2022

BIOM 4730 / MECH 4365: Biomaterials (Syllabus)

Joel D. Bumgardner
University of Memphis

BIOM 4730/MECH4365: Biomaterials
Fall 2022

Instructor: Dr. Joel D. Bumgardner; e-mail: jbmgrdnr@memphis.edu; office : ET330

Class: Lecture: Tues. and Thurs.: 11:20a.m. – 12:45p.m.; Room ET 238

Course Goal: The goal of this course is to introduce the student to fundamental concepts of biomaterials, including the types of materials used, basic chemical, structural and mechanical/physical properties, degradation, and host-material interactions.

Course Description: This course will introduce to students the terminology, definitions, and concepts that are required to select, manipulate, evaluate and successfully use materials in biomedical applications. This course covers structure-property relationships, biocompatibility criteria, and physiological/clinical performance, as well as regulatory and ethical issues. The course should provide a framework for each student to understand biomaterial physical and biological properties used in medical device design applications.

Books:

Required:

BIOMATERIALS: The Intersection of Biology and Materials Science, by J.S. Temenoff and A.G. Mikos, Pearson Prentice Hall , 2008 (**ISBN-13:** 978-0130097101; **ISBN-10:** 0130097101).

Recommended Reference resource:

Biomaterials Science: an Introduction to materials in medicine, 4th edition, Eds: Wagner, Sakiyama-Elbert, Zhang & Yaszemski. Academic Press/Elseveir (2020).

Tentative Schedule

August			**Textbook assignments**
	23	Introduction - Bonding	Chapter 1; Chapter 2.0-2.1
	25	Bonding & Crystal Structures (lect 1)	Chapter 2.0- 2.2
	30	Crystal structures (lect 2)	Chapter 2.3-2.4
September			
	1	Crystal structures and characterization methods (lect 3)	Chapter 2.4-2.5
	6	Physical Properties (lect 4)	Chapter 3
	8	Mechanical Properties – stress-strain (lect 5)	Chapter 4.1-4.2.2
	13	Mechanical Properties – viscoelasticity (lect 6)	Chapter 4.2.3-4.2.4
	15	Mechanical Properties – fracture/fatigue (lect 7) & Common Biomaterial Compositions	Chapter 4.3-4.6
	20	Presentation I	

Commented [JDB(1]: Need to work on revising lecture to cover material more quickly in 2022 have taken til 8spet to complete lectures on xstals and characterizations

	22	Test I	Chapters 1 -4
	27	Degradation – metal corrosion (lect 8)	Chapter 5-5.2
	29	Degradation – polymer&ceramic (lect 9)	Chapter 5.3-5.5
October			
	4	Processing – Metals/alloys (lect 10)	Chapter 6.1-6.4
	6	Processing – Ceramics (lect 11)	Chapter 6.5
	11	FALL BREAK	
	13	Processing – Polymers (lect 12)	Chapter 6.6-6.7
	18	Surfaces part I (lect 13)	Chapter 7.1-7.2
	20	Surfaces part II (lect 14)	Chapter 7.3-7.6
	25	Presentation II	
	27	Test II	Chapters 5-7
November			
	1	Protein Interactions (lect 15)	Chapter 8
	3	Cell interactions (lect 16)	Chapter 9
	8	Acute Inflammation and healing (lect 17)	Chapter 10 & 11
	10	Immune Response (lect 19)	Chapter 12
	15	Thrombosis (lect 20)	Chapter 13
	17	Standards & FDA Regulatory Process	Guest Lecture
	22	Infection, tumors, calcification (lect 21)	Chapter 14
	24	Thanksgiving Holiday	
	29	Presentation III	
December			
	9	**Test III – Final 8:00 – 10:00a**	

Project: Students will work in teams of three to four to explore in detail a clinical problem/disease of interest and the biomaterial(s) therapies/devices used to treat the disease. The project will be divided into 3 parts;

A] The team will first identify and describe in detail **the clinical symptoms, diagnosis, pathology, demographics and societal impacts** associated with their disease/problem.

B] The team will then describe **current *biomaterials/devices*** (composition and structure/organization) and how implanted to treat/address their clinical problem. Team needs to clearly describe current biomaterials/devices composition (e.g. metal/alloy, polymer, ceramic or composite formulations), how device functions/performs in repairing, restoring or replacing missing/damaged/diseased tissue/organ, AND areas/needs for improvement.

C] Next, the team will develop **an implant design concept** to address clinical issue using biomaterials/technologies (e.g. new materials/compositions, tissue/regenerative engineering, surface modifications, drug/material combinations etc). For the design concept, teams will need to;

1. Clearly articulate the implant problem being addressed and how addressing this problem will meet clinical needs
2. Develop design criteria/ performance specifications that need to be met to solve/address implant problem
3. Describe materials composition and structure of components of new implant (schematics should be included), how will be

implanted/used and how meets design criteria/specifications and improves function over current clinical devices taking into account public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

4. Describe a testing/ development plan for getting device to clinical use. *Testing plan should include both materials and biological tests, types of data to be collected and how data will be used to determine if design meets clinical performance specifications.* Teams may also consider obstacles with regard to approval by regulatory agencies, and or cultural/ethical, patent and marketing issues.

Teams will turn in reports and make an oral presentation on each section.

Note: Honor students in will be required to do an additional presentation on a biomaterials topic to be determined.

Assessment:

1. 45% tests
2. 30% project reports and presentations
3. 15% quizzes/homework
4. 10% team member assessment

A(90-100); B(80-89); C(70-79); D(60-69); F(<60)

Policies

1. Collegial and professional behavior is expected during both virtual and in-person class meetings. Specifically, we will create a collaborative, respectful, mindful, and sociable environment.
2. You are responsible for all material, whether covered in class or as part of an assignment.
3. If you miss a class, you are responsible for obtaining any material covered in class.
4. You are expected to come to class prepared and to participate actively in class. This participation may include, but not be limited to, explanation or demonstration of concepts, in–class problem solving, or discussion of assignments. Volunteers for participation may be solicited, or you may be called upon.
5. Except when collaboration and teamwork is specifically encouraged or required, any work submitted for a grade must be your own original work. Working together on homework is certainly acceptable, but each person must work through the problem individually. Do not simply copy someone else's solution.
6. **Homework assignments must be turned in by the due date in ecourse. Late assignments will be accepted at discretion of instructor and subject to 50% reduction in credit**

7. No make-up exams will be given. If your absence from an exam is officially excused (documentation required), an alternate exam time may be scheduled at the discretion of the instructor. A grade of zero will be assigned for a missed exam in all other cases.
8. **Academic dishonesty of any form will not be tolerated.** See the "Code of Student Rights & Responsibilities" in the Student Handbook (http://www.memphis.edu/saos/pdfs/csrr.pdf) for further details.
9. You are responsible for determining the availability of the computing resources used in this class and for scheduling your work accordingly.
10. You must fully comply with all university guidelines and applicable laws regarding the use of computing facilities and software that may be provided for this course.
11. Please show up on time for class. Attendance is taken at the beginning of class and if you are not present, you will be marked as absent
12. *Please do not bring food to class, and please be sure to take care of personal/bathroom business either before or after class. Leaving in the middle of class for reasons other than emergencies will be considered leaving and you will be marked as absent.*
13. These policies may be revised or augmented as required during the term.

Prepared by: Joel D. Bumgardner, PhD, FBSE, FAIMBE, Professor, Biomedical Engineering