

BME 4931 Biomaterials for Regenerative Medicine

1. Catalog Description: This course introduces the students to biomaterials used in regenerative medicine and tissue engineering. This course will highlight chemical and physical properties of various natural and synthetic biomaterials, and how these features relate to choosing a material for a regenerative medicine application. This course will also provide tissue-specific examples of successful tissue regeneration.
2. Pre-requisites and Co-requisites: EMA3010 and EMA3066
3. Course Objectives:
  - a. to become familiar with different types of biomaterials used for regenerative medicine
  - b. to apply engineering principles to select materials for specific tissue regeneration applications
  - c. to understand methods to assess the clinical effectiveness of biomaterials in tissue regenerative
4. Contribution of course to meeting the professional component: N/A
5. Relationship of course to program outcomes: N/A
6. Instructor – Gregory A. Hudalla, Ph.D.
  - a. Office location: BMS J293
  - b. Telephone: (352) 273-9326
  - c. E-mail address: ghudalla@bme.ufl.edu
  - d. Class Web site: <https://lss.at.ufl.edu/>
  - e. Office hours: Tuesday 10am-11am or by appointment
7. Teaching Assistant - none
8. Meeting Times – Course meets 3 times per week, M W F 3<sup>rd</sup> period
9. Class/laboratory schedule – Course meets 3 50 minute periods per week
10. Meeting Location – BLK 315
11. Material and Supply Fees - none
12. Textbooks and Software Required
  - a. Title - BIOMATERIALS FOR TISSUE ENGINEERING APPLICATIONS: A REVIEW OF THE PAST AND FUTURE TRENDS
  - b. Editors – Jason Burdick and Robert Mauck
  - c. ISBN number - 9783709103845

**Please note:** the UF library has electronic access to this book, and students can download the entire thing as a PDF for free. The ISBN for the online version is 978-3709103852. Additionally, students who prefer a print copy can purchase a 'MyCopy Softcover Edition' for \$24.99 because of the library's subscription to the ebook.
13. Recommended Reading
  - a. Title – Tissue Engineering
  - b. Authors – Bernhard O. Palsson and Sangeeta N. Bhatia
  - c. ISBN number: 0-13-041696-7
  
  - a. Title – Molecular Biology of the Cell

- b. Authors – Bruce Alberts
- c. ISBN number: 0-8153-3218-1

#### 14. Course Outline

Week 1: Overview of Tissue Engineering – reading: book introductory chapter

*why, what, how, where, and when of tissue engineering – broad overview of course*

- history of tissue engineering – from space-filling models to ECM mimics
- overview of the ECM – organic and inorganic composition, structure-function relationship, spatial organization (e.g. basement membrane) – much of biomaterials for TE is focused on mimicking the ECM

#### **Begin Module 1 – Biomaterials as ECM mimics for TE**

Week 2: Natural materials as TE biomaterials – chapter 8

- Engineered ECMs from ECM-derived molecules – collagens, HA...
- Engineered ECMs from xenogeneic sources – alginate, chitosan, dextran...
- decellularized ECMs

Week 3: Synthetic polymers as TE biomaterials – chapters 2 and 4

- overview of ‘hydrogels’ – physical vs chemical crosslinked materials
- degradable synthetic materials – enzymatic vs. hydrolytically degradable
- functionalizing synthetic materials
- **Homework #1 due Friday Jan 24**

Week 4: Mineralized materials for TE – chapter 7

- compare and contrast bony ECM to non-bony ECM
- Materials that promote mineral formation
- Functional mineralized materials

Week 5: Engineered biomolecules as TE biomaterials – chapter 9

- collagen-like peptides
- Silk-inspired
- elastin-like peptides
- **quiz #1, in class, Friday, Feb 7**

Week 6: Nanofibers as ECM – chapter 3, Collier review

- beta-sheet fibrillizing peptides
- lecture on peptide amphiphiles
- electrospun polymers

Week 7: Composite materials – reading T.B.A.

- **Homework #2 due, Friday, Feb 21**

Week 8: Micro- and nano-scale materials for TE – chapter 5, 6

**Midterm exam, in class, Friday Mar 28**

**Begin Module 2 – Cell-biomaterial interactions - Recommended reading from Bhatia book**

Week 9: The cell

- What is a cell
- Sources of cells for TE

Week 10: Cell behavior

- Cell fate
- Cell morphology
- Stem cell differentiation
- **Homework #3 due, Friday Mar 21**

Week 11: Tools to analyze cell behavior, tools to analyze tissues

- Cell viability, expansion, death
- Cell differentiation
- Cell morphology
- Histology

**Begin Module 3 – Clinical applications of TE**

Week 12: **Quiz #2, in class, Monday, Mar 31**

Week 12, continued: Epithelial tissues (bladder, windpipe...) – chapter 14

Week 13: Bone, cartilage, tendon – chapter 10, 11, 12

Week 14: Cardiovascular – chapter 15, 16

- **Homework #4 due, Friday, Apr 18**

Week 15: Neural – chapter 17

Final exam

15. Attendance and Expectations: Attendance is highly recommended, as material is presented in class that is not in the textbook. Exceptions are made and conform to university policies

16. Grading – methods of evaluation:

- Two exams: midterm and final
- Homework: 4 assignments
- In-class quizzes: 2, one halfway to midterm, one halfway to final.

Extra credit opportunities:

- *Regenerative Medicine in the News*, 1 point awarded per article, maximum of 5 points
- Students can create an exam question, 1-5 points awarded based on quality of question.

Grade breakdown:

Exams: 25% each – Midterm (March 28). Final (T.B.A.)

Homework: 7.5% each – Due Jan 24, Feb 21, Mar 21, and Apr 18

Quizzes: 10% each – in class, Feb 7 and Mar 31

17. Grading Scale

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
≥ 92	90-91	87-89	83-86	80-82	77-79	73-76	70-72	67-69	63-66	60-62	<60

A C- will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

18. Requirements for class attendance and make-up exams, assignments, and other work are consistent with university policies that can be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

19. Honesty Policy – UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code

(<http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Note that failure to comply with this commitment will result in disciplinary action compliant with the UF Student Honor Code Procedures.

See <http://www.dso.ufl.edu/sccr/procedures/honorcode.php>

20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. UF Counseling Services –Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, <http://www.counseling.ufl.edu/cwc/Default.aspx>, counseling services and mental health services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

University Police Department 392-1111

22. Software Use – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.
23. Students are expected to provide feedback on the quality of instruction in this course based on 10 criteria. These evaluations are conducted online at <https://evaluations.ufl.edu>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results>. “