JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Biomedical Engineering 580.447/647
Computational Stem Cell Biology
Spring, 2021 (3 credits, EQ)

Instructor
Associate Professor Patrick Cahan
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Office hours: Email me to set up time

Teaching Assistants
Kathleen Noller
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Ray Cheng
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Office hours: TBD

Meetings
Tuesday, Thursday, 12noon-1:15pm, https://wse.zoom.us/j/97931135911
Requires Johns Hopkins SSO authentication to join the meeting

Textbook
None

Online Resources
Please log in to Blackboard for all materials related to this course.

Course Information

- This course will provide the student with a mechanistic and systems biology-based understanding of the two defining features of stem cells: multipotency and self-renewal. We will explore these concepts across several contexts and perspectives, emphasizing seminal and new studies in development and stem cell biology, and the critical role that computational approaches have played. The course will start with an introduction to stem cells and a tutorial covering computational basics. The biological contexts that we will cover thereafter include "Cell Identity", "Pluripotency and multipotency", "Stem cells and their niche", "Modeling cell fate decisions", and "Engineering cell fate". This class is heavily weighted by individual computational assignments. The motivation for this strategy is that regularly occurring, moderately-sized computational projects

are the most efficient way to impart an understanding of our models of this extraordinary class of cells, and to inspire a sense of excitement and empowerment. Preferred background: familiarity with R and the UNIX shell.
- **Recommended Background:** EN.580.151 – Structural Biology of Cells, or equivalent.

Course Goals

This course will address the following Criterion 3 Student Outcomes
- An ability to apply knowledge of mathematics, science and engineering to solve problems related to stem cell engineering
- An ability to analyze and interpret data using statistical, computational or mathematical methods
- An ability to function on multidisciplinary teams (Criteria 3(d))
- An understanding of professional and ethical responsibility (Criteria 3(f))
- An ability to communicate effectively (writing) (Criteria 3(g))
- An ability to communicate effectively (oral presentation) (Criteria 3(g))

Course Topics

- Cell identity
- Pluripotency
- Gene regulatory networks
- Cell fate engineering
- Single cell transcriptomics

Course Expectations & Grading
Students will be evaluated based on five short computational projects and one final project that collectively count 2/3 of the final grade and weekly quizzes that count 1/3 of the final grade. There is no mid-term or final exam. Quizzes are given at the beginning of Tuesday meetings and cover material presented the prior week. We drop the two lowest quiz scores. Projects 1-5 are due 11 days after being posted. Students are given a total of 3 days to hand in a project after the deadline. This extension of three days applies over the whole semester. In other words, you do not get three late days per project. You get three late days in total. Every day thereafter will reduce the score by one letter grade. The first 5 projects will be completed individually. The final project is a team effort of 2-3 students. It is worth twice the points as the other projects, and it will entail a presentation at the end of the semester.

Assignments & Readings
Posted on Blackboard

Ethics
The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices,

unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. In addition, the specific ethics guidelines for this course are:
(1) Projects 1-5 are to be completed by each student alone. Do not discuss or share your projects with other students or use material from prior years.
Report any violations you witness to the instructor. You can find more information about university misconduct policies on the web at these sites:

- For undergraduates: http://e-catalog.jhu.edu/undergrad-students/student-life-policies/
- For graduate students: http://e-catalog.jhu.edu/grad-students/graduate-specific-policies/

Key Dates

Week	Day	Date	Quiz	Lecture #	Lecture topic
1	Tues	1/26/2021		1	Introduction
1	Thurs	1/28/2021		2	Cell identity
	Mon	2/1/2021			**Project 1 posted**
2	Tues	2/2/2021	Q	3	R primer
2	Thurs	2/4/2021		4	Classification methods
3	Tues	2/9/2021	Q	5	Pluripotency
3	Thurs	2/11/2021		6	Pluripotency
	Fri	2/12/2021			**Project 1 due**
	Mon	2/15/2021			**Project 2 posted**
4	Tues	2/16/2021	Q	7	RE:IN
4	Thurs	2/18/2021		8	Gene regulatory networks
5	Tues	2/23/2021	Q	9	Cell fate engineering: Reprog
5	Thurs	2/25/2021		10	Cell fate engineering: Comp
	Fri	2/26/2021			**Project 2 due**
	Mon	3/1/2021			**Project 3 posted**
6	Tues	3/2/2021	Q	11	Cell fate engineering: Differentiation
6	Thurs	3/4/2021		12	Cell fate engineering: New approaches
7	Tues	3/9/2021	Q	13	Single cell technologies
7	Thurs	3/11/2021		14	Single cell analysis: basics (Kathleen Noller TA lecturer)
	Fri	3/12/2021			**Project 3 due**
	Mon	3/15/2021			**Project 4 posted**
8	Tues	3/16/2021	Q	15	Single cell analysis: classification (Yuqi Tan Guest lecturer)
8	Thurs	3/18/2021		16	Trajectory inference
9	Tues	3/23/2021	Q	17	RNA velocity (Ray Cheng TA lecturer)
9	Thurs	3/25/2021		18	sc CFE
	Fri	3/26/2021			**Project 4 due**
	Mon	3/29/2021			**Project 5 posted**
10	Tues	3/30/2021			NO CLASS
10	Thurs	4/1/2021			sc GRN (Emily Su Guest lecturer)
	Mon	4/5/2021			**Project 6 posted**
11	Tues	4/6/2021	Q	19	cell-cell/cell-niche interactions; spatial transcriptomics
11	Thurs	4/8/2021		20	Predicting fate potential
	Fri	4/9/2021			**Project 5 due**
12	Tues	4/13/2021	Q	21	Cell-based modeling
12	Thurs	4/15/2021		22	Lineage tracing
13	Tues	4/20/2021	Q	23	Stem cell controversies
13	Thurs	4/22/2021			NO CLASS
	Mon	4/26/2021			**Project 6 due**
14	Tues	4/27/2021			P6 presentations
14	Thurs	4/29/2021			P6 presentations

Personal Well-being

- If you are sick, in particular with an illness that may be contagious, notify me by email but do not come to class. Rather, visit the Health and Wellness: 1 East 31 Street, 410-516-8270. See also http://studentaffairs.jhu.edu/student-life/support-and-assistance/absences-from-class/illness-note-policy/
- All students with disabilities who require accommodations for this course should contact me at their earliest convenience to discuss their specific needs. If you have a documented disability, you must be registered with the JHU Office for Student Disability Services (385 Garland Hall; 410-516-4720; http://web.jhu.edu/disabilities/) to receive accommodations.
- If you are struggling with anxiety, stress, depression or other mental health related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out our services. The Counseling Center is located at 3003 North Charles Street in Suite S-200 and can be reached at 410-516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter/