

BIOL 525: Analysis and Interpretation of Sequence-based Functional Genomics
Department of Biology, University of North Carolina at Chapel Hill
Spring 2019

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Class Meeting Times: Tues/Thurs 2:00-3:15pm, GSB 1378
Final Exam: Monday May 6th, 2:00pm, GSB 1378
Concurrent enrollment in lab class required

Description

This class aims to provide a practical introduction into functional genomics experiments that measure different aspects of biological activity in cells. We will focus on computational techniques for the analysis of these large-scale genomics data, and the interpretation of results. With advances in technology that enable running experiments that generate massive amounts of genome-wide data, the ability to accurately and efficiently interpret and extract information from these data is critical for many fields of biological research.

Goals

The goals of this class are to

- (i) provide introduction to computational biology software, and using Linux command line and web-based tools and resources for the analysis of genomics data;
- (ii) provide a deeper understanding of high-throughput experimentation, the enabling technologies, and the data produced to put these in the larger context of biological knowledge and research;
- (iii) provide an overview of key aspects and techniques of computational biology research including understanding strengths and limitations of these efforts, and the ability to critically evaluate high-throughput analysis techniques and results.

Prerequisites

This course is intended for upper-level undergraduate and beginning graduate students in life sciences. Basic knowledge of molecular biology, beginning level computer skills, and familiarity with basic statistical concepts are expected, such as those learned in the following UNC classes or their equivalents:

BIOL 202 – Molecular Biology and Genetics
COMP 116 – Introduction to Scientific Programming, COMP 110 – Introduction to Programming, or equivalent
STOR 155 – Introduction to Statistics, or equivalent

Students may also request a waiver from the instructor.

Weekly Topics

Week 1 (1/10): Introduction to genomics and computational biology

Week 2 (1/15, 1/17): Computers, operating systems, and algorithms

Week 3 (1/22, 1/24): DNA sequencing and analysis overview

Week 4 (1/29, 1/31): DNA sequence alignment

Week 5 (2/5, 2/7): Gene transcription, RNA-seq

Week 6 (2/12, 2/14): Differential RNA-seq analysis

Week 7 (2/19, 2/21): Gene regulation, ChIP-seq

Week 8 (2/26, 2/28): ChIP-seq analysis

Week 9 (3/5, 3/7): Gene set enrichment analysis, **Midterm (3/7)**

**** Spring Break (3/11-3/15) ****

Week 10 (3/19, 3/21): Databases, Genome annotations and browsers

Week 11 (3/26, 3/28): Motif finding

Week 11 (4/2, 4/4): Open chromatin, Chromatin conformation capture

Week 13 (4/9, 4/11): micro-RNAs, analysis

Week 14 (4/16, 4/18): DNA Methylation, Genome-wide Association Studies (GWAS)

Week 15 (4/23, 4/25): Class presentations, review

Final (5/6, 2:00pm)

Reading and Resources

The Sakai system at UNC (<http://sakai.unc.edu>) will be used extensively to provide instructional material, assignments including student submission and grading of assignments. Reading will consist of relevant journal articles and web resources, and will be assigned through the Sakai system.

Grading

Grades for this course will reflect the ability of the student to master both the theoretical and practical aspects of this course. These will be assessed through in-

class quizzes, graded computer-based assignments, and a final exam or project. Late homework assignments will be penalized 10% a day, cumulatively. This means that an assignment three days late will be penalized 30%. Exceptions will be made by prior approval by instructor. Final grades will be computed as follows:

- Class attendance and participation (10%)
- Homework, quizzes (40%)
- Mid-term exam (20%)
- Final exam/Project (30%) – will include concepts from the whole semester.

A 10% grading scale will be used, meaning:

A	90% - 100%
B	80% - 89%
C	70% - 79%
D	60% - 69%
F	<60%

If a student misses a midterm, the weight of that midterm in the course grade will be added to the weight on the student's final. An exception will be made for University Approved Absences; students with this type of absence may request a make-up examination or equivalent assessment at a time convenient to both student and instructor.

Project in lieu of final exam

Students have the option of substituting a project in lieu of the final exam. The project may be performed individually or in a group of up to 4 students. The project should demonstrate an overall mastery of concepts from throughout the semester. A written proposal of the project, including participants and division of labor, must be submitted to the instructor no later than March 9th. Prior discussions with the instructor about project ideas is strongly encouraged. The instructor reserves the right to negotiate final project goals. The project deliverables will include:

- Overall project report (1 per project)
- Individual project report (1 per student if project includes multiple students)
- Class presentation (1 per project)

The overall project report should be approximately 10 pages and should clearly state the project goal, background information (rationale), methods, and results. The individual project reports should be approximately 3-4 pages and should clearly state the contribution of the student to the project, the relevance of the project to this class, and individual insights gleaned from this work. The class presentation does not have a set format, but should be 15-20 minutes in length and should clearly describe the rationale, methods, and results of the project.

Honor Code

Computational genomic research is, in general, highly collaborative and open. That being said, students need to learn to independently perform the work assigned in this class. Students are encouraged to help classmates understand general concepts and techniques learned in class, even related to homework assignments, but under no

circumstances should complete answers, computer code, or the like for homework be shared. Specific questions about individual homework assignments should be discussed with the professor.

The in-class exams will be open note, open computer, and open Internet, but must be completed independently by each student.

University Approved Absences

No right or privilege exists that permits a student to be absent from any class meetings, except for these University Approved Absences:

1. Authorized University activities
2. Disability/religious observance/pregnancy, as required by law and approved by [Accessibility Resources and Service \(ARS\)](#) and/or the [Equal Opportunity and Compliance Office \(EOC\)](#)
3. Significant health condition and/or personal/family emergency as approved by the [Office of the Dean of Students](#), [Gender Violence Service Coordinators](#), and/or the [Equal Opportunity and Compliance Office \(EOC\)](#).

Neither you nor the student are obligated to contact these offices if the information you have received from the student sufficiently meets the standards for a University Approved Absence. Written verification is not required.

Diversity Pledge

The Department of Biology values the perspectives of individuals from all backgrounds reflecting the diversity of our students. We broadly define diversity to include race, gender identity, national origin, ethnicity, religion, social class, age, sexual orientation, political background, and physical and learning ability. We strive to make this classroom and this department an inclusive space for all students.

Counseling and Psychological Services : CAPS is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: <https://caps.unc.edu> or visit their facilities on the third floor of the Campus Health Services building for a walk-in evaluation to learn more.

Accessibility Resources & Service : UNC-Chapel Hill facilitates the implementation of reasonable accommodations for students with learning disabilities, physical disabilities, mental health struggles, chronic medical conditions, temporary disability, or pregnancy complications, all of which can impair student success. See the ARS website for contact and registration information: <https://ars.unc.edu/about-ars/contact-us>

Syllabus Changes

The professor reserves the right to make changes to the syllabus, including project due dates and test dates. These changes will be announced as early as possible.