

Master Syllabus

Course: BNG162, Current topics in bioengineering: designing a healthier planet and its people

Cluster Requirement: 2B, Science in the Engaged Community

Instructors: Qinguo Fan, office hours: TEX 215, MTWTh, 12 -1 pm,
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Classroom Location: TEX 102. MWF, 9 - 9:50

Course credit: 3

Contact hours: Lecture 3 hours/week

Course Overview

An overview of important areas of bioengineering with a focus on how design can benefit all biological systems spanning from the environment and our planet, to the humans that populate the planet. Topics for study will include how chemistry can help improve energy sources, waste management and help decrease the effect of human activities on the environment, how medicine science has developed to solve problems with human bodies, how engineering design can improve the health and well being of humans through biomedical devices, tissue regeneration and organ replacement, how government agencies work to regulate the biobusiness activities in the US, and how effective communication play an important role in R&D and marketing of bio-related concepts and products. We will examine the social and political issues surrounding these topics including the cost of healthcare, ethics of bioresearch and impacts of legislation and regulations on the "progress" in all of these fields.

Course-Specific Learning Outcomes

Having successfully completed this course, the student will have a basic understanding of the current and future roles of bioengineering design for sustaining our world. The students will have discernment of biological functions and how organisms at all levels impact the health of our planet and the humans that live here. They will know current energy sources and the challenges to generate cleaner, more affordable energy economically, and the mechanisms to be used in designing more efficient systems. They will also see the future role of biomedical devices in medicine, including an appreciation of the importance of animal and clinical testing, business considerations, regulatory affairs and medical ethics.

University Studies Learning Outcomes

Cluster 2B: Science in the Engaged Community- After completing this course, students will be able to:

1. Analyze and evaluate the use of scientific information in the context of social, economic, environmental or political issues.
2. Apply scientific theories and knowledge to real-world problems.
3. Effectively communicate scientific information in writing. Students will engage in the design of a "solution" to a current day problem. They will research and analyze their topic, apply concepts provided in the class and design a plan of action. This will require them to identify real-world problems and synthesize the knowledge into a coherent research plan. This will require generating a written report that includes extensive background information on the problem and a well-written plan of action.

Prerequisites

None

Readings

Online notes will be made available after class.

Readings will be made available online and will be drawn from current event topics

Examples:

Cutting Edge Prosthetic Arms- YouTube (<http://www.youtube.com/watch?v=T6R5bm6qx2E>)

Bionic Soldiers- You Tube (http://www.youtube.com/watch?v=52tFyg0O_bs)

Drug Delivery Systems, Edited by Kewal K. Jain, Humana Press, 2008, ISBN: 978-58829-891-1

<http://www.altenergy.org>

Wood TK, Hong SH, Ma Q. Engineering biofilm formation and dispersal. Trends Biotechnol. 2011 Feb;29(2):87-94. Epub 2010 Dec 4. Review.

Logan BE. Exoelectrogenic bacteria that power microbial fuel cells. