

# INTRODUCTION TO BIOMATERIALS

- INSTRUCTOR:** Dr. Becky Wachs  
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Phone: (402) 472-2262  
Office hours: By appointment
- CLASS TIME/PLACE:** M 2:00 PM – 3:15 PM  
W 2:00 PM – 4:00 PM
- CLASS STRUCTURE:** All classes will be taught in person in Chas Hall Room 112. The class will be subdivided into three **Neighborhoods** of 12-13 students for presentations. Each *Neighborhood* will be further divided into four **Blocks** of 3 students each for discussions and projects. Information on composition of *Neighborhoods* and *Blocks* can be found on Canvas.
- READING MATERIALS:**
- 1) *Biomaterials Science: An Introduction to Materials in Medicine*, edited by Ratner et al. (3<sup>rd</sup> Edition, Elsevier Academic Press)—**REQUIRED**  
**\*Note** – It is recommended that you download the entire textbook for free via the link below when you are campus so you have it for reference when needed.  
<http://www.sciencedirect.com/science/book/9780123746269#ancS1>
  - 2) Research Articles as assigned (Journal Clubs & Assignments)
  - 3) Reference Texts: Dee, Puleo and Bizios' *Tissue-Biomaterial Interactions*; F. von Recum's *Handbook of Biomaterials Evaluation*
- DESCRIPTION:** This course is designed as an introduction to the materials used in medicine, or more specifically, biomaterials. Developing materials for use in medicine is an interdisciplinary process that requires an understanding of material science (bulk and surface properties), biological responses to materials, manufacturing, regulatory issues, and medical applications. Topics to be covered include an introduction to biomaterials, mechanical and physical properties of biomaterials including surface properties, the use of various types of materials in biomaterials, the choice of natural vs. synthetic biomaterials, cell-biomaterial interactions, host reaction to biomaterials, degradation of biomaterials, FDA testing of biomaterials, and finally, applications of biomaterials, including implants, tissue engineering scaffold, controlled release drug technology, adhesives and sutures, and dental applications, as well as materials for gene delivery. The course will focus on evaluation of current primary literature in the field and how to critically assess the merits of a publication.
- PREREQUISITES:** AGEN/BSEN 225 (Engineering Properties of Biological Materials) or MECH 325; BIOC 321 or 431 (Biochemistry)

**ATTENDANCE:** Attendance and real-time interaction with the class is an important part of your learning of the course material and engagement in the course. However, **please stay home if you are sick and attend via ZOOM if possible.** Please let Dr. Wachs know ahead of time if at all possible if you will miss class.

**MASKING:** Given current CDC guidance and the current transmission level of COVID-19 in our community, *I respectfully request that you join me in wearing a face covering during our classes.*

**CLASS PROCEDURES:**

- 1) Scheduled classes: Class begins *promptly* at 2:00 PM.
- 2) Announcements may be given via Canvas so **be prepared to check regularly. Also be sure your email is correct on Canvas.**
- 3) Reading assignments will be given from the **required textbook**, as well as **primary literature articles** distributed via Canvas.
- 4) Journal Clubs:
  - a. Journal clubs will be presented weekly by Dr. Wachs at ~3:30 PM on Wednesdays. Prior to 2 PM on Wednesdays each **Block** must discuss posted questions in Canvas (this will count towards 20% of your weekly HW grade).
  - b. During the last two weeks of class, each student will lead a “journal club” on a **primary literature article** of their choosing, **approved by Dr. Wachs.** Each student will be required to **present their own article** and **lead discussion** on that article. Each student will be required to read a portion of the assigned articles in preparation for other students Journal Club Presentations and pose questions.
- 5) Homework: Homework will be assigned weekly and may include a literature review and summary of relevant articles, standard engineering problems, and analysis of methods or results. In addition, 20% of each HW score will come from the weekly Discussion of the Journal Club with your Block. **All assignments are due one week from the date of assignment at 2pm, unless noted otherwise. Late homework will not be accepted without approved absence.**
- 6) Participation: Includes class participation and engagement as well as participation and engagement in online discussions. Participation is part of your grade and will be assessed at the end of the semester.
- 7) Rationale for Device Testing: Each *Block* of students will write *Rationale for Device Design* using FDA Guidance Documents and ISO 10993 standards. More information will be distributed later in the semester.
- 8) Exams: The two exams may include multiple choice, true/false, short answer, and essay questions.

