USC Viterbi School of Engineering

BME 406 Introduction to Bioengineering in Medicine

Units: 3
Term—Day—Time: Spring, MW, 3:30-4:50pm

Location: TBD

Instructor: Keyue Shen
Office: DRB 316
Office Hours: MW 2:00-3:00pm
Contact Info: keyue.shen@usc.edu, Office: 213-740-0380.
Timeline for replying to emails/calls: within 48 hours.

Teaching Assistant:
Office: TBD
Office Hours: TBD
Contact Info: TBD

Course Description

Bioengineering concepts and technologies applied to cancer diagnosis, drug discovery, immunotherapeutic development, and mechanistic research.

Expanded Course Description

The next generation of biomedicine development will be fueled by technological advances in bioengineering field. Bioengineering offers unique abilities in understanding cell-cell and cell-microenvironment communications from subcellular, cellular, to tissue, organ, and whole-body levels in disease progression and tissue regeneration, through engineered biomimicry systems matching the length scale phenomena in living systems. It also provides tools and platforms that accelerates drug discoveries and enable cellular functions unattainable through conventional approaches. This course will use up-to-date research progresses, clinical translations, and commercialization to introduce students exciting applications of engineering approaches in medicine, including micro- and nano-technologies, microscopy and single-cell techniques, materials and surface chemistry, in understanding fundamental biological mechanisms as well as therapeutic development, using cancer and immunotherapy as examples and model systems. It will also acquaint students with concepts in pathology and histological techniques as well as animal disease models in biomedical research. This course is designed for undergraduate students who are interested in contemporary bioengineering research and therapeutic development, as well as pursuing pharmaceutical or industrial positions related to cellular and molecular bioengineering.

Learning Objectives

Students will learn:

- The current trends of bioengineering techniques and their applications.
- The basic concepts of body system and pathology, and how bioengineering techniques transform these areas.
- The basic concepts of the bioengineering technologies used for constructing and observing the micro- and nanoscale physiological and pathophysiological processes
- The major challenges and focal areas in cancer and immune system bioengineering
- The translation of bioengineering innovations from bench to bedside and biomedical industry.

Recommended Preparation: General cell biology (e.g. BISC 220) and chemistry (e.g. CHEM 105a).

Course Notes

Copies of lecture slides and other class information will be posted on Blackboard.

Technological Proficiency and Hardware/Software Required

Course materials (syllabus, lecture slides, homework assignments, etc.) will be available through Blackboard (http://blackboard.usc.edu/)

Supplementary Materials

The course recommends the following textbooks (not required):

- Fundamentals of Microfabrication and Nanotechnology, 3rd edition, Volume II (Manufacturing Techniques for Microfabrication and Nanotechnology), by Marc J. Madou, CRC Press, 2011 (can be purchased on Amazon.com or other online/brick-and-mortar bookstores)
- The Biology of Cancer, 2nd edition, by Robert A. Weinberg, Garland Science, 2013 (can be purchased on Amazon.com or other online/brick-and-mortar bookstores)
- Cellular and Molecular Immunology, 8th edition, by Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, Saunders, 2014. (available electronically through USC library)

Additional reading materials will be provided through Blackboard.

Description and Assessment of Assignments

Homework (100 points total): There will be four homework sets which will be assigned a week before they are due. All questions will be analytical, based on research questions and techniques/concepts introduced in the class. The assessment will be on the identification of fundamental concepts learned in the class in a real-world research question and/or application. Assignments are due on the specified date at the beginning of class.
Quizzes (100 points total): There will be 4 randomly assigned in-class quizzes at the beginning or the middle of the class. Quizzes are on the concepts introduced in the current or recent lectures. Quizzes are due in the class. There will be no make-up quizzes.

