

San José State University
Biomedical Engineering Department
BME/MATE 175 – Biomaterials – Fall 2018

Course and Contact Information

Instructor:	Matthew Leineweber
Office Location:	ENG 233G
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Office Hours:	M 16:30-17:30 TR 17:30-18:30
Class Days/Time:	TR 10:30-11:20
Classroom:	CL 222
	Canvas: FA18: MATE-175 Sec 01 - Biomaterials
Prerequisites:	MATE 25 or equivalent, Instructor consent

Course Format

Technology Requirements

The course adopts a traditional lecture format as a primary teaching method, combined with in-class discussions and occasionally problem-solving sessions. Typical lectures will require the use of an internet-connected device (phone, tablet, or laptop) to be used with iClicker technology (iClicker remotes can also be used), for accessing online materials, or submitting in-class assignments.

This course also incorporates a required lab component (BME 175L), for which a separate lab syllabus is provided.

Canvas and Piazza

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on the [Canvas Learning Management System course login website](http://sjsu.instructure.com) at <http://sjsu.instructure.com>. You are responsible for regularly checking with the messaging system through Canvas to learn of any updates.

In addition to Canvas, the online [Piazza platform](http://piazza.com/sjsu/fall2018/bme175/home) (piazza.com/sjsu/fall2018/bme175/home) will be used for discussions on homework, labs, exams, and all other course material. You will be responsible for enrolling yourself using the signup link provided piazza.com/sjsu/fall2018/bme175.

Course Description (Required)

The need for biomaterials is constantly increasing. This is the result of the enormous advances that have been created in both surgical and medical technologies. This course will cover the fundamentals of the structure, processing, and properties of metallic, ceramic and polymeric materials that are utilized in biomedical devices and biotechnology. The effect of structure and processing on the properties, especially biocompatibility, corrosion and long term reliability will be explored. The various methods for characterization and testing of materials, including their biocompatibility and corrosion behavior, will be discussed. Emphasis is placed on

using biomaterials for interventional cardiology, surgical devices, implants, vascular prostheses, catheters and orthopedics, among others. New trends in biomaterials such as metallic shape memory nickel-titanium, and new families of polymers, biopolymers, and composites with specific clinical properties will be discussed.

Course Goals

The fundamental objective of this course is to educate engineers on the importance of understanding the interaction between synthetic and biological materials. Of particular importance here is the role of the structure-processing-property relationship, and how these play a key role in the design, manufacture, clinical performance, long-term reliability and quality/regulatory assurance of medical and implant devices.

Course Learning Outcomes (CLO)

Upon successful completion of this course, students will be able to:

- **Define** short term and long term medical applications for biomaterials made of metals, polymers, composites and ceramics.
- **Explain** significant current problems in medicine that require development of versatile and sophisticated biomaterials.
- **Demonstrate** knowledge of the use of different material types used in biomedical implants and biomedical devices.
- **Define, synthesize and apply** course principles towards materials selection; including trade-off issues and evaluations, for biomedical implants and devices.
- **Explain** mechanical and surface properties of biomaterials.
- **Describe** experimental methods for the characterization of mechanical and surface properties of biomaterials.
- **Comprehend** the design principles involved in biomedical implants and devices, especially issues of biocompatibility with living tissue, and principal mechanisms of material/implant interaction with tissues.
- **Explain**, for each type of biomaterial, the host response upon implantation and how it impacts prosthetics and implanted devices.
- **Explain** the physical and chemical degradation of metal and ceramic materials in the biological environment.
- **Comprehend** the importance of alloy chemistry and thermomechanical processing and analyze how these processing factors determine the physical and mechanical properties, and the type and amount of phase transformation.
- **Define and describe** the steps in the fabrication and the properties of steel, titanium alloy, and other metallic implants and their applications as biomaterials.
- **Define and describe** the steps in the synthesis and the properties of synthetic and natural polymers and their applications as biomaterials.
- **Describe** the types of ceramics used for biomedical implants, and the reasons for using ceramics, processing requirements, and the effect of chemical composition of ceramics and glasses on biocompatibility.
- **Define and describe** the steps in the fabrication and the properties of porous and bioactive ceramic implants and their applications as biomaterials
- **Comprehend** surface treatments used for surgical and medical devices and implants, including laser treatment, heat treating, mechanical and electropolishing, and applications of coatings.

