BME/MSE 410 Design and Applications of Biomaterials

Semester: Fall, 2017
Days/Times: Monday/Wednesday 10.00-11:30 AM
Classroom: 133 Chrysler

Professor: Geeta Mehta, Ph.D.
Depts. of Materials Science and Engineering, Biomedical Engineering, and Macromolecular Science and Engineering

Office: 3044W Building 28, NCRC (my office is in Building 28 of NCRC, there are campus buses that go to NCRC, and on foot it is ~15 minutes walk from the Duderstadt Library)
Office Hours: Immediately after class or via E-mail
E-mail: mehtagee@umich.edu

GSI: Michael Bregenzer
Office Hours: TBD (After polling)

Sending Emails: Use [BME 410] in the subject line. Copy both Dr. Mehta and Michael Bregenzer

Prerequisites: One year of general biology or biochemistry and MSE 220 or 250.

(Book is available online via UMich Library:
http://mirlyn.lib.umich.edu/Record/012216410
Pertinent Chapters from Ratner are posted on Canvas)

Course website: https://ctool.umich.edu/

• The Web of Science Citation Index:
http://isi10.newisiknowledge.com/portal.cgi
(ned need to use from on campus or with your umich uniquename and password)

Accommodations for Students with Disabilities:
If you think you need an accommodation for a disability, please let me know at your earliest convenience. Some aspects of this course, the assignments, the in-class activities, and the way we teach may be modified to facilitate your participation and progress. As soon as you make me aware of your needs, we can work with the Office of Services for Students with Disabilities (SSD)
to help us determine appropriate accommodations. SSD (734-763-3000 or ssd.umich.edu) typically recommends accommodations through a Verified Individualized Services and Accommodations (VISA) form. I will treat any information you provide as private and confidential.

I. Course Goals
1) Development of global perspective of interdisciplinary issues (biology, materials science, chemistry, and engineering) involved in biomaterials.
2) Learn how to design, synthesize, evaluate, and analyze biomaterials.
3) Critical thinking and analysis.
4) Communication of ideas; communication to coordinate work
5) Familiarization with biomaterials literature.

Structure of Lectures
1. Materials (Lectures 1-2)
   Bulk properties and surface properties
2. Class of materials used in biomedical applications (Lectures 3 - 12)
3. Biological interactions with materials (Lectures 13 - 27)
   Proteins, cells, and tissues
   Biological responses: Inflammation, immunity, toxicity, coagulation, tumorigenesis.
   Biofilms, Pathological calcification, Biocompatibility
4. Applications of biomaterials (All throughout the course): drug delivery, tissue engineering, cardiovascular, orthopedic, dental, functional tissues, etc.)

II. Grading
   (a) Midterm exam: 30% of grade
   (b) Homeworks: 20% of grade
   (c) Quizzes/Class Participation: 10% of grade
   (d) Final Exam: 40% of grade

III Exams: Exams will be split between short-answer type questions and quantitative problems with opportunities for partial credit. Important concepts that might appear on exams will be highlighted in each lecture.

For the midterm and final exams, I will allow 1 side of 1 cheat sheet (8.5x11 inch) (include name neatly on the blank side) turned in with your exam. This will be used to perform learning analytics and determine the course concepts and topics that you might need more help with.

Final Exam prep: There will be an overall review session before the final exam.

Final exam will be cumulative.

IV Homework

**HWs discussion with other students in the class:** You may discuss HWs with your classmates (it is expected), and work towards solutions together. You must submit individual work that is not
a verbatim copy of any other student's work. Do not forget that even when working in groups, you are individually responsible for your learning.

HWs will be collected by the GSI each time they are due, at the beginning of the class.

**Late HW Policy:**
Same day late HW: 15% deduction
Next day late HW: 50% deduction
Third day late HW: 100% deduction

**V Quizzes/Class participation:** To ensure active learning and engagement in class, we will be using the iClicker system in lectures. Your personal iClicker must be registered under your uniqname and UMID. Your responses to in-class questions will be recorded via iClicker, and these will go towards your participation points.

We will also conduct active learning exercises during each class. Your participation is essential for these activities, and will count towards your participation points.

**VI Course Evaluation:** Your feedback is extremely important to make this course better and to improve your learning experience. To encourage course evaluation, I will be awarding extra points:
- If more than 90% of the class completes the final class evaluations, 5 points (from the class participation points) will be awarded to all students.
- With your last homework assignment, staple a receipt of your course evaluation, and you will be awarded an extra 2 points towards your homework points.

Please note that the course evaluations are anonymous and the final evaluations aren’t available to me until after your final course grades have been submitted.