Midterm Exam (100 points total): A midterm exam will cover the topics up to the midterm and will be assigned and due in class. There will be no make-up exam. The midterm includes:
1) True or false (30 points)
2) Analytical questions (70 points)

Article Reading and in-class Presentation/Discussion (100 points total): 5~6 Teams of students (two students/team, up to 3 in case of odd-number enrollment) will be assembled to discuss research articles (based on a typical enrollment of 10 to 12 students). Prof. Shen will introduce the overall background of the covered areas in the first 45 minutes, followed by a team of two presenters in each class. The presentation will be 20 minutes with PowerPoint slides + 15 minutes of discussion. Presentations will be evaluated by Prof. Shen, with the following criteria and weight (subtotal of 50 points):
1) Background: introduction of the field, problem, and significance (30%)
2) Research: key bioengineering techniques used, and results (20%)
3) Discussion: the limitations and potential applications (10%)
4) Moderating discussion: prepare two questions for audience and guide the discussion (20%)
5) Organization of the presentation and teamwork (20%)

The rest of the students (non-presenters) will write a 1-page summary (1" margin, 12pt Arial, single spaced) of the article (subtotal of 50 points for all the non-presenter articles, on average 10~12.5 points per article depending on enrollment), due at the beginning of each class. The presenters does not need to submit the 1-page summary for the paper they present. For the non-presenters. The grading will be based on:
1) Identification of research question, bioengineering methods, and key results (60%)
2) Listing one significant follow-up research question or potential translational application (30%)
3) Formatting and delivery (10%)

Final Exam (100 points total): A final exam will cover the topics taught throughout the semester and will be assigned and due in the designated timeslot of the final week. There will be no make-up exam. The final exam includes:
1) True or false (30 points)
2) Analytical questions (70 points)

Grading Breakdown

Assignment	**Points**	**% of Grade**
Homework 1-4	100	30
Quizzes 1-4	100	10
Midterm exam	100	20
Article reading and discussion	100	20
Final exam	100	20
Total		100

Grading Scale (Example)

Final letter grades will be based on the average (AVG) and standard deviation (SD) of the accumulated scores of the class.

Range definition	Letter grade
A:	>= AVG+1*SD
A-:	>=AVG, but <AVG+1*SD
B+:	>=AVG-1*SD, but <AVG
B:	>=AVG-2*SD, but <AVG-SD
B-:	>=AVG-3*SD, but <AVG-2*SD
C:	<AVG-3*SD

Assignment Submission Policy

Assignments are due one week after being assigned, at the beginning of the class. Quizzes and exams are due in class.

Grading Timeline

Gradings are provided within one week of submission.

Additional Policies

Late homework, exams, and project reports will only be accepted in cases of extreme extenuating circumstances, and permission should be obtained from the instructor before the deadline. Otherwise, points will be reduced by 10% each hour it is late. All the regrading requests for homework or exams are due within one week of their return to the students. The requester must type or write clearly an explanation for the regrade and submit it to Prof. Shen with the original assignment.

Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Readings & Homework	Due Dates
Week 1	Introduction and course plan Body system and diseases		
Week 2	Histopathology and next-generation molecular techniques Cellular length-scale I – micro-engineering technologies	Articles assigned	
Week 3	**No class (Labor day)** Cellular length-scale II – microfluidics and patterning	HW1 assigned	
Week 4	Subcellular length-scale I – nano-deliveries Subcellular length-scale II – nano-devices		HW1 due
Week 5	Seeing is believing I – microscopy concepts Seeing is believing II – resolving molecular/cellular features		article presentations
Week 6	Single-cell technologies Cell-materials interface	HW2 assigned	
Week 7	Animal models and in vivo technologies Introduction to cancer I – origin and diagnosis		HW2 due
Week 8	Introduction to cancer II – progression Engineering epithelial morphogenesis and carcinogenesis		article presentations
Week 9	**Midterm exam** **No class (Annual BMES Conference)**		
Week 10	Engineering onco-transformation and chemo-resistance Engineering tumor microenvironment		
Week 11	Engineering invasion and metastasis Capturing circulating tumor cells	HW3 assigned	
Week 12	Immune system – a historical and evolutionary view Immune system – cellular and molecular machineries		HW3 due
Week 13	Cancer immunity and immunotherapy Immune cell biomanufacturing and chimeric antigen receptor		article presentations
Week 14	Engineering immune cell crosstalk **No class (Thanksgiving)**	HW4 assigned	
Week 15	Photo-immunotherapy and cancer vaccine Cell-surface engineering		HW4 due
FINAL	**Final exam**		

Statement on Academic Conduct and Support Systems

Academic Conduct:
Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/scampus-part-b/. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems:
Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. https://engemannshc.usc.edu/counseling/

