

# ENGG\*3170 Biomaterials

## Fall 2016



(Revision 1: Aug. 23, 2016)

---

## 1 INSTRUCTIONAL SUPPORT

### 1.1 Instructor

Instructor: Karen Gordon, Ph.D., P.Eng.  
Office: Richards 2517, ext. 52435  
Email: [kgordon@uoguelph.ca](mailto:kgordon@uoguelph.ca)  
Office hours: By appointment

### 1.2 Lab Technician

Jacqueline Fountain  
Thornbrough 1102, ext. 56676  
[fountain@uoguelph.ca](mailto:fountain@uoguelph.ca)

### 1.3 Teaching Assistants

---

GTA	Email
Calvin Young	<a href="mailto:cyoung@uoguelph.ca">cyoung@uoguelph.ca</a>
Connor Davies	<a href="mailto:cdavie05@uoguelph.ca">cdavie05@uoguelph.ca</a>
Oscar Valerio	<a href="mailto:ovalerio@uoguelph.ca">ovalerio@uoguelph.ca</a>

---

---

## 2 LEARNING RESOURCES

### 2.1 Course Website

Course material including lecture notes, news, announcements, and grades will be regularly posted to the ENGG\*3170 CourseLink site. You are responsible for checking the site regularly.

### 2.2 Required Resources

i>clickers are required for quizzes. There is not a required text book for this course.

### 2.3 Recommended Resources

1. W.D. Callister and D.G. Rethwisch, *Materials Science and Engineering: An Introduction*, 8<sup>th</sup> Edition, John Wiley & Sons, Inc., 2010.
2. J.S. Temenoff. And A.G. Mikos, Biomaterials, *The Intersection of Biology and Materials Science*, Pearson Prentice Hall Bioengineering, 2008.

### 2.4 Additional Resources

**Lecture Information:** All the lecture notes will be posted on the course website.

**Lab Information:** The lab manual will also be posted on the course website.

**Miscellaneous Information:** Other information related to Biomaterials may also be posted on the course website.

**2.5 Communication & Email Policy:** Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. **It is your responsibility to check the course website regularly.** As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its student.

---

## 3 ASSESSMENT

### 3.1 Dates and Distribution

**Quizzes (Individual):** 10% (best 3 of 4 – each quiz will be approximately 20 minutes in length)

Sept 22, in class

Oct 13, in class

Nov 10, in class

Nov. 24, in class

**Labs:** 25%

See section 5.3 below for due dates

**Debate:** 15%

Submission 1: Tuesday October 25, in class (5% details to follow)

Final Debate: During lab sessions the week of Nov 21 (10%)

**Midterm test:** 20%

Tuesday October 25, in class

**Final Exam:** 30%

Friday December 9, 11:30-1:30 pm, Room TBA on Webadvisor

### 3.2 Course Grading Policies

**Quizzes:** There will be four i>clicker quizzes during the lectures throughout the semester as scheduled. Students are expected to be present and use their own i>clicker during these quizzes. The quizzes are intended to help you better understand the course content and account for 10% of the course marks. Prior to the first quiz, you must register your i>clicker serial number by clicking on the “*Student i>clicker Registration*” link on the right side of the webpage: <http://www.tss.uoguelph.ca/lhci/clickers/index.cfm>

**Missed Assessments:** If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

**Accommodation of Religious Obligations:** If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

**Passing grade:** The passing grade in this course is 50%.

**Missed midterm tests:** If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the final exam. There will be no makeup midterm test.

**Lab Work:** You must attend and complete all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab.

**Late Lab Reports:** Late submissions of lab reports will only be accepted with the approval of the course instructor, and will be subject to penalties.

---

## 4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

### 4.1 Calendar Description

Physical properties of natural and synthetic (e.g. stainless steel, polymers) materials used in biological engineering applications. Topics will include microstructure and mechanical properties of typical biomaterials, quantification of advanced material properties and behaviours, fabrication, compatibility, biodegradation and mechanical failure. Typical applications will include processing of biomaterials as well as equipment and implant design.

*Prerequisite(s):* ENGG\*2120

### 4.2 Course Aims

This course is an introductory course in biomaterials, examining the materials used in biomedical and biological applications, and the materials that they are replacing such as bone, cartilage and ligament. The mechanical, chemical and physiological considerations for the use of these materials in medical applications will be examined. As well, design implications for the use, manufacture and processing of these materials will be covered. Finally ethical considerations as an engineer employed in this industry will be covered.

### 4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Analyze materials engineering problems specific to biomedical applications using a balance of mathematics, physics, chemistry, and physiologic considerations.
2. Demonstrate a working knowledge of general properties (mechanical, chemical, physiological) of both synthetic and natural materials used in biomedical and biological engineering applications.
3. Predict the stress/strain/time response of biological materials using mathematical equations.
4. Demonstrate competency in using materials testing equipment to obtain mechanical properties of biological materials.
5. Appraise and critique current methods of testing/standards required for the development of biomaterials in medical applications; including ethical issues involved.
6. Communicate effectively in a professional environment through technical reports and presentations.

#### 4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

<b>Graduate Attribute</b>	<b>Learning Objectives</b>	<b>Assessment</b>
1. Knowledge Base for Engineering	1,2,3,4,5,6	Quizzes, Exams
2. Problem Analysis	1,2,3,4	Quizzes, Exams,
3. Investigation	4	Labs
4. Design	-	-
5. Use of Engineering Tools	2,4,5	Labs
6. Communication	6	Labs, Debate
7. Individual and Teamwork	4,6	Labs, Debate
8. Professionalism	5	Debate
9. Impact of Engineering on Society and the Environment	5	Debate
10. Ethics and Equity	5	Debate
11. Business, & Project Management	-	-
12. Life-Long Learning	-	-

#### 4.5 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on CourseLink/D2L but these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and project.