- **Evaluate** and **discuss** ethical concerns relevant to biomaterial science.
- **Write** a cohesive and informative paper on a subject related to biomaterials, including explaining the materials science principles, biocompatibility considerations, design considerations, and other pertinent factors.
- **Prepare** and **deliver** a professional presentation, using presentation software, to an audience of peers.

Required Texts/Readings

Textbook

Required: C. Mauli Agrawal et al., Introduction to Biomaterials, 2014, Cambridge University Press (ISBN: 978-0-521-11690-9) – available in the library reserves for checkout of up to 2 hours at a time

Other Readings

Buddy D. Ratner et al., Editors, Biomaterials Science – An Introduction to Materials in Medicine, 3rd Edition, Elsevier Academic Press. –available as an E-book for free through <https://library.sjsu.edu/> (search for title name)

Other technology requirements / equipment / material

iClicker Reef polling app or iClicker remote (see “In-class iClicker questions” section of this syllabus).

Library Liaison

Megwalu, Anamika

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Email: anamika.megwalu@sjsu.edu

Course Requirements and Assignments

“Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.”

Attainment of the learning objectives (as listed above) will be assessed via homework, laboratory activities, in-class design problems, quizzes, one mid-term examination, and the term paper and presentation.

Homework assignments

Students are expected and encouraged to work together on assignments. However, submitted homework should be individual work. Homework must be turned into the box in ENG 233 **no later than the beginning of class (10:30am)** on the due date. **Late submissions** (any submission after 10:20:01) will not be accepted. The lowest homework score of the semester will be dropped.

Laboratory assignments

Students will **work in pre-assigned** groups to prepare laboratory reports, based on post-lab assignments. The report must include an Acknowledgments section indicating the specific contributions of each student. Students with no contribution will receive no credit for the report.

Reports must be turned into the Lab Instructor at the **beginning of class** on the due date. **Late submissions** will be assessed 10% per day off of the maximum possible score.

In-class design problems (“Challenges”)

Occasionally throughout the semester, students will be presented with open-ended design/challenge problems during the Lab sessions.

Each challenge will be related to the course materials already introduced up to that point. The challenge problem will be disclosed at the beginning of the dedicated lab period. Students will work on the challenge problem in their lab groups, and are expected to deliver a short (5 minute) presentation on their solution to the class, without the use of slides. During the challenge, students are allowed to peruse their notes, the lecture slides provided by the instructor, the textbook, and the internet. These challenges are structured to drive learning innovative problem definition skills, and to give students experience with the “on-the-fly” problem-solving and communication skills that are often required in real-world engineering settings.

In addition to their presentation, students should submit short (one-page) written report to Canvas before the start of the next Lab meeting. Although they can access a vast array of resources for the challenge, students are not allowed to quote any source *verbatim* (i.e. “copy and paste” is not acceptable). All written essays will be automatically scanned in Turnitin to locate matching or similar text within the paper. The instructor will decide whether there is plagiarism case-by-case, in which case academic and administrative sanctions will be assigned according to the University Academic Integrity Policy S07-2 (<http://www.sjsu.edu/senate/docs/S07-2.pdf>).

In-class iClicker questions

There will be regular in-class quizzes based on multiple answer questions. Students will participate in these quizzes using the iClicker system. These quizzes will consist of “concept questions” that will help students understand core ideas, and help me to understand what material needs additional explanation. I will not use iClicker to keep track of attendance. Refer to the Grading Policy and Student Technology Resources section for additional details on iClicker. The [iClicker Reef app](#) can be downloaded here: <https://www.iclicker.com/students>. Alternately iClicker remotes can be accessed through SJSU eCampus. Information on how to obtain a remote can be found on the eCampus website <http://www.sjsu.edu/ecampus/teaching-tools/reef/index.html>.

