BENG 541: Biomaterials

Fall 2016
Credits: 3
MW 5:55 pm - 7:10 pm
Blueridge Hall 127

Instructor:
Sahar Jafari, PhD
Adjunct Professor
Department of Bioengineering
Office: Nguyen Engineering Building Room 3707
Email: sjafari2@gmu.edu
Office hours: Monday/Wednesdays 4:00-5:00 pm and by appointment

Prerequisite(s):
Grade of C or better in BIOL 213 (or equivalent), CHEM 251 (or equivalent)

Textbook (Required):
Edited by: Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons
Publisher: Elsevier, 2013.

Course Description:
Biomaterials are a wide range of materials used in medicine and dentistry to replace, augment or repair tissues of the body in different situations, possibly as a result of illness or disease. These materials all come into contact with biological systems and their interaction with the body will be the main focus of your study. Biomaterials are used to make artificial hips, knees and bone substitutes, drug delivery systems, contact lenses, artificial blood vessels and heart valves, and all the materials used in dentistry, ranging from different filling materials to crowns and dentures. The course therefore aims to give you a thorough background in materials science, engineering and experimental design, all of which are relevant to the use and development of biomaterials.

Learning Objectives:
Developing materials for use in medicine is a challenging interdisciplinary process and requires an understanding of material bulk and surface properties, the various biological responses to the materials, different types of materials, manufacturing processes, cost, sterilization, packaging and regulatory issues. This course is designed to introduce students to the various classes of biomaterials in use and their application in selected subspecialties of medicine.

Upon successful completion of this course, the student should be able to:
1. Differentiate the various classes of biomaterials on the basis of structure and function.
2. Differentiate various analytical methods based on their use to characterize bulk and surface properties of biomaterials.
3. Differentiate the molecular and cellular events that follow exposure of materials to bodily fluids and to contact with various tissues of the human body.

4. Differentiate various biomaterials testing methods.

5. Describe various practical aspects of biomedical device design, fabrication and testing.

**Grading Policy:**

In-class activity (10%)
Homework (30%)
Midterm exam (30%)
Final exam (30%)

**Course structure:**
The course will consist of two weekly lectures, weekly homework assignments, 3 lab sessions, post-lab assignments, and two written exams. Please note that both exams will be closed-book and closed-notes.

**Homework:**
There will be assigned homework throughout the semester. The homework will be assigned on Wednesdays and will be due the following Wednesdays by midnight. Homework submitted after the due date will be penalized (10% penalty for each day late). No homework will be accepted after one week from the due date.

**In-class Exercises:**
Active participation in class has been shown to improve learning and retention. Each lecture will include in-class questions and discussions. Students are expected to actively engage in classroom discussions. Scoring for the in-class exercises is described below. You are expected to attend and prepare for each class. This includes reviewing previously covered material, as well as completing the assigned reading. You are responsible for all material covered in class and in the assigned reading. The amount of student engagement in the class and the student’s attendance in the class will be considered for the score of in-class activity.

