BME 420
Biomaterials and Biocompatibility
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Class Times: Tue/Fri 2:30pm – 3:55pm

Office hours: Tue 1:00-2:30pm/ Fri 10:00-11:00am

Prerequisites: Math 222, BME 303, Mech 320, MtSE 301

Textbooks and Materials:

1. Tissue-Biomaterial Interactions (TBI); Dee, Puleo, and Bizios, Wiley-Liss
2. MtSE 301 textbook, Foundations of Materials Science and Engineering (FMSE); William F. Smith, McGraw-Hill
3. Supplementary material posted on My NJIT/ Highlander Pipeline

Course Description:

An introduction to the field of biomaterials. The goal of this course is to learn about material selection, important properties of materials for use in the body and failure modes of applied biomaterials. The first part of the course will cover the definition and criteria for a biocompatible material with emphasis on clinical relevance. The process of material selection for biocompatibility will be introduced in regards to body responses including immunological, cell and tissue interaction, toxicity and safety. Failure analysis and performance testing will be discussed. The second part of the class will cover the structure and properties of materials used as biomaterials including metals, ceramics, synthetic polymers, and biopolymers. The structure of these materials will be reviewed and how structure defines the behavior of a material. The bulk behavior of materials will be reviewed, including the generalized Hooke's Law, and new concepts will be introduced (including thermal strain, surface properties, and viscoelasticity). Students will be presented with problems of property characterization, failure analysis and performance testing. The third part of the class will discuss common clinical applications of biomaterials. Design criteria, material selection, performance, property retention, and typical failure modes will be presented. Students will work in teams to analyze a marketed implant or device using biomaterial(s) using the tools and concepts learned in the course.

Course Objectives:

At the completion of this course the student should be able to:

- Define and understand what qualifies a material as biocompatible.
- Understand the multidisciplinary nature of biomaterials as a field of study.
- Define design criteria for a material with relationship to their clinical application.
- Describe the relationship between material selection and performance *in vivo*.
- Describe the major types of materials that are used in the body and their major modes of failure.
- Apply material property fundamentals to analyze the performance of a material *in vivo.*
- Understand how to analyze the interaction of materials with the human body and what biocompatibility is in relation to specific materials.

- Analyze issues relevant to property retention for materials when implanted in the human body.
- Predict the safety of biomaterial designs in regards to bodily responses including immunological, cell and tissue interaction, toxicity.
- Be capable of reading, comprehending and communicating the content of technical articles on biomaterials research and applications.
- Ability to work as a part of a multidisciplinary team analyzing and interpreting current performances of contemporary and novel biomaterials and present recommendations for further study.
- Ability to present data analysis and effectively communicate interpretation of design, test results, and data interpretation. Ability to discuss clinical relevance.

Week	Date:	Reading / Homework	Topic
1	9/4	1) TBI Ch1, 2) Supp Docs	Introduction to the Study of Biomaterials, Definition of Biocompatibility
	9/7	Biomaterials Science handout http://consensus.nih.gov/1982/1982Biomaterials034html.htm HW#1	Clinical Applications of Biomaterials and Material Selection
2	9/11	TBI Ch2	Protein Structure and Function
	9/14	TBI Ch3 HW#1 Due, HW#2	Protein-Surface Interactions
3	9/18	TBI Ch4	Blood-Biomaterial Interactions and Coagulation
	9/21	TBI Ch5 HW#2 Due, HW#3	Inflammation and Infection
4	9/25	TBI Ch6	Immune System and Inflammation
	9/28	TBI Ch7 HW#3 Due	Wound Healing
5	10/2		Exam 1: Through 9/25 lecture
	10/5	TBI Ch8, Supp Docs, Handouts HW#4	The Physiological Environment: Molecular, Cell and Tissue interactions with biomaterials, Surface modification
6	10/9	FMSE Ch6.2-6.3,7.1-7.3	Failure modes of materials, Mechanical Properties of Materials
	10/12	FMSE 7.4, 10.11, Handouts HW#4 Due, HW#5	Viscoelastic Properties of Materials
7	10/16	TBI Ch8	Other important properties of materials
	10/19	FMSE Ch6.5-6.8 HW#5 Due	Metal Biomaterials: Strength, Plastic Deformation, Fatigue
8	10/23		Exam 2: Through 10/16 lecture
	10/26	FMSE Ch13 HW#6	Metal Biomaterials: Corrosion
9	10/30	FMSE Ch11.5-11.10	Ceramic Biomaterials: Strength and Crack Propagation
	11/2	FMSE Ch10.1-10.9 HW#6 Due, HW#7	Polymer Biomaterials: Chemistry-Material Property Relationship

10	11/6	FMSE Ch10.10-10.12	Polymer Biomaterials: Creep Deformation, Thermal Effects
	11/9	HW#7 Due	Natural Materials
11	11/13		Exam 3
	11/16	HW#8	Biomaterials Degradation
12	11/20	TBI Ch9	Testing biomaterials for function and safety
	11/23		No Class
13	11/27	HW#8 Due	Testing biomaterials for function and safety
	11/30		Student presentations / biomaterials topics
14	12/4		Student presentations / biomaterials topics
	12/7		Student presentations / biomaterials topics
15	12/11		Review

Course Grading:

In class participation	5%
Homeworks	20%
In class exams	25%
Project	25%
Final exam	25%

Grading policy:

Students are expected to abide strictly to the NJIT code of honor which can be viewed at http://www.njit.edu/academics/honorcode.php.

Exams:

There will be three in class exams during the semester. The lowest grade will be dropped. The final exam is mandatory and cannot be dropped. If you miss a test, that is the test that will be dropped. Make-up exams will only be given with clearance and request from the Dean of Students office.

Homework:

Homework is due the Friday of the following week unless a change agreed upon in class. Homework will not be accepted after the end of class. Answers must be complete showing how the problem was solved and not simply the answer. Legible submissions are important otherwise I cannot grade or give you comments! Copied homework from piers is unacceptable and will result in both/all students not receiving credit for the homework.

Homework will be graded on the 1) understanding of the problem, 2) applying the correct engineering principle/equation, 3) obtaining the correct answer, and 4) the correct interpretation of the answer. Partial credit for each problem will be given based on these factors.

In class participation:

In class discussion is an important component of the learning process. Be prepared to discuss the information prepared in lecture by reading the assigned materials and completing

homework. This will be your opportunity to ask questions and clarify topics. Grading for in class participation will be based on your participation by volunteering or responses when called upon.

Team Project:

There will be one team project assigned. The project will be graded by team participation, team presentation, class evaluation and written report. All written reports are due at the same time prior to presentations. Reports handed in after the due date will not be accepted. This project will consist of both a written report (individual) and presentation (team participation).