Bioinformatics and Genomics
MCDB 5520 Course Syllabus
Spring 2020

Instructor: Dr. Edward Chuong

Course meeting: Tu/Thur 3:30-4:45pm, JSCBB (BIOT) B331

Office: JSCBB (BIOT) E232 (east campus, same building as class)

Instructions: 2nd floor JSCBB, go through E-wing double doors, and through E243 ('faculty huddle'), and my office is on the right.

Email: Edward.chuong@colorado.edu

Office hours: Thursday 2-3pm, or by appointment. Please e-mail me to let me know if you're coming. Exception- no office hours the week of Feb 12-14.

Course Content

This course aims to provide a survey of key concepts in bioinformatics and genomics. The course will cover bioinformatic algorithms and technological developments that have enabled the field of genomics. The course will include critical discussions of genomics studies in diverse fields of biology, including basic cell biology, evolution, population genetics, and human disease.

Rough schedule of the course:

- Bioinformatics and genome sequencing/assembly (weeks 1-3)
- Evolutionary and population genomics (weeks 4-6)
- Functional genomics (weeks 7-10)
- Cutting edge technologies (weeks 11-13)
- Student group presentations (weeks 14-15

A detailed schedule (including links to notes, readings, and assignments) will be updated as the course progresses.

Course prerequirements

The course is designed for graduate (MCDB 5520) or advanced undergraduate students (MCDB 4520) from diverse disciplines including biology/biochemistry, physiology, chemistry, engineering, and computer science. It is assumed that students are familiar with basic concepts in genetics (e.g., MCDB 2150) and molecular biology (e.g, MCDB 3135). Students should also be familiar with critically reading primary research papers. No programming experience is expected. Students without the recommended prereqs are should contact me as soon as possible to discuss whether the course is suitable.

Course web site

The course site on Canvas will contain lecture handouts, additional reading/video lectures, class announcements, homework, and quizzes.

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Required readings

There will be several required readings, from textbooks or recent primary literature, which will all be provided as PDFs on Canvas. Questions from these readings will be included in homework and quizzes. There is no required textbook for this course. Suggested "primers" on biology or computer science will provided for students with little to no background on these topics.

Grading

- Homework (30%)
- Quizzes (30%)
- Group project (30%)
- Attendance/participation (10%)

Homework (30%)

Homework is designed to help you learn and understand core concepts in genomics. Assignments will be announced in class and posted on canvas. Assignments will include questions from lecture materials or required reading, and bioinformatics exercises using online databases discussed in class (no prior programming experience required). Students are encouraged to discuss homework with each other, but you must work out the details of any solution completely on your own. Clearly acknowledge, ***in writing***, with whom you discussed, collaborated, or helped on the problem.

There will be 3 homework problem sets. Every homework will have two sections: a core section (required for all) and an advanced section (required for graduate students enrolled in MCDB 5520). Advanced sections may be completed by undergraduates (enrolled in MCDB 4520) for extra credit.

Quizzes (30%)

Quizzes are designed to encourage attending class and will draw from lectures and readings. We will have ~6 quizzes throughout the semester. Quizzes will be administered through Canvas and announced/opened on Tuesdays (at the end of class) and must be completed before beginning of class the following Thursday. The lowest quiz score will be dropped for the final grade.

Group Project (30%)

A group project will be assigned part-way through the course. Groups will consist of 3-4 students. To promote interdisciplinary discussion, groups are required to be composed of students from at least 2 different departments. The project will involve proposing a modification to a genomic algorithm or technology and applying this method to a research question. A detailed rubric will be provided and the project will consist of a written proposal and a 20 minute presentation at the end of the semester, which will be evaluated by your peers.

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Attendance/participation (10%)

All students are expected to be fully engaged in discussions, video content, and paying attention in class. To minimize distractions to other students, no texting, cell phone use, or laptop use for non-note taking purposes will be allowed. Attendance is taken randomly and student's participation in lectures, office hours, and discussions is roughly recorded. Students should come to class ready to discuss the assigned material. Participation in class is encouraged and will benefit students with borderline grades.