National Suicide Prevention Lifeline - 1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. https://engemannshc.usc.edu/rsvp/

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: http://sarc.usc.edu/

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. https://equity.usc.edu/

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. https://studentaffairs.usc.edu/bias-assessment-response-support/

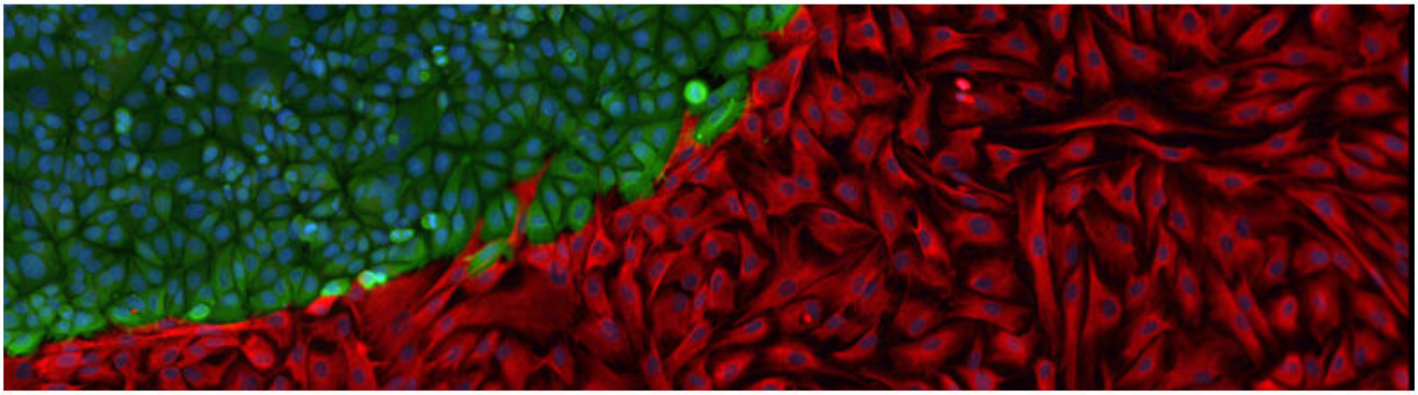
The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. http://dsp.usc.edu

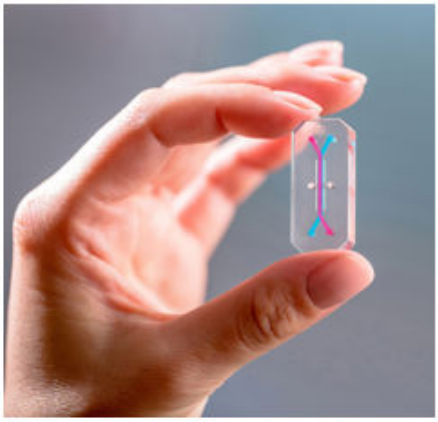
Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/

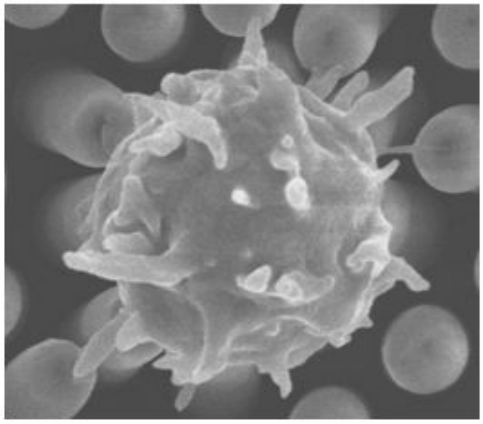
Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. https://diversity.usc.edu/

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, http://emergency.usc.edu

USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.
Provides overall safety to USC community. http://dps.usc.edu







FALL 2018

BME 406: INTRODUCTION TO BIOENGINEERING IN MEDICINE

Mondays and Wednesdays, 3:30~4:50 pm

Learn about bioengineering concepts and technologies applied to cancer diagnosis, drug discovery, immunotherapy, and basic research.

- **Current trends in bioengineering techniques**
- **Health and disease at micro- & nano-scales**
- **Innovations in cancer and immune system bioengineering**
- **Translation from bench to bedside & industry**