BIOL 525: Analysis and Interpretation of Sequence-based Functional Genomics
Department of Biology, University of North Carolina at Chapel Hill
Fall 2020

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Class Meeting Times: Tues/Thurs 1:15-2:30pm, Howell 115
Concurrent enrollment in lab class required
Final Project: Due Wed. Nov 18th, 12:00pm (end of final exam period)

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 an 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 methods, 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

You may also request a waiver from me for one or more of the above, based on other training or work experience that provides similar knowledge.

Weekly Topics

Week 1 (8/11, 8/13): Testing platforms for online learning; Big data genomic science

Week 2 (8/18, 8/20): Operating systems and linux; Sequencing technologies

Week 3 (8/25, 8/27): RNA-seq assay/Quality control (QC) analysis; Scientific papers

Week 4 (9/1, 9/3): DNA sequence alignment (STAR); Analysis of single RNA-seq samples

Homework 1 assigned

Week 5 (9/8, 9/10): TCGA, GTex Project; Genome Browsers/Databases

Week 6 (9/15, 9/17): Differential RNA-seq analysis

Homework 1 due (9/18); Homework 2 assigned

Week 7 (9/22, 9/24): Gene Ontology and Gene set/pathway enrichment analysis

Week 8 (9/29, 10/1): RNA-seq of Autism/Schizophrenia; Genome biology and gene regulation

Homework 2 due (10/2)

Week 9 (10/6, 10/8): Midterm (10/6); ChIP-seq

Project descriptions due (10/9)

Week 10 (10/13, 10/15): ChIP-seq analysis; Single-cell RNA-seq

Homework 3 assigned

Week 11 (10/20, 10/22): Motif finding; micro-RNAs, analysis

Week 12 (10/27, 10/29): Open chromatin, Chromatin conformation capture

Homework 3 due (10/30);

Week 13 (11/3, 11/5): DNA Methylation; Genome-wide Association Studies (GWAS)

Week 14 (11/10, 11/12): Crohn's disease presentation/example presentation; Class presentations

Week 15 (11/17): Class presentations

Final period: Class presentations

Final project written report due

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. For remote learning, we will be using zoom.

Grading

Your grade for this course will reflect your ability to master both the theoretical and practical aspects of this course. These will be assessed through graded computer-based assignments, a midterm, 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 (30%)
- Mid-term exam (20%)
- Final Project (40%)

A 10% grading scale will be used, meaning:

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

If you miss the midterm with a University Approved Absence (see below), the weight of the midterm in the course grade will either be added to the weight on the final project, or you may request a make-up examination or equivalent assessment at a time convenient to both you and me.

Final Project

All students are required to do a final project. 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 October 9th. We will discuss in class possible project ideas, using either publicly available data or data generated in a lab you are working in (with consent of the PI). 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 your contribution to the project, the relevance of the project to this class, and individual insights gleaned from this work. The class presentation should be 15-20 minutes in length and should clearly describe the rationale, methods, and results of the project. I will give an example presentation to demonstrate good practices in giving a scientific talk.

Honor Code
Computational genomic research is, in general, highly collaborative and open. That being said, I want each of you to learn to independently perform the work assigned in this class. I encourage you to help classmates understand general concepts and techniques we discuss in class, even related to homework assignments, but under no circumstances should you give complete answers, computer code, or the like for homework or exams. If you have specific questions about individual homework assignments, please discuss them with me.

The in-class exams will be open note, open computer, and open Internet, but you must complete them independently.

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
I reserve the right to make changes to this syllabus, including homework and project due dates and test dates, especially in during this atypical classroom environment that may slow our progress through material. These changes will be announced as early as possible.

Community Standards in Our Course and Mask Use.
This fall semester, while we are in the midst of a global pandemic, all enrolled students are required to wear a mask covering your mouth and nose at all times in our classroom. This requirement is to protect our educational community — your classmates and me — as we learn together. If you choose not to wear a mask, or wear it improperly, I will ask you to leave immediately, and I will submit a report to the Office of Student Conduct. At that point you will be disenrolled from this course for the protection of our educational community. An exemption to the mask wearing community standard will not typically be considered to be a reasonable accommodation. Individuals with a disability or health condition that prevents them from safely wearing a face mask must seek alternative accommodations through the Accessibility Resources and Service. For additional information, see Carolina Together.