Related courses in computational biology

This course is focused on teaching fundamental concepts in the development and application of genomic technologies and will not require any programming. Students interested in genomics research are highly encouraged to learn basic Linux usage and programming (R, Python). Related, highly recommended courses in computational biology include:

- Biological Data Science (MCDB 3450)
- Statistical and Computational Analysis of the Human Genome (BCHM 4631/5631)
- Software Engineering for Scientists (MCDB 4100)
- Short-read workshop (2 weeks in the summer) by the Dowell and Allen labs, in BioFrontiers

Policies

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition or injury, see Temporary Medical Conditions under the Students tab on the Disability Services website.

Classroom Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Students are expected to be fully engaged in class, and no texting or laptop use for non-note taking purposes will be allowed. Those who fail to adhere to such behavioral

standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression,

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veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Code of Conduct.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. Please notify me as early as possible so that I can use your preferred name/pronoun. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the Honor Code Office website.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, intimate partner abuse (including dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting , and the campus resources can be found on the OIEC website.

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please notify me at least 2 weeks in advance of any conflict you may have and we will make every effort to accommodate.

See the campus policy regarding religious observances for full details.

Course Summary:

Detailed schedule

Thu Feb 6, 202	Quiz 1	due by 3:30pm
Thu Feb 27, 2020	Quiz 2	due by 3:30pm
"	Quiz 5	due by 11:59pm
Thu Apr 30, 2020	Quiz 3	due by 11:59pm
"	Quiz 4	due by 11:59pm

Detailed schedule
Group project
HGT discussion
Hwk 2 (ug)
Hwk1 (grad)
Hwk1 (ug)
Hwk2 (grad)
Participation
Peer review

Course syllabus located here (or click sidebar link)

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Required readings will be posted before the lecture, slides and assignments will be posted after the lecture. This is only a rough topic roadmap and the schedule is subject to changes throughout the semester based on timing and student interest.

From March 17 onwards, lecture will be on Zoom at the scheduled time: https://cuboulder.zoom.us/j/925825027

Week	Date	Topic	Reading	Assignments
	Jan 14	Course intro Brief history of genomics	Syllabus Optional/rlated Biology primer for computer scientists C value paradox	Compete student information survey (due before class, Jan 16)
	Jan 16	Genome sequencing technologies	Overview of sequencing methods	
	Jan 21	Genome Assembly	Human genome paper Suggested: OLC vs BDG review	
	Jan 23	Short read mapping	Suggested: Overview of short read alignment	Homework 1 assigned Due in class Feb. 4

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Week	Date	Topic	Reading	Assignments
	Jan 28	BWT review Global sequence alignment		
	Jan 30	Local sequence alignment and intro to BLAST		
	Feb 4	BLAST		QUIZ #1 (due Feb 6 before class) Student group assignments Group Project
	Feb 6	Genome annotation		
	Feb 11	Hidden Markov Models		
		Genome evolution/HGT Homework 1 key	Horizon transfer in cheese-associated bacteria	
	Feb 18	Gene evolution		
	Feb 20	Non-coding evolution		
	Feb 25	Functional genomics		Homework 2 assigned. Due in class March 10. Quiz #2 (due Feb 27 before class)

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Week	Date	Topic	Reading	Assignments
	Feb 27	Transcription factors	Feb 27	
	Mar 3	3D genome	Mar 3	3D genome
	Mar 5	Transcriptomics	Mar 5	Transcriptomics
	Mar 10	Transcriptome assembly and mapping		
	Mar 12	**CLASS CANCELED**		
	Mar 17	Differential Expression Slides Video		
	Mar 19	Cllustering Video Notes Youtube PCA explanation		
	Mar 24	**NO CLASS**		
	Mar 26	**NO CLASS**		
	Mar 31	Group discussion time		Quiz 3 posted. Due April 2 before class.
	Apr 2	Single cell genomics Slides Video		

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Week	Date	Topic	Reading	Assignments
	Apr 7	T-SNE Video Slides		Quiz 4 asigned Due April 9 before class.
	Apr 9	Genome engineering Video Kmeans notes Crispr slides		
	Apr 14	Group discussion time	Hwk 2 key Excel solver	Quiz 5 posted. Due April 16 before class
	Apr 16	Genomic medicine Slides		**Group project proposals due by email end of day April 20!**
	Apr 21	Student presentations **Groups 1 and 3**		
	Apr 23	Student presentations **Groups 4 and 5**		
	Apr 28	Student presentations **Groups 6,7,8**		
	Apr 30	Student presentations **Groups 9, 10, 2**		