**Exams:**
There will be one midterm exam and one final exam in the class. Please note that both exams will be closed-book and closed-notes. The exams will test your level of comprehension of the material covered in this class. The topics covered in the exams will not be cumulative. The midterm exam will cover the material from the first day of class to the midterm and the final exam will cover the material covered after the first midterm to the last day of class. Absence from either of the exams will be accepted on an emergency only basis. Please contact me at sjafari2@gmu.edu as soon as possible in the event that you will not be able to attend the scheduled exams.
<table>
<thead>
<tr>
<th>Date</th>
<th>Reading Assignment</th>
<th>Topic</th>
<th>Assignments and deadlines</th>
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<tbody>
<tr>
<td>29 Aug</td>
<td>BS: 1-15;</td>
<td>Introduction</td>
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<tr>
<td>31 Aug</td>
<td>BS: 5-21, 34-55</td>
<td>Bulk properties of Materials, Surface Properties and Surface Characterization of Materials</td>
<td>Homework #1 Assigned</td>
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<tr>
<td>5 Sep</td>
<td>No Class</td>
<td>Labor day-Holiday</td>
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<tr>
<td>7 Sep</td>
<td>BS: 21-34</td>
<td>Finite Elements in Biomechanics</td>
<td>Homework #1 Due</td>
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<tr>
<td>12 Sep</td>
<td>BS: 111-127</td>
<td>Metals: Basic Principles, A - Titanium and Nitinol (NiTi), B - Stainless Steels</td>
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<tr>
<td>14 Sep</td>
<td>128-151</td>
<td>Ceramics, Glasses, and Glass-Ceramics: Basic Principles</td>
<td>Homework #2 Assigned</td>
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<tr>
<td>19 Sep</td>
<td>151-166</td>
<td>A - Natural and Synthetic Hydroxyapatites, Alumina</td>
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<tr>
<td>21 Sep</td>
<td>BS: 64-79,82-91</td>
<td>Polymers and Silicones</td>
<td>Homework #2 Due</td>
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<tr>
<td>26 Sep</td>
<td>BS: 166-179,247-258</td>
<td>Hydrogels and Smart Polymers</td>
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<tr>
<td>28 Sep</td>
<td>BS: 179-195</td>
<td>Degradable and Resorbable Biomaterials</td>
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<td>3 Oct</td>
<td>BS: 209-222</td>
<td>Pyrolytic Carbon</td>
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<td>5 Oct</td>
<td>BS: 223-241</td>
<td>Composites</td>
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<tr>
<td>11 Oct</td>
<td>BS: 321-331</td>
<td>Textured and Porous Materials</td>
<td>Monday class on Columbus day will meet Tuesday</td>
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<tr>
<td>12 Oct</td>
<td>BS: 360-388</td>
<td>Microparticles and Nanoparticles</td>
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<td>17 Oct</td>
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<td>Midterm</td>
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<td>19 Oct</td>
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<td>Lab 1</td>
<td>Lab Homework #1 Assigned</td>
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<tr>
<td>24 Oct</td>
<td>BS: 503-512</td>
<td>Inflammation and wound healing</td>
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<td>26 Oct</td>
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<td>Lab 2</td>
<td>Lab Homework #1 Due Lab Homework #2 Assigned</td>
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<tr>
<td>31 Oct</td>
<td>BS: 588-592</td>
<td>Biocompatibility</td>
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<td>2 Nov</td>
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<td>Lab 3</td>
<td>Lab Homework #2 Due Lab Homework #3 Assigned</td>
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<tr>
<td>7 Nov</td>
<td>BS: 593-617</td>
<td>In Vitro and In Vivo testing</td>
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<tr>
<td>9 Nov</td>
<td>BS: 695-715</td>
<td>Body fights back, Chemical and Biochemical degradation of Polymers intended to be biostable</td>
<td>Lab Homework #3 Due</td>
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<td>Date</td>
<td>BS:</td>
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<tr>
<td>14 Nov</td>
<td>760-761, 761-771</td>
<td>Cardiovascular Medical Devices</td>
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<td>16 Nov</td>
<td>771-784</td>
<td>Stents</td>
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<td>21 Nov</td>
<td>827-841</td>
<td>Artificial Organs</td>
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<tr>
<td>23 Nov</td>
<td>No Class</td>
<td>Thanksgiving Holidays</td>
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<td>28 Nov</td>
<td>841-882</td>
<td>Orthopedic Applications</td>
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<td>30 Nov</td>
<td>882-888, 1024-1027</td>
<td>Dental Implants, Drug delivery systems</td>
<td>Homework #3 Assigned</td>
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<tr>
<td>5 Dec</td>
<td>1027, 1028-1036</td>
<td>Injected Nano careers, Targeting</td>
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<tr>
<td>7 Dec</td>
<td>1119-1137</td>
<td>Tissue Engineering</td>
<td>Homework #3 Due</td>
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**Academic Honesty and Collaboration:**

The integrity of the University community is affected by the individual choices made by each of us. GMU has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and rather simple principles to follow at all times are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification. No grade is important enough to justify academic misconduct.

With collaborative work, names of all the participants should appear on the work. Homework problems are designed to be undertaken independently. You may discuss your ideas with others and confer with peers; however, it is not appropriate to give your work to someone else to review. You are responsible for making certain that there is no question that the work you hand in is your own. If only your name appears on an assignment, your professor has the right to expect that you have done the work yourself, fully and independently.

