Microbial Genomics & Genetics

Plant & Microbial Biology c148
Molecular & Cell Biology c148

Spring 2014

Instructors

Steven E. Brenner <c148brenner@compbio.berkeley.edu>
Office Hours: Monday 2:00-3:00 pm in Koshland 461A during genomics component
Janet Jansson <jrjansson@lbl.gov>
Office Hours: Thursday 12:30-1:30 Koshland 111F (during genetics component)
Daniel Barsky <c148barsky@gmail.com>
Office Hours: Thursday 2 – 3:30 pm in Koshland 111F (during genetics component)

Graduate Student Instructors

Genomics GSI: To Be Named
Office Hours: To Be Announced

Genetics GSI: Sam Coradetti <scorad@berkeley.edu>
Office Hours: To Be Announced

Class Location/Time

Lecture:	Tuesday & Thursday, 11:00 am -12:30 pm, 141 McCone Hall
Discussion:	Thursday, 4-5p, 107 GPB
	Friday, 11-12p, 109 Morgan

Course Prerequisites

Biology 1A-1B

Computational Module

This module will introduce the basic principles that underlie computational genomics. While students are not expected to know how to program, they will master key biological, algorithmic, and statistical concepts that are foundational for sequence comparison. With an understanding of these ideas, student should be able to wisely put common tools into practice, understanding their strengths and limitations, and to make appropriate inferences. This education will also allow students to make an informed analysis of new methods.

Because material and approaches in this module may be unfamiliar, students should anticipate additional study time.

Computational Module Outline

Schedule subject to change pending class comprehension

Week 1. Molecular evolution of sequences & structures
Basic principles; rates of evolution; selection; orthology, paralogy, homology, analogy, terminology and definitions; relationships between homology, similarity, function & structure, meaning of alignment, number of alignments, principles of dynamic programming (Fibonacci)

Week 2. Principles of pairwise sequence alignment
Optimal alignment, dotplot, complexity, longest common substring, Needleman-Wunsch dynamic programming algorithm, global, local, and variants

Week 3. Typical pairwise sequence alignment approaches. Statistics
Smith-Waterman dynamic programming algorithm, BLAST heuristics and variants, substitution matrix principles, BLOSUM series, affine gap scoring. Empirical statistics.

Week 4. Statistics of alignment; multiple alignment and methods
Extreme value distribution for local alignment; analytic statistics; assumptions and violations. Multiple alignments principles; optimal, progressive, iterative alignment algorithms. PSI-BLAST, Profiles, hidden Markov models, Pfam

Week 5. Phylogeny; genome annotation. Exam
Phylogenetic reconstruction (distance, parsimony, likelihood, Bayesian), Practical approaches to predicting protein functions; all questions answered; exam

Computational Module Readings

All readings should be completed prior to the lecture for which they are assigned.

Text: There is *no* text suitable for this module, and key material presented in lecture will not be found in any of the readings. It is thus essential to pay careful attention during lecture. Readings for the class will be posted on the c148 bSpace site.

Lecture 1.
Fitch, W. M. (2000). Homology a personal view on some of the problems. Trends Genet, 16, 227-31.
Pages 1-21 of: Pearson W. R. (2000). Protein sequence comparison and Protein evolution. ISMB tutorial.

Lecture 2.
No reading

Lecture 3.
Pages 22-29 of Pearson W. R. (2000). Protein sequence comparison and Protein evolution. ISMB tutorial.

Lecture 4
No reading

Lecture 5.
Pearson pp30-36;Altschul-TIBS

Lecture 6.
Galisson

Lecture 7
Eddy

Lecture 8
Brenner-TIG; Eisen-GenomeResearch; Brenner TIBS

Lecture 9
TBA

Microbial Genetics and Genomics Module Outline

Text *Molecular Genetics of Bacteria* by Synder and Champness, 4th edition.
Additional readings and problem sets will be posted on bSpace

Comparative Genomics and Metagenomics

Week 6 (Feb 25/27) Microbial Diversity and Genome organization in Bacteria and Archaea
DNA replication, transcription and translation
Readings: Introduction, Chapters 1, 2 and 3

Week 7 (Mar 4/6) Bacterial Cell cycle, Mutation and Variation in Bacterial Genomes.
Readings: Chapter 1, additional Readings posted on bspace

Week 8 (Mar 11/13) Metagenomics
Readings: posted on bspace
- Thomas, T. et al., Microb. Inform Exp. 2012. Feb. 9:2(1):3. Doi:10.1186/2042-5783-2-3.

Bacterial Genetics

Week 9 (Mar 18/20) Plasmid Replication/Conjugation
Readings: Chapter 4, 5

Spring Break (Mar 24–28)

Week 10 (Apr 1/3) Genetic elements: Bacteriophage
Readings: Chapter 7

Week 11 (Apr 8/10) Gene regulation in Bacteriophage
Readings: Chapter 8

Week 12 (Apr 15/17) Transposons/Transposition/Recombination
Readings: Chapters 9 and 10

Week 13 (Apr 22/24) Regulatory mechanisms in prokaryotes
Readings: Chapter 12

Week 14 (Apr 29/May 1) Global Regulatory mechanisms in prokaryotes
Readings: Chapter 13

Reading/Recitation/Review (RRR) week (Apr 30–May 4)

Final Exam (May 15)

Problem Sets

Problem sets are due at 11:10am *sharp* in class on the date specified. Problem set grades are reduced by 10 (of 100) points for each day late until answers are distributed, after which the problem set will get a 0.

