PRELIMINARY SYLLABUS – Subject to change

USC Viterbi School of Engineering

BME 406 Introduction to Bioengineering in Medicine

Units: 4

Term—Day—Time: Spring, MW, 2:00-3:50pm

Location: TBD

Instructor: Keyue Shen
Office: DRB 316
Office Hours: MW 1-2pm
Contact Info: keyue.shen@usc.edu, Office: 213-740-0380.
Timeline for replying to emails/calls: within 48 hours.

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

Course Description

Bioengineering concepts and technologies applied to cancer diagnosis, drug discovery, immunotherapeutic development, STEM CELL TECHNIQUES AND THERAPIES, 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 bioengineering, immune system bioengineering, and STEM CELL 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 five 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.

Midterm Exam (100 points total): A midterm exam will cover the topics up to the midterm. The midterm will be assigned and due during the Monday class of week 9. 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 Teams of students (three students/team) will be assembled to discuss research articles (based on a typical enrollment of 15 students; more students will be assigned to each group under higher enrollment). Prof. Shen will introduce the overall background of the covered areas in the first 60 minutes, followed by a team of presenters in each class. The presentation will be 30 minutes with PowerPoint slides + 20 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%)

All the students (including the presenters) will write a 1-page summary (1" margin, 12pt Arial, single spaced) of the article (subtotal of 50 points for all the articles, on average 10 points per article), due at the beginning of each class. 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)

THE STUDENTS SHOULD EXPECT, ON AVERAGE, ROUGHLY 8 HOURS OF OUTSIDE-OF-CLASS WORK PER WEEK.

Grading Breakdown

Assignment	**Points**	**% of Grade**
Homework 1-5	100	25
Midterm exam	100	25
Article reading and discussion	100	25
Final exam	100	25
Total		100

Grading Scale

Course final grades will be determined using the following scale

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Submission Policy

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

Grading Timeline

Gradings are provided within two weeks of submission.

Additional Policies

Late homework and journal club summaries 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.

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Course Schedule: A Weekly Breakdown

(HW: homework; JC: journal club)

	Topics/Daily Activities	**Readings & Homework**	**Due Dates**
Week 1	Introduction and course plan Introduction to body system and diseases		
Week 2	**No class (Labor day)** Histopathology and next-generation molecular pathology	Articles assigned	
Week 3	Cellular length-scale I – fundamentals of micro-engineering Cellular length-scale II – microfluidics and micropatterning	HW1	
Week 4	Subcellular length-scale – nano-deliveries and nano-devices Seeing is believing – microscopy concepts and techniques		JC1 HW1 due
Week 5	Flow cytometry and single-cell genomic and proteomic techniques Biomaterials and cell-materials interface		JC2
Week 6	Animal models and in vivo technologies Introduction to cancer I – origin and diagnosis	HW2	
Week 7	Introduction to cancer II – progression and therapeutic challenges Engineering epithelial morphogenesis and carcinogenesis		HW2 due JC3
Week 8	**Midterm exam (Monday)** **No class (Wednesday) (Annual BMES Conference)**		
Week 9	Engineering onco-transformation and chemo-resistance Engineering tumor microenvironment and cancer invasion	HW3	
Week 10	Engineering metastasis and capturing circulating tumor cells Immune system – a historical and evolutionary view		HW3 due JC4
Week 11	Immune system – cellular and molecular machineries Cancer immunity and immunotherapy	HW4	
Week 12	Immunobioengineering and chimeric antigen receptor T cells Immune cell crosstalk AND BIOMANUFACTURING		HW4 due
Week 13	ENGINEERING ADAPTIVE IMMUNITY AND CANCER VACCINE INTRODUCTION TO STEM CELLS		JC5
Week 14	ORGANOIDS AND IN VITRO ORGAN DEVELOPMENT **No class (Thanksgiving)**	HW5	
Week 15	STEM CELL-SURFACE ENGINEERING AND THERAPY STEM CELL REPROGRAMMING AND GENE THERAPY		HW5 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" 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, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following *protected characteristics*: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710

uscsa.usc.edu

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101

diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu

Non-emergency assistance or information.