#### 4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

## 4.7 Relationships with other Courses & Labs

### Previous Courses:

**ENGG\*2120 Materials Science.** Fundamentals of materials science are reviewed in this class, and built upon with biomedical applications in mind

### Follow-on Courses:

**ENGG\*4400 Biomechanical Engineering Design** – Design projects will integrate materials science principles with biomechanical applications.

**ENGG\*41X Fourth year engineering design IV** Design projects will integrate materials science principles.

---

## 5 TEACHING AND LEARNING ACTIVITIES

### 5.1 Timetable

#### Lectures:

Tuesday, Thursday	8:30 – 9:50	MCLN 102
----------------------	-------------	----------

#### Laboratory:

Friday	Sec 0101	3:30-5:20	THRN 1104
Monday	Sec 0102	3:30 - 5:20	THRN 1104
Monday	Sec 0103	1:30-3:20	THRN 1104
Wednesday	Sec 0104	3:30 - 5:20	THRN 1104
Friday	Sec 0105	1:30 - 3:20	THRN 1104
Thursday	Sec 0106	3:30 - 5:20	THRN 1104

## 5.2 Tentative Lecture Schedule

Lectures	Date	Lecture Topics	Learning Objectives
1-2	Sept 8 -13	Introduction to Biomaterials and Review of ENGG*2120	2,3
3-4	Sept 15-20	Fracture Mechanics/Failure Theory	2,3
5-6	Sept. 22	Thermal and Surface Properties of materials	2,3
6-7	Sept. 27-29	Metals and Metal Alloys	1,2,3
8	Oct 4	Ceramics	1,2,3
9	Oct. 6	Polymers	
10	Oct.13	Composites	1,2,3
11-12	Oct. 18-Oct. 20	Natural Materials; Properties and Characterization; Viscoelasticity	2.3.4
13	Oct. 25	Midterm exam	
14	Oct. 27	Bone	2,3
15	Nov. 1	Cartilage	2,3
16-17	Nov. 3-8	Ligament and Tendon	2,3
18-19	Nov. 10-15	Cell/Immune response	2,3
20	Nov. 17	Testing/Standards	
21-23	Nov.22-29	Corrosion and Wear	6
24	Dec 1	Review	

### 5.3 Lab Schedule

<b>Week</b>	<b>Topic</b>	<b>Due</b>
1 (Sept. 12)	No labs scheduled	
2 (Sept. 19)	Groups A, B and C: Safety and Lab equipment Orientation; Lab1- <i>Note: students must pass safety quiz administered at this lab session.</i>	During Lab period week 4
3 (Sept. 26)	Group D, E, and F: Safety and Lab equipment Orientation; Lab1 - <i>Note: students must pass safety quiz administered at this lab session.</i>	During Lab period week 6
4 (Oct. 3)	Group A – Lab 2; Group B – Lab 3 and 5, Group C – Lab 4	During Lab period week 7
5 (Oct. 10)	No labs – week of Thanksgiving and Fall Study day	
6 (Oct. 17)	Group D – Lab 2; Group E – Lab 3 and 5, Group F – Lab 4	During Lab period week 8
7 (Oct. 24)	Group A – Lab 3 and 5; Group B – Lab 4, Group C – Lab 2	During Lab period week 9
8 (Oct. 31)	Group D – Lab 3 and 5; Group E – Lab 4, Group F – Lab 2	During Lab period week 10
9 (Nov. 7)	Group A – Lab 4; Group B – Lab 2, Group C – Lab 3 and 5	During Lab period week 11
10 (Nov. 14)	Group D – Lab 4; Group E – Lab 2, Group F – Lab 3 and 5	During Lab period week 12
11 and 12 (Nov. 21 and 28)	All Groups – Debate. More details to follow on Courselink	



Note: Lab 5 is due from all groups on Nov. 30 by 5pm, to be submitted on Courselink. During off weeks when your group is not scheduled to conduct an experimental lab it is recommended to meet at a location of your choice with your group members to work on the lab report. The TA will be available during your lab time in THORN 1104 to answer questions related to the written submission.

#### **5.4 Other Important Dates**

Thursday, September 8, 2016: First day of class

Monday, October 10, 2016 Holiday: no classes scheduled

Tuesday, October 11, 2016: Fall Study Break Day – no classes scheduled

Friday, November 4, 2016: 40<sup>th</sup> class day, last day to drop

Friday, Dec. 2, 2016: Last day of class

---

## **6 LAB SAFETY**

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible. Each student will be required to pass a safety quiz during their first lab of the semester in order to gain access to the lab to complete the remaining labs.

---

## **7 ACADEMIC MISCONDUCT**

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member.

## 7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:

<http://www.academicintegrity.uoguelph.ca/>

Please also review the section on Academic Misconduct in your [Engineering Program Guide](#).

The School of Engineering has adopted a Code of Ethics that can be found at:

<http://www.uoguelph.ca/engineering/undergrad-counselling-ethics>

---

## 8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Student Accessibility Services as soon as possible

For more information, contact Student Accessibility Services SAS or see the website:

<http://www.uoguelph.ca/csd/>

---

## 9 RECORDING OF MATERIALS

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether this is the instructor, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

---

## 10 RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs: <http://www.uoguelph.ca/registrar/calendars/index.cfm?index>