ILLINOIS

BIOENGINEERING

BIOE 498/598: Stem Cell Bioengineering

Meeting time: Tuesdays and Thursdays, 12:30 – 1:50 PM
Location: 305 Materials Science and Engineering Building

Credit hours: 3 (498), 4 (598)
Semester: Spring 2018

Instructor Information

Name	Dr. Shannon J. Sirk
Contact Info	sirk@illinois.edu
Office Location	1107 IGB
Office Hours	Weds, 2-4pm

TA Information

Name	Max Simon
Contact Info	msimon10@illinois.edu
Office Location	TBD
Office Hours	TBD

Course Description

Students will explore concepts surrounding the field of stem cell biology, with a focus on applying engineering approaches for quantitative analysis in areas such as stem cell genetics, stem cell microenvironments, and stem cell manufacturing. Students will also investigate design principles underlying stem cell-based therapies and diagnostics. Critical analysis of scientific findings will be facilitated through instructor-led lecture as well as student-led literature discussions. Assignments, exams, and in-class activities will focus on critical analysis and thoughtful evaluation of data and conclusions, as well as effective written and oral communication skills.

Required Textbook

None. Assigned reading material will be posted online and may include, but is not limited to, the following: primary research papers, review articles, and book chapters.

Course Objectives

- apply knowledge of mathematics, science, and engineering to identify, formulate, and solve engineering problems in stem cell biology
- understand and implement the design of logical and meaningful experiments, including appropriate controls
- utilize primary literature, review articles, and other reputable scientific resources to understand a research topic and develop research goals
- interpret and critically evaluate data and effectively communicate technical details, data interpretation, and experimental conclusions in both written and oral formats
- understand contemporary issues, including professional and ethical responsibility, in stem cell bioengineering,
- function in multidisciplinary teams

Course Policies

- **Attendance:** Students are expected to attend every class, with the exception of pre-authorized absences or unavoidable emergencies. Midterms will include information covered during in-class discussions. Makeup work will not be accepted for missed in-class assignments.
- **Course-related communications:** Course announcements will be sent out via the class roster; please check your email regularly. For general course questions and information, please first consult the syllabus and course website. If your question/issue is still not answered/addressed, please email ***both*** Prof. Sirk and TA Max Simon. Whomever responds first will cc the other, and we will make every effort to reply promptly.
- **Academic integrity:** *I take academic integrity, and ethical behavior in general, very seriously.* Please be familiar with the UIUC student code regarding cheating, plagiarism, fabrication, facilitating infractions, bribes/favors/threats, and academic interference. In this course, all submitted work must be your own – you may discuss, you may not copy (words or ideas).
- **Laptops and mobile devices:** Mobile devices should be on silent and out of sight during class. Laptops may be used for course-related tasks, e.g., to take notes or investigate relevant topics. If you choose to use class time to do anything that may be disruptive or distracting to other students, please sit in the back.

- **Diversity statement:** The diversity of the participants in this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued for any reason, please speak with me privately or contact the department if you wish to remain anonymous.

Grading

Percent values of total grade for each course component are shown in italics

- **In-class activities:** Periodic assessments of comprehension; attendance required.
  498 – 7.5% 598 – 7%

- **Homework:** Short answer assignments based on reading, due at beginning of class on specified days.
  498 – 7.5% 598 – 7%
  598-only additional homework assignments – 7%

- **Group paper presentation:** Randomly assigned groups of 3-4 students will lead class discussion of assigned primary literature stem cell research paper. Detailed guidelines will be posted online and discussed in class.
  498 – 10% 598 – 9%

- **Two midterms:** Closed-book exams during normal lecture period.
  498 – 25% 598 – 23.5% Midterm 1
  498 – 25% 598 – 23.5% Midterm 2

- **Project:** Self-assembled groups of 3-4 students will select a topic from a list posted online, and complete a project related to stem cells. Students will present their project to the class Detailed guidelines will be posted online and discussed in class.
  498 – 12.5% 598 – 11.5% Oral presentation
  498 – 12.5% 598 – 11.5% Written report