**COURSE OBJECTIVES:**

- 1) Define the term biomaterial and explain how biomaterials differ from materials in general.
- 2) Recognize the chemical and mechanical properties of general types of biomaterials, including natural and synthetic, used in devices in contact with body. (ABET 6)

- 3) Describe and demonstrate how biomaterials are synthesized, fabricated, and characterized.
- 4) Discuss the biological performance of materials, including tissue responses that follow exposure of the body to materials and techniques utilized to control the physiological response to the biomaterial.
- 5) Critically evaluate design criteria used for the selection and function of biomaterials for a given biological application, including biocompatibility. (ABET 1,7)
- 6) Recognize social, safety, and medical consequences of biomaterial use and regulatory issues associated with selection of biomaterials.
- 7) Explain and analyze clinical applications of biomaterials and regulatory path to market. (ABET 7)
- 8) Interpret and evaluate current biomaterials literature and research in the field and evaluate data and design limitations in verbal, written, and graphical format. (ABET 3)

**GRADING:**

Homework	20%
Exam #1	20%
Exam #2	20%
Rationale for Device Design	15%
Journal Club Presentation	15%
Class Participation/Engagement	10%

<b>Final Percentage</b>	<b>Final Grade</b>
90-100%	A-, A
80-90%	B-, B, B+
70-80%	C-, C, C+
60-70%	D-, D, D+
60% or below	F

**SUPPLEMENTARY INFORMATION:**

Journals Relevant to Biomaterials Field (see page Appendix D of textbook for extensive list)

*Journal of Biomedical Materials Research (Part A and B)\**  
*Biomaterials\**  
*Journal of Applied Biomaterials*  
*Journal of Biomaterials Science—Polymer Edition\**  
*Artificial Organs\**  
*Annals of Biomedical Engineering\**  
*Journal of Biomechanics\**  
*Cells and Materials*  
*Biotechnology Progress\**  
*Biotechnology and Bioengineering\**  
*Materials in Medicine*  
*Journal of Dental Research\**  
*Journal of Controlled Release\**  
*Acta Biomaterialia*  
*Tissue Engineering*  
*Journal of Tissue Engineering and Regenerative Medicine*  
*Nature Materials\**  
*Nature Biotechnology\**  
*Nature Nanotechnology\**  
*Science\**  
*Molecular Therapy*

\* UNL Library has this resource (full or partial years) in either hard copy format or online subscription. For articles in journal to which UNL does not subscribe, requests will need to be made through interlibrary loan.

**ACADEMIC INTEGRITY AND DISHONESTY:**

Students are expected to adhere to guidelines concerning academic dishonesty outlined in the University's Student Code of Conduct (<http://stuafs.unl.edu/ja/code/>). The BSE Department process for grade and academic dishonesty appeals can be found at: <http://engineering.unl.edu/bse/bse-academic-resources>. Students are encouraged to contact Dr. Wachs for clarification of these guidelines if they have questions or concerns.

**ADA:**

Students with disabilities are encouraged to contact Dr. Wachs for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

**EMERGENCY RESPONSE MEASURES:**

- **Fire Alarm (or other evacuation):** In the event of a fire alarm: Gather belongings (Purse, keys, cellphone, N-Card, etc.) and use the nearest exit to leave the building. Do not use the elevators. After exiting notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.
- **Tornado Warning:** When sirens sound, move to the lowest interior area of building or designated shelter. Stay away from windows and stay near an inside wall when possible.
- **Active Shooter**
  - **Evacuate:** if there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.
  - **Hide out:** If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.
  - **Take action:** As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.
- **UNL Alert:** Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: <http://unlalert.unl.edu>.
- Additional Emergency Procedures can be found here: [http://emergency.unl.edu/doc/Emergency\\_Procedures\\_Quicklist.pdf](http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf)

**RECORDING OF CLASS RELATED ACTIVITY:**

I invite all of you to join me in actively creating and contributing to a positive, productive, and respectful classroom culture. Each student contributes to an environment that shapes the learning process. Any work and/or communication that you are privy to as a member of this course should be treated as the

intellectual property of the speaker/creator and is not to be shared outside the context of this course.

Students may not make or distribute screen captures, audio/video recordings of, or livestream, any class-related activity, including lectures and presentations, without express prior written consent from me or an approved accommodation from Services for Students with Disabilities. If you have (or think you may have) a disability such that you need to record or tape class-related activities, you should contact Services for Students with Disabilities. If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Failure to follow this policy on recording or distributing class-related activities may subject you to discipline under the Student Code of Conduct.

Furthermore, please note that any lecture may be recorded throughout the duration of this course.

**NEIGHBORHOODS AND BLOCKS:** *See Canvas for group assignments and Course Schedule*

Hawley Neighborhood:

S Street  
T Street  
U Street  
R Street

Hartley Neighborhood:

N 28th Street  
N 30th Street  
Kleckner Court  
N 31st Street

Clinton Neighborhood:

Fair Street  
Potter Street  
Starr Street  
Dudley Street