**VII Journal relevant to Biomaterials (selected ORIGINAL ARTICLE for the Scientific Literature Oral Presentation must be from 2012 or newer)**

- Minimum you should browse through
  - Nature
  - Science
  - Nature Biotech
  - Nature Materials
  - Nature Communications
  - Proceedings of the National Academy of Science USA (PNAS)
  - Biomaterials
  - Scientific Reports
  - Nature Biomedical Engineering
  - Science Advances
  - Journal of the American Chemical Society (JACS)
  - European Cells & Materials (eCM)
**Lab on a Chip**

**Nanomedicine**

**Soft Matter**

**Journal of Biomedical Materials Research Part A**

- Others (just some examples, there are more, See Appendix D in Textbook)

**VIII Other Textbooks and References** (Also see Appendix D in Textbook)


Atala, A; Mooney, D. J. Eds *Synthetic Biodegradable Polymer Scaffolds*, Springer Verlag, New York, 1997


**IX Honor Code Statement:** All students in the BME/MSE/Macro 410 are presumed to be decent and honorable, and as such, are bound by the College of Engineering Honor Code. You may not seek to gain an unfair advantage over your fellow students; you may not consult, look at, or possess the unpublished work of another without their permission; and you must appropriately acknowledge your use of another's work. Any violation of the honor policies appropriate to each piece of course work will be reported to the Honor Council, and if guilt is established penalties may be imposed by the Honor Council and Faculty Committee on Discipline.
X. Course Outline

<table>
<thead>
<tr>
<th>#</th>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
<th>Homework</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>September 6 (Wed)</td>
<td>Orientation and Introduction to Biomaterials</td>
<td>Ratner: pp xxv to xxxvii, xli-lii</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>September 13(Wed)</td>
<td>Surface Characterization and Polymers</td>
<td>Ratner: pp 34-53, 63-109</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>September 18(Mon)</td>
<td>Polymers and Hydrogels</td>
<td>Ratner: pp 63-109, 166-176</td>
<td>HW#1 Due</td>
</tr>
<tr>
<td>5</td>
<td>September 20(Wed)</td>
<td>Polymers and Hydrogels</td>
<td>Ratner: pp 63-109, 166-176</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>September 25(Mon)</td>
<td>Hydrogels, Smart Polymers</td>
<td>Ratner: pp 166-176, 247-255</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>September 27(Wed)</td>
<td>Medical Fibers and Biotextiles, Biodegradable materials</td>
<td>Ratner: pp 301-319, 179-193</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>October 2(Mon)</td>
<td>Biodegradable materials, Natural materials</td>
<td>Ratner: pp 179-193, 195-206</td>
<td>HW#2 Due</td>
</tr>
<tr>
<td>10</td>
<td>October 9(Mon)</td>
<td>Surface Patterning, Metals</td>
<td>Ratner: pp 276-296, 111-119</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>October 11(Wed)</td>
<td>Metals, Ceramics and Glasses</td>
<td>Ratner: pp 111-159</td>
<td></td>
</tr>
<tr>
<td></td>
<td>October 16(Mon)</td>
<td>STUDY BREAK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>October 25(Wed)</td>
<td>MIDTERM EXAM</td>
<td>Lectures 1-13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>During class hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>October 30(Mon)</td>
<td>Proteins on biomaterials</td>
<td>Ratner: pp 394-407</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>November 1(Wed)</td>
<td>Proteins on biomaterials, Non fouling surfaces</td>
<td>Ratner: pp 394-407, 241-246</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Topic</td>
<td>Reading Material</td>
<td>Homework Due Date</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>17 Nov 6 (Mon)</td>
<td>Cell/tissue biomaterial interactions, Cells and surfaces</td>
<td>Ratner: pp 408-422, 452-473</td>
<td>HW#4 Due</td>
<td></td>
</tr>
<tr>
<td>18 Nov 8 (Wed)</td>
<td>Biological response to biomaterials</td>
<td>Ratner: pp 499-503</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 Nov 13 (Mon)</td>
<td>Inflammation and immunity</td>
<td>Ratner: pp 503-512</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Nov 15 (Wed)</td>
<td>Innate Immunity</td>
<td>Ratner: pp 512-519</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 Nov 20 (Mon)</td>
<td>Adaptive Immunity</td>
<td>Ratner: pp 519-532</td>
<td>HW#5 Due</td>
<td></td>
</tr>
<tr>
<td>22 Nov 22 (Wed)</td>
<td>Toxicity, Hypersensitivity, Tumorigenesis</td>
<td>Ratner: pp 545-550, 558-563</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Nov 29 (Wed)</td>
<td>Biofilms</td>
<td>Ratner: pp 565-579</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 Dec 4 (Mon)</td>
<td>Pathological Calcification</td>
<td>Ratner: pp 739-750</td>
<td>HW#6 Due</td>
<td></td>
</tr>
<tr>
<td>26 Dec 6 (Wed)</td>
<td>Biocompatibility, Biological testing of biomaterials</td>
<td>Ratner: pp 587-616</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 Dec 11 (Mon)</td>
<td>Overall Course Review</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>December 18 (Mon)</strong></td>
<td>Final Exam 1:30 pm - 3:30 pm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>