DISCUSSION

This is a seminar course, which involves a small group of students discussing and exchanging ideas based on readings of research. Class meetings will be coordinated each week by two student leaders working together. **Student leaders will be responsible for a ~30-45 minute presentation, and for leading a class discussion. Students must sign up to be leaders for two sessions.** *The goal of the presentation is to provide a review of the material, and to pose discussion topics or questions for the class during your presentations*. **Everyone** is responsible for bringing ideas and questions to class, and for contributing to the discussion. With a few exceptions, discussion leaders will be responsible for incorporating two papers into their discussion. The first paper will be instructor-selected and the second paper will be selected by the leaders.

Expectations for Discussion Leaders

Your introduction should draw on the readings, but should not necessarily re-state what we have all read unless it's needed. Use the time to lead into discussion questions. Your job as leader is to get a discussion going. This is hard (and I will help), but far more interesting for everyone involved. Once it's going, it will often run itself - and if it is doing this you should let it. Don't worry if you are still a little confused or don't have everything 'right' when leading your session. If you have questions, others will too! If you are stuck/confused seek help from the class.

Expectations for the rest of the class

In classes that you are not leading, make sure that you have thought about the material enough that you can help the leader out. Come prepared with at least 2 or 3 ideas to talk about if things get too quiet (see Commentary papers, below). If the leader has posted questions, actually think about them before class. And be responsible about doing the reading. If you do all this stuff, others will do the same when it's your turn to lead. Read the material for class before you get there. Review the expectations for Presenters – it's your job to make the discussion flow, and you'll be grateful when you are a presenter and the other students help you.

Commentary papers: Each participant who is not leading is responsible for submitting a commentary paper **that is no more than 1 page** on the readings before each class (please email directly to the instructor **at 12:00 pm on Wednesday**). In this written assignment you are expected to (a) concisely summarize each paper in 2-3 sentences, (b) synthesize or tie together the main themes emerging from each group of readings in a short paragraph, and (c) develop 2-3 questions to be discussed in class.

When summarizing each paper, consider the following points:

- *What specific questions were the researchers attempting to answer?*
- *What was the theoretical context for these questions? Why were these questions considered important?*
- *What is the main point or message conveyed by each paper?*
- *What line of reasoning/type of evidence is used to support this point?*
- *How did the work extend or transform the original theoretical context?*

When integrating across papers, consider the following points:

- *What unifying concepts are addressed by this group of papers?*
- *What are the major achievements from these papers and what are the areas of debate?*
- *What are the outstanding research questions or implications of the results? What ideas do you have for improving or extending these studies? Where might the answers/solutions come from?*

(2) BIOINFORMATICS WORKSHOP

Small Group Exploration

The last portion of each week's meeting will be a bioformatics workshop, in which students will work through an instructor developed script in small groups. The rationale is to develop further familiarity and to apply new-found skills in new contexts.

Individual Problem Sets

All students will be responsible for completing instructor-developed problem sets designed to emphasize skills learned in-group explorations (see schedule for due dates). Though you can and ***are encouraged*** to complete these with your fellow classmates, every student will be responsible for turning in their own problem set. Please email directly to the instructor **before each class at 6:00 pm on Wednesdays.**

Evaluation: Students will be evaluated on leadership, participation, commentary papers, and problem sets.

Grading:

Class Leadership	25%
Participation	25%
Problem Sets	20%
Group Presentation	15%
Commentary Papers	15%

Respect for Diversity: It is my intent that students from all diverse backgrounds and perspectives be wellserved by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, religion, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.