Plagiarism means using the exact words, opinions, or factual information from another person without giving the person credit. Writers give credit through accepted documentation styles, such as parenthetical citation, footnotes, or endnotes. Paraphrased material must also be properly cited. A simple listing of books or articles is not sufficient. Plagiarism is the equivalent of intellectual robbery and cannot be tolerated in the academic setting.

There will be a zero tolerance policy in this course for plagiarism and cheating in the written project report, in homework submissions, and in take home exam. Every instance of plagiarism or cheating will be reported to the GMU Honor Committee. No excuses. No exceptions. If you have any doubts about what constitutes plagiarism, please see the instructor. **The sanction for an Honor Committee violation on an exam in this class will be a straight F.**

**Email Policy:**

You must use your Mason email account for all email correspondence having anything to do with your work at Mason. Federal laws protecting your privacy rights require that we only communicate
student information directly to students – and use of the university email system is our only way to validate your identity. You may forward your campus email elsewhere, but we can respond only to a Mason email account.

**Relevant Campus and Academic Resources:**

**Disability Services**
Any student with documented learning disabilities or other conditions that may affect academic performance should: 1) make sure this documentation is on file with the Office of Disability Services (SUB I, Rm. 2500; 703-993-2474; http://ods.gmu.edu) to determine the accommodations you might need; and 2) talk with the instructor to discuss reasonable accommodations.

**Office of Diversity, Inclusion and Multicultural Education**
SUB 1, Rm. 2400; 703-993-2700; https://odime.gmu.edu

**Writing Center**
Robinson 114A; 703-993-1200; http://writingcenter.gmu.edu

**WAVES: Wellness, Alcohol and Violence Education and Services:**
WAVES promotes wellness within the Mason community through health education, alcohol/drug assessment and education, and violence awareness, prevention and sexual assault response. We help students make healthy, safe choices and encourage lifelong, thoughtful healthy decision-making through individualized support, creative programming, and evidence-based education and outreach.

**WAVES office 703-993-9999**
SUB I, Suite 3200
24-Hour Sexual and Intimate Partner Violence Crisis Line 703-380-1434
waves.gmu.edu

- 703-360-7273 (Fairfax County Office for Women and Domestic and Sexual Violence Services 25 hotline)
- 703-228-4848 (Arlington County Domestic Violence Services Hotline)
- 703-368-4141 (Prince William County Sexual Assault Victims Advocacy Services (SAVAS) hotline)
- 1-800-838-8238 (Virginia Family Violence and Sexual Assault Hotline)
- 1-800-656-HOPE (Rape, Abuse and Incest National Network)
  https://ohl.rainn.org/online/

**CAPS: Counseling and Psychological Services:**
Counseling and Psychological Services (CAPS) provides a wide range of free confidential services to students, faculty, and staff. Services are provided by a staff of professional clinical psychologists, social workers, counselors, learning specialists, and psychiatric providers. CAPS individual and group counseling, workshops, and outreach programs are designed to enhance students’ personal experience and academic performance.
Visit us at caps.gmu.edu for additional resources.
For consultation or emergency assistance during office hours call 703-993-2380.
For assistance during non-office hours, call University Police at 703-993-4357.
703-527-4077 (CrisisLink)
1-800-273-8255 (National Suicide Prevention Lifeline)
1-877-838-2838 (Veterans' Crisis Hotline)

Student Health Services (SHS):
Provides confidential health care to enrolled students in emergency and non-emergency circumstances on the Fairfax, Arlington and Prince William campuses. If there is a medical emergency and Student Health Services (SHS) is closed, please contact the free after-hours nurse ((703) 993-2831), a hospital emergency room, an urgent care facility, or call 911.

SUB 1, Suite 2300
703-993-2831

University Police:
Emergency: 911 Non-Emergency: (703) 993-2810
Reporting a Crime (Crime Solvers Anonymous Tip Hot-Line): (703) 993-4111
Mason Police Website: http://police.gmu.edu/
Eric Heath, Chief of Police Phone: (703) 993-3840 E-mail: eheath2@gmu.edu