Examinations

There will be one mid-semester examination and one final examination. The midterm examination will cover the entire course material covered until the time of the examination. The final examination will cover the entire course material covered during the entire semester. Examinations may include multiple-choice questions, open-ended questions, and problems. During the exam, students can have only a non-programmable scientific calculator. Internet-connected devices, books and notes are not allowed. Furthermore, the instructor reserves the right to enforce seating assignments for all exams.

The dates of the examinations are indicated in the Lecture Schedule.

Term paper

All students are required to write a term paper on a specific material used for medical devices, and present it in class during a dedicated session. The requirements for the term paper and the evaluation criteria will be posted on Canvas.

Students will work in small teams, which will be formed with members of their laboratory section. Each team will choose one material on which to report. Like the labs, the term paper must include an Acknowledgments section

indicating the specific contributions of each student. Students with no contribution will receive no credit for the term paper. Both term paper and presentation will be assessed by the instructor and one other student team, according to a rubric that will be made available at the beginning of the semester.

The deadline for submitting the term paper is **November 27, 2018**. Presentations are also scheduled for the week of November 26, 2018 (*subject to change with fair notice*), during the laboratory hours.

The term paper must be prepared in accordance with the Biomedical Engineering Department's Thesis Guidelines (posted on Canvas in the "Files" section). One electronic copy of the term paper must be submitted by the indicated deadline. **Only PDF files will be accepted.**

Students must cite **all sources** of data or information (including images) used in the term paper. Quoting *verbatim* (i.e. "copy and paste") from papers, textbooks, websites or other is strongly discouraged, and is strictly prohibited without the use of quotations. **Very limited use** of verbatim quotes is acceptable **only if** (1) the quoted text is short, (2) quote marks are used to delimit the quoted text, and (3) an appropriate reference is provided, with a citation number added immediately after the quoted text.

Failure to comply with proper citation requirements may be interpreted as plagiarism, which constitutes a violation of academic integrity. All term paper submissions will be automatically scanned in Turnitin to locate matching or similar text within the paper. The instructor will decide whether there is plagiarism case-by-case, in which case academic and administrative sanctions will be assigned according to the University Academic Integrity Policy S07-2 (<http://www.sjsu.edu/senate/docs/S07-2.pdf>).

Please view the video on plagiarism at the library's website for more information:
<http://libguides.sjsu.edu/plagiarism>

Late submissions are strongly discouraged. However, under exceptional circumstances and pending instructor approval, in case of late submission of the term paper, points will be deducted as follows:

- One day late: -10%
- Two days late: -25%
- Three days late: -50%

No submission will be accepted later than three days after the deadline. *Please note that this late submission policy only applies to the term paper assignment.*

Grading Information

Determination of Grades

Grades will be determined based on all the assignments and examinations, weighted as reported below:

Homework	5%
Challenges	5%
Midterm	20%
Final Examination	30%
Term Paper	10%
Term Paper Presentation	10%
Laboratory	20%
Extra-credit (iClicker)	2%

Participation with iClicker will be the only extra credit opportunity provided during the semester. Students will gain a fraction of the maximum 2% Extra-credit in proportion to their performance on the iClicker quizzes.

Letter Grades:

A+	> 97%
A	> 93% – 97%
A-	> 90% – 93%
B+	> 87% – 90%
B	> 83% – 87%
B-	> 80% – 83%
C+	> 77% – 80%
C	> 73% – 77%
C-	> 70% – 73%
D+	> 67% – 70%
D	> 63% – 67%
D-	> 60% – 63%
F	< 60%

Absence during examinations, without prior approval, will result in a zero. Prior approval will be given only under exceptional circumstances. All exam dates are posted on the Course Schedule. Please contact the instructor as soon as possible if you have such a situation. Traveling for breaks, vacation, family events, etc. do not constitute “exceptional circumstances”.

Note that “All students have the right, within a reasonable time, to know their academic scores, to review their grade-dependent work, and to be provided with explanations for the determination of their course grades.” See University Policy F13-1 at <http://www.sjsu.edu/senate/docs/F13-1.pdf> for more details.