Schedule

WEEK	DATE	TOPIC	ASSIGNED READING	HOMEWORK DUE
1	1/16	**Lecture 1** Course overview and introduction to stem cell bioengineering		
	1/18	**Lecture 2** Identifying and isolating stem cells		
2	1/23	**Discussion 1** Prof. Sirk – Example paper and demonstration of format	**Eriksson_Nat Med_1998** Neurogenesis in the adult human hippocampus	
	1/25	**Lecture 3** Stem cell population dynamics	*Additional reading* **Peerani_EMBO J_2007** Niche-mediated control of embryonic stem cell self-renewal and differentiation	
3	1/30	**Discussion 2** *(Stefan Gentile, Chih-Chung Chen, Do Yeon Kim, Nivetha Gunaseelan)*	**Leushacke_Cell Rep_2013** Lgr5+ gastric stem cells divide symmetrically to effect epithelial homeostasis in the pylorus *Additional reading* **Snippert_EMBO Rep_2011** Tracking adult stem cells	

	2/1	**Lecture 4** Reprogramming		
4	2/6	**Discussion 3** *(Hamza Ahmed, Jingwei Zhang, Silpa Gali)*	**Abad_Nature_2013** Reprogramming *in vivo* produces teratomas and iPS cells with totipotency features	
	2/8	**Lecture 5** Epigenetics and karyotype		HW 1 due in class
5	2/13	**Discussion 4** *(Victoria Barnhouse, Shabnam Bonyadi, Jonathan Heideman, Benjamin Liang)*	**Lister_Nature_2011** Hotspots of aberrant epigenomic reprogramming in human induced pluripotent stem cells	
	2/15	**Lecture 6** Genomics-scale and single-cell analyses		HW 2 due in class
6	2/20	**Discussion 5** *(Elija Karvelis, Priya Patel, Wenjie Liu)*	**White_PNAS_2011** High-throughput microfluidic single-cell RT-qPCR	598 extra HW 1 due in class
	2/22	**Group project guidelines** **Midterm review**	(Project guidelines slides) (Midterm topics to review)	
7	2/27	**Midterm #1**		
	3/1	**Lecture 7** Stem cell microenvironments: niche-mediated regulation		
8	3/6	**Discussion 6** *(Dominic Demma, Reema Patel, Jad Maamari, Priya Soni)*	**Hartwell_Nat Chem Biol_2013** Niche-based screening identifies small-molecule inhibitors of leukemia stem cells	Group Project topic selection
	3/8	**Lecture 8** Microenvironmental signal		
9	3/13	**Discussion 7** *(Jacob Beal, Isamar Pastrana-Otero, Monica Muthaiya)*	**Soen_Mol Syst Biol_2006** Exploring the regulation of human neural precursor cell differentiation using arrays of signaling microenvironments	
	3/15	**Lecture 9** Mechanical forces	*Additional reading* **Fu_Nat Methods_2010** Mechanical regulation of cell function with geometrically modulated elastomeric substrates	HW 3 due in class
10	3/20	*Spring Break*		
	3/22	*Spring Break*		

11	3/27	**Discussion 8** *(Karla Ramos-Cruz, Christine Lannon, Erin Tevonian, Matthew Tang)*	**Gilbert_Science_2010** Substrate elasticity regulates skeletal muscle stem cell self-renewal in culture	
	3/29	**Lecture 10** Engineered *in vitro* platforms		598 extra HW 2 due in class
12	4/3	**Discussion 9** ***(****Michael Israel, Daniel Hong, Michael Gleason)*	**Toh_Integr Biol_2011** Spatially organized in vitro models instruct asymmetric stem cell differentiation	
	4/5	**Lecture 11** Scale-up biomanufacturing		
13	4/10	**Discussion 10** *(Alessandra Garcia, Yi Wen, Jonathan Chang, Daniel Capua)*	**Cutler_Blood_2013** Prostaglandin-modulated umbilical cord blood hematopoietic stem cell transplantation	HW 4 due in class
	4/12	**Lecture 12** Transplantation and drug screening	(Midterm topics to review)	HW 5 due in class
14	4/17	**Midterm #2**		
	4/19	**Group project discussions** *Attendance required*		
15	4/24	**Project presentations** Groups 1, 2, 3		
	4/26	**Project presentations** Groups 4, 5, 6		
16	5/1	**Project presentations** Groups 7, 8, (9)		
	5/3	*NO CLASS*		
Finals Week	5/10	**Final written report due:** Thurs, 5 pm		