JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Biomedical Engineering 580.447/647
Computational Stem Cell Biology
Spring, 2019 (3 credits, EQ)

Instructor
Assistant Professor Patrick Cahan
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Office: School of Medicine Miller Research Building, Rm 653
Office hours: Mondays 9:00–11:00 am and by appointment

Teaching Assistant
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Office hours: Tuesdays 1:30-2:30pm

Meetings
Tuesday, Thursday, 12-1:15pm, Krieger 300

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 the UNIX shell.

- **Recommended Background:** EN.580.221 - Molecules and 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 six computational projects (2/3 of the final grade) and weekly quizzes (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 three lowest quiz scores. Projects are due two weeks 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

Key Dates

Assignment due dates are listed on Blackboard. Listed below is a tentative schedule of lecture topics.

Day	Date	Quiz	Lecture topic
Tues	1/29/2019		Introduction
Thurs	1/31/2019		Cell identity
Mon	2/5/2019		**Project 1 available**
Tues	2/5/2019	Q	Classification methods
Thurs	2/7/2019		R primer
Tues	2/12/2019	Q	Pluripotency
Thurs	2/14/2019		RE:IN
Satuday	2/16/2019		**Project 1 due**
Monday	2/18/2019		**Project 2 available**
Tues	2/19/2019	Q	Pluripotency
Thurs	2/21/2019		Gene regulatory networks
Tues	2/26/2019	Q	Gene regulatory networks
Thurs	2/28/2019		Cell fate engineering
Saturday	3/2/2019		**Project 2 due**
Monday	3/4/2019		**Project 3 available**
Tues	3/5/2019		SOM Guest lecture
Thurs	3/7/2019	Q	Cell fate engineering
Tues	3/12/2019	Q	Cell fate engineering
Thurs	3/14/2019		Single cell technologies
Saturday	3/16/2019		**Project 3 due**
Tues	3/19/2019		SPRING BREAK
Thurs	3/21/2019		SPRING BREAK
Monday	3/25/2019		**Project 4 available**
Tues	3/26/2019	Q	Single cell analysis basics
Thurs	3/28/2019		Single cell analysis basics
Tues	4/2/2019	Q	Single cell analysis classification
Thurs	4/4/2019		Trajectory inference
Saturday	4/6/2019		**Project 4 due**
Monday	4/8/2019		**Project 5 available**
Tues	4/9/2019	Q	Trajectory inference
Thurs	4/11/2019		RNA Velocity
Tues	4/16/2019	Q	RNA Velocity
Thurs	4/18/2019		cell-cell interaction
Saturday	4/20/2019		**Project 5 due**
Monday	4/22/2019		**Project 6 available**
Tues	4/23/2019	Q	cell-cell interaction
Thurs	4/25/2019		sc GRN
Tues	4/30/2019	Q	sc GRN
Thurs	5/2/2019		Final project presentations
Saturday			**Project 6 due**
	Date TBD		Final project presentations

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/

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/