Classroom Protocol

Attendance and arrival times

Students are expected to be set up for lecture by the time the class begins. Attendance in class is not mandatory and shall not be used per se as a criterion for grading. However, class attendance and participation are highly recommended.

NOTE that University policy F69-24 at <http://www.sjsu.edu/senate/docs/F69-24.pdf> states that “Students should attend all meetings of their classes, not only because they are responsible for material discussed therein, but because active participation is frequently essential to insure maximum benefit for all members of the class. Attendance per se shall not be used as a criterion for grading.”

Behavior

Students should remain respectful of each other at all times. Interruptive or disruptive attitudes are discouraged. While in the classroom, the use of electronic devices (laptops, tablets, smartphones) should be limited to activities closely related to the learning objectives, and should not be used for personal communication, included messaging and use of social media. All cell phones must be silenced prior to entering the classroom.

Students will respect a diversity of opinions, ethnicities, cultures, and religious backgrounds. Students will treat online discussions with their peers as if they were in-class, face-to-face interactions.

Safety

Students should familiarize themselves with all emergency exits and evacuation plans.

University Policies (Required)

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' [Syllabus Information web page](http://www.sjsu.edu/gup/syllabusinfo) at <http://www.sjsu.edu/gup/syllabusinfo>

BME/MATE 175 – Biomaterials – Fall 2018 Course Schedule

Tentative Course Schedule (*subject to change with fair notice*)

Week	Date	Topics & Readings	Term Paper Deadlines
1	8/21	Intro to Biomaterials. The Syllabus	
1	8/23	Biomaterial Requirements, Molecular Origins of Biomaterial Behavior (Ch. 1)	
2	8/28	Mechanical Properties of Biomaterials I (Ch. 2)	
2	8/30	Mechanical Properties of Biomaterials II (Ch. 2)	
3	9/4	Guest lecture - Corrosion, Dr. Guna Selvaduray	
3	9/6	Mech. Props. III	Term paper assigned
4	9/11	Surface Properties (Ch. 2 & 4.3)	
4	9/13	Metals as biomaterials – Stainless steel (Ch. 5)	Topic Selection due
5	9/18	Metals as biomaterials – Stainless steel (Ch. 5)	
5	9/20	Metals as biomaterials – Titanium (Ch. 5)	
6	9/24	Metals as biomaterials – CoCr alloys, Nitinol (Ch. 5)	
6	9/27	Sterilization of Medical Devices (Ch. 10)	
7	10/2	Ceramics as biomaterials (Ch. 7)	
7	10/4	Ceramics as biomaterials	Progress Report 1 due
8	10/9	Materials Characterization Techniques (Ch. 4)	
8	10/11	Midterm review	
9	10/16	Midterm exam	
9	10/18	TBD	
10	10/23	Introduction to polymers (Ch. 6)	
10	10/25	Polymers as biomaterials – PE, PMMA, PU	
11	10/30	Polymers as biomaterials – Silicones, Fluor., Acrylics	Progress Report 2 due
11	11/1	Polymers as biomaterials – Hydrogels	
12	11/6	Degradable and resorbable polymers (Ratner I.2.6)	
12	11/8	Surface modification (Ch. 9)	
13	11/13	Smart Polymers (Ratner, I.2.11)	
13	11/15	Biocompatibility testing, Biological Responses to Biomaterials (Ratner, II.2.1 & II.2.2)	

Week	Date	Topics & Readings	Term Paper Deadlines
14	11/20	Blood Interactions with Biomaterials/Thrombogenicity (Ratner, II.2.6)	
14	11/22	<i>THANKSGIVING – NO CLASS – CAMPUS CLOSED</i>	
15	11/27	Drug Delivery Systems (Ch. 12)	Term paper due
15	11/29	Guest lecture – TBD	
16	12/4	TBD	
16	12/6	Final exam review	
	12/11	<i>NO CLASS – FINALS BEGIN</i>	
Final Exam	12/12	09:45-12:00 in CL 222	