BME 4414 Biomaterials
Fall 2017

Instructor
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Teaching Assistants
TA1
TA2

Meeting Time: MW 2:00 – 3:15 pm, 1041 MR5
Office Hours: MW 10 am – noon (or by appointment), 1213 MR5
Prerequisite: BME 2104 and BME 2220

Required Materials

Internet access via laptop or smartphone

Recommended Textbooks

1) *An Introduction to Tissue-Biomaterial Interactions*, Kay C. Dee, David A. Puleo, and Rena Bizios, John Wiley and Sons, ISBN 0-471-25394-4 (2002).
2) *Biomaterials Science*, Second Edition, Buddy Ratner, Alan Hoffman, Frederick Schoen, Jack Lemons, Academic Press, ISBN 978-0125824637 (2004).

The Why

Why are artificial knees destined to fail? Why can't we leave contact lenses in permanently? Why do fillers for lip injections need to be re-applied every five years? The answers lie in the realities of replicating tissue, a material that has grown in a way that was guided by function and has the ultimate advantage of an internal repair system. So how do we, as engineers, address this seemingly impossible task? Think like an engineer. Project and optimize an expected outcome based on your knowledge of environmental parameters, your functional goals, and your available tools. To have the most success possible we must agree that sometimes the goal of an engineer is not to find THE right answer – when considering biomaterials we don't have perfect answers yet, but there are a lot of possible answers (hint: some are better than others). Equally important, you will learn how to communicate your understanding and creativity in ways that are useful and varied (no matter where you go after UVA).

The What

By the end of this course you should be able to:

1. Identify how the body recognizes foreign material (F)
2. Analyze and project the expected changes in tissue activity as a function of material choice (F, A)

3. Strategize methods for adjusting materials to improve their function (F, A)
4. Critically evaluate past and current biomaterial approaches using current scientific literature (F, A, I, L)
5. Communicate complex ideas in an accessible manner for the general public (H, C, I)
6. Communicate complex ideas using accurate terminology to an expert audience (F, H, A)

Evaluation

In this course you will be evaluated by completing the following approaches:

Application Exams (mid-term and non-cumulative final) (20% each) In-class examinations will provide an opportunity for you to demonstrate your comprehension of both the overarching themes and important details of the course. Each exam will include a focus on applied knowledge. Exams will be written and taken individually.

Comprehension Quizzes (10%) Before the introduction of each new topic, you will read an assigned scientific review article to help provide professional context to the topic. An online 10-minute quiz will be used to keep everyone moving through course material at the same pace and to help inform emphasis of subsequent lectures. (In-class demonstration: 8/23)

Participation (5% bonus) Staying engaged with lecture is important to gain the most benefit. Throughout the lecture-portion of the class, you will be asked to answer questions via iClicker. This will help to gauge your understanding and inform the speed/direction of the class. Grading is all or nothing! To get your 5% extra credit, you must answer 90% of the questions and get 50% of the questions correct.

Communication-focused reflection (10%) One of the major services that biomedical engineers can provide to the general public is a clear communication of complex biomedical issues. To help you practice this, you will briefly summarize (2-3 sentences each) what you feel in your opinion are: the most important points from the 1) first and 2) second half of the introduction, 3) the most important method/technique, 4) the most important finding/result, and 5) the most important conclusion. Importantly, you will write this in terms that a general audience could understand (e.g. your parents, humanities major, etc.). (In-class collaborative demonstration: 8/28)

Communication Portfolio (40% total, breakdown listed below): You will complete a five-piece multimedia portfolio in which you focus on a biomaterial that is inherently flawed. The portfolio will force you to practice different mindsets of communication, including: 1) "The Imperfect Biomaterial" – an undergraduate summer research proposal (In-class collaborative demonstration: 9/18), 2) "Reviewing the Field" – a referenced introduction to a fellowship application (In-class collaborative demonstration: 10/16) that will be transformed into 3) a Wikipedia-like article, and 4) "More Perfect Biomaterial" – a Specific Aims page for a small business grant (In-class collaborative demonstration:

11/6) that you will transform into a 5) "More Perfect Biomaterial Investor Pitch" – video pitch to potential investors (In-class demonstration: 11/20).

