

# Engineering Biomaterials

## 27-411, 42-411 (U, 9 Units)

## 27-709, 42-611 (G, 12 Units)

**Instructor:** Prof. Christopher Bettinger

### Contact Information

Office Hours: W 1:30-3:30PM  
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### Course Assistants

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**Lectures:** MW 11:30AM-1:30PM, Wean Hall 5409

**Pre-requisites:** 06-221 or 24-221 or 27-215, or equivalent. Junior or Senior in CIT, or permission of instructor. Instructor has final permission on student enrollment.

**Description:** This course will cover structure-processing-property relationships in biomaterials for use in medicine. This course will focus on a variety of materials including natural biopolymers, synthetic polymers, and soft materials with additional treatment of metals and ceramics. Topics include considerations in molecular design of biomaterials, understanding cellular aspects of tissue-biomaterials interactions, and the application of bulk and surface properties in the design of medical devices. This course will discuss practical applications of these materials in drug delivery, tissue engineering, biosensors, etc.

### Teaching Objectives:

A student who completes this course will be able to:

1. Understand engineering aspects of biomaterials.
2. Devise strategies to characterize properties of biomaterials.
3. Quantify various aspects of cell- and tissue-biomaterials interactions.
4. Integrate knowledge of materials properties and biological responses for rational design of biomaterials for medical applications.

### Responsibilities of the Instructor:

- Start/End Lectures *on time*.
- Create a learning environment that encourages instructor-peer and peer-peer interactions.
- Accurately assess the student's knowledge through appropriate evaluation methods.
- Return assignments and quizzes in a timely fashion

- Respond to emails within 24 hours during the work week (48 hours on the weekend). ***Students must type "411" in the subject line when addressing the instructor or CAs.*** Failure to do so may lead to a delayed response.

### **Responsibilities of the Student\*:**

- Attend lecture ready to listen, engage, and participate.
- Arrive on time to all classroom activities.
- Turn in all assignments on time and with one's best effort.
- Promote a distraction-free classroom environment through:
  - i. NOT using cell phones during classroom activities.
  - ii. NOT using laptops, etc. during classroom activities.
- Inform the instructor if there is any meaningful potential conflict, issue, or concern regarding the course or its participants.
- Turn in "Feedback Cards" at the end of select lectures.

*\*Observation of these policies (or lack thereof) may impact the student's grade via the class participation component (both positively and negatively).*

### **Course Textbook(s):**

**Required:** Biomaterials Science: An Introduction to Materials in Medicine. 2nd ed. Burlington, MA: Academic Press, 2004. ISBN: 9780125824637

**Other Useful Textbook(s):**

- Principles of Colloid and Surface Chemistry. 1997. 3<sup>rd</sup> Ed. Hiemenz and Rajagopalan. (QD549.H53 1997)
- Receptors. 1993. Lauffenburger & Linderman. (ISBN-13: 978-0195106633)

**Additional Materials:** Select course notes, slides, reading, and examples will be placed on Blackboard @ <http://www.cmu.edu/blackboard>. ***Handwritten notes created during lecture will not be placed online.***

### **Reading Assignments:**

- Recommended readings from the text will be assigned appropriately.
- Select readings will also be drawn from recent literature.

### **Homework Assignments:**

- There will be a total of 7 homework assignments distributed on a weekly to bi-weekly basis (approximately).
- Homework must be turned into the instructor before the start of class on due dates.
- Students may discuss homework sets with other students. However, students must write up their own solutions and must disclose any group discussions/collaborations.

### **Quizzes:**

- There will be three 60-minute in class quizzes.
- Quizzes will be closed book, and closed notes with the exception of one 8.5x11 sheet of paper with hand written notes front and back (2 sides, 1 sheet).

**Graduate Project:**

- Students enrolled in 27-709 and 42-611 will complete a mandatory project in the area of the design and evaluation of a new biomaterial for an implantable medical device.
- Projects will be completed in groups of no more than 3 students.
- Project topics will be assigned after Quiz 1.
- *Projects will be due the LAST DAY OF CLASS.*

**Grading Metric:****Grade Scale (411)\***

A = 90-100  
 B = 80-90  
 C = 70-80  
 D = 50-70  
 R < 50

Component	Weighting
Homework (7)	14% total (Equally weighted)
Quizzes (3)	75% total (25% each)
Class Participation	11%

**Grade Scale (611/709)\***

A = 90-100  
 B = 80-90  
 C = 70-80  
 D = 50-70  
 R < 50

Component	Weighting
Homework (7)	14% total (Equally weighted)
Quizzes (3)	60% total (20% each)
Project	15%
Class Participation	11%

**\*Note:** *There will be +/- modifiers (i.e. A-, B+) for graduate students. Graduate students will be graded on a separate scale from undergraduate students.*

**Late Submission and Rescheduling Policy:**

- Homework: <= 24 hrs late, 50% penalty. >24 hrs late, zero credit.
- In rare cases (medical, family emergency, etc.) and with prior notification, the quizzes may be rescheduled at the discretion of the instructor.

**Cheating and Plagiarism Policy:**

- Gross reproduction of work from colleague or external source without credit.
- Misrepresentation of your work as original.
- See also [http://www.studentaffairs.cmu.edu/acad\\_integ/acad\\_integ\\_text.html](http://www.studentaffairs.cmu.edu/acad_integ/acad_integ_text.html)
- Handling of suspicions will be handled by the course instructor.

**Special Learning Situations:**

- Please alert the instructor and CAs if you have any special learning situations.
- Please provide necessary documentation by the end of the 2<sup>nd</sup> week of class.

<b>ABET Criteria</b>	<b>Relation of Class to Criteria</b>	<b>Mechanism</b>
Ability to apply knowledge of mathematics, science, and engineering	<i>Primary</i>	Lectures Homework Quizzes
Ability to design and conduct experiments, as well as to analyze and interpret data	<i>Secondary</i>	Homework
Ability to function on multidisciplinary teams	<i>n/a</i>	
Ability to identify, formulate, and solve engineering problems	<i>Primary</i>	Lectures Homework Quizzes
Ability to communicate effectively	<i>Primary</i>	Class Discussion
Recognition of the need for, and an ability to engage in life-long learning	<i>Tertiary</i>	Lectures Readings
Knowledge of contemporary issues	<i>Secondary</i>	Lectures Readings Homework
Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	<i>Tertiary</i>	Lectures Homework
Understanding of biology and physiology	<i>Primary</i>	Lectures Homework Quizzes
Capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology	<i>Primary</i>	Lectures Homework Quizzes
Ability to make measurements on and interpret data from living systems	<i>n/a</i>	
Ability to address problems associated with the interaction between living and non-living materials and systems	<i>Primary</i>	Lectures Homework Quizzes