For each problem set, you are encouraged to work with other students to discuss the general principles that underlie each question. However, you must work on the actual problem set questions and develop answers on your own and write them in your own words. You are welcome to make use of any published an online materials for reference, except, you may *not* refer to any problem sets or exams from Berkeley courses covering similar material.

The lowest problem set grade is dropped in computing final grades. You can also turn in one problem set up to 24 hrs late without penalty.

Grading

Problem sets 20%
Midterm 25%
Final 45%
Participation and holistic evaluation 10%

Exams

Midterm: 20 Feb 2014 in class.
Final: See registrar's posting for official and updated details.
Currently showing as Final Exam Group 13: Thu, 15 May 2014, 8am-11am

Important Dates

21 Feb 2014: deadline to add/drop classes
24-28 March 2014: spring break, no classes
5-9 May 2014: RRR Week

Special Needs

Students with special needs should email the instructors in advance of the first day of class or meet with an instructor during the first office hours. All special needs must be documented with a letter from DSP presented to the instructor (do not assume DSP will reliably contact the instructor), or other documentation provided directly to the instructor

Persistent Webcast

We will attempt to make an audio webcast available to enrolled students via the bSpace site subsequent to the lectures. These audio recordings are for the exclusive use of enrolled students, and distribution of these beyond the class or public posting of the access information will lead to these being withdrawn. Be sure not to share or post the webcast URLs. We will also attempt to make video webcasts available as well.

Attendance

Attending lecture and section is required. You are responsible for all material covered in lecture, much of which is not available in any readings. Section will review information from lecture and cover material possibly left out of lecture. If you miss lecture or section, it is your responsibility to learn the material missed, for example by obtaining notes from a classmate. The lecturer and GSI will be available at office hours to answer questions that clarify or extend the material covered in lecture or section, but office hour time will not be used for repeating missed course content.

To minimize distraction, laptops may only be used in the last two rows of the classroom. Please contact the professor if there are special needs requiring their use elsewhere.

Email and bSpace

Email to your University email address and bSpace announcements will be the primary ways of providing updates regarding course materials. You are expected to read your email every day.

Participation and Holistic Evaluation

We recognize active participation in lecture, section (especially), and office hours. Attendance is the minimal level of participation, for the best recognition you need active participation (asking and answering questions). We do not generally formally take attendance at lecture or section; however, we can often tell if you are absent and make a note of it. We also take account of positive characteristics that may not be reflected in the problem set and exam scores. It is uncommon for participation / holistic evaluation to affect the final grade; however, in rare cases it can be determinative.

Honor Code (text adapted from that recommended by campus administration)
The student community at UC Berkeley has adopted the following Honor Code:
"As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others." The hope and expectation is that you will adhere to this code.

Collaboration and Independence: Reviewing lecture and reading materials and studying for exams can be enjoyable and enriching things to do with fellow students. This is recommended. However, unless otherwise instructed, homework assignments are to be completed independently and materials submitted as homework should be the result of one's own independent work.

Cheating: A good lifetime strategy is always to act in such a way that no one would ever imagine that you would even consider cheating. Anyone caught cheating on a quiz or exam in this course will receive a failing grade in the course and will also be reported to the University Center for Student Conduct. In order to guarantee that you are not suspected of cheating, please keep your eyes on your own materials and do not converse with others during the quizzes and exams.

Plagiarism: To copy text or ideas from another source without appropriate reference is plagiarism and will result in a failing grade for your assignment and usually further disciplinary action. For additional information on plagiarism and how to avoid it, see, for example: http://gsi.berkeley.edu/teachingguide/misconduct/prevent-plag.html

Academic Integrity and Ethics: Cheating on exams and plagiarism are two common examples of dishonest, unethical behavior. Honesty and integrity are of great importance in all facets of life. They help to build a sense of self-confidence, and are key to building trust within relationships, whether personal or professional. There is no tolerance for dishonesty in the academic world, for it undermines what we are dedicated to doing – furthering knowledge for the benefit of humanity.

Your experience as a student at UC Berkeley is hopefully fueled by passion for learning and replete with fulfilling activities. And we also appreciate that being a student may be stressful. There may be times when there is temptation to engage in some kind of cheating in order to improve a grade or otherwise advance your career. This could be as blatant as having someone else sit for you in an exam, or submitting a written assignment that has been copied from another source. And it could be as subtle as glancing at a fellow student's exam when you are unsure of an answer to a question and are looking for some confirmation. One might do any of these things and potentially not get caught. However, if you cheat, no matter how much you may have learned in this class, you have failed to learn perhaps the most important lesson of all.

Agreement

We will in general ask you to sign a statement of compliance with the honor code. However, regardless of whether such a statement exists, inscribing your name on problem sets and exams will be interpreted as conclusive agreement to the assertion that "On my honor, I have neither given nor received inappropriate assistance in the taking of this exam"