Communication Portfolio Breakdown

The Imperfect Biomaterial (8%): For this first step, you will focus on the selection and proposed use of an imperfect natural material from a temperate forest (limitations listed will be covered in class) for a biomedical application. Expect that any material you choose will be very imperfect…accept that upfront. The format of the proposal will be an application for undergraduate summer funding to research the material with a focus on evaluation of the material, including perceived benefits and drawbacks (focusing on material moduli, structure, degradation, etc.). To give you plenty of time to ruminate on this project, you will be required to "pitch" your idea via email to Prof. Griffin no later than 2 weeks before the deadline (October 9th). This portion of your portfolio is due October 24th.

Reviewing the Field (8%): The second step of this project is to research the biomedical application previously proposed in "The Imperfect Biomaterial" section. This is intended to give you practice in reviewing and critically analyzing the current state of the art material approaches. The format of the assignment will be in the context of the introduction of a fellowship application (with a focus on statement of the problem and how its being approached).

Wikipedia-like article (8%): An important role that biomedical engineers play in society is acting as an accurate conduit of complex ideas to the public. To practice this role, you will translate the critical review you wrote for "Reviewing the Field" into a Wikipedia-style article using language aimed at the general public, but maintaining accuracy.

More Perfect Biomaterial (8%): Next, we will build from the first project ("The Imperfect Biomaterial") with a focus on either chemically/physically modifying the original material or combining it with a different material (forming a composite) to produce a more functional (as argued by you) biomaterial construct. This assignment will come in the form of a Specific Aims page for a NIH Small Business Innovation Research (SBIR) Award.

More Perfect Biomaterial Investor Pitch (8%): The final stage will require you to make a 5-minute video pitching your biomaterial to a potential financial investor. This investment pitch will be a translation of your "More Perfect Biomaterial" and should be a PowerPoint-assisted (max of 3 content slides) oral presentation. Your peers will vote on which video they feel is the most convincing and these will be shown in the last class period (for a small bonus credit!).

Course Schedule

<u>Before either a review article or research article class period (indicated below) you will have to do one of these:</u>

1) On days that a review article is to be discussed you must complete a 10-minute graded online quiz (cumulative this will account for 10% of your grade). The quiz must be completed by 10am the day of the class. This means you must read the review article before the class!
2) On days that a research article is to be discussed you must complete a reflection of the article (cumulative this will account for 10% of your grade). The details of the reflection are described in the "The How" section above.

Introduction
Wednesday, 8/23

Cohesion, Adhesion, Surface Tension
(Tissue is 3D, so do these silly 2D things even matter?)
Monday, 8/28: [review article]
Wednesday, 8/30: [research article]

Protein Adsorption
(Who cares about proteins? Where are the plastics, metals, and ceramics?)
Monday, 9/4: [review article]
Wednesday, 9/6: [research article]
Monday, 9/11: [research article]

Cell-Surface Interactions
(We've made contact, so where do we go from here?)
Wednesday, 9/13: [review article]
Monday, 9/18: [research article]
Wednesday, 9/20: [research article]

Bulk and Surface Properties
(Does the body judge the book by its cover?)
Monday, 9/25: [review article]
Wednesday, 9/27: [research article]

No Class Monday, 10/2: Reading Day

Biocompatibility
(If it doesn't kill you, it makes you stronger, right??)
Wednesday, 10/4: [review article]
Monday, 10/9: [research article]

MID-TERM EXAM

Wednesday, 10/11

Overview of Biomaterial Bonds
(Why do the bonds matter?)
Monday, 10/16: [review article]

Naturally-Derived Biomaterials
(Organic is better, right?)
Wednesday, 10/18: [review article]
Monday, 10/23: [research article]

Polymeric Biomaterials
Wednesday, 10/25: [review article]
Monday, 10/30: [research article]
Wednesday, 11/1: [research article]
Monday, 11/6: [research article]

Ceramic Biomaterials
Wednesday, 11/8: [review article]

Metallic Biomaterials
Monday, 11/13: [review article]

Wound Healing
Wednesday, 11/15: [review article]
Monday, 11/20: [research article]

No Class Wednesday, 11/22: Happy Thanksgiving!

Bone Implants
Monday, 11/27 [review article]
Wednesday, 11/29 [research article]

Course Review
Monday, 12/4

FINAL EXAM
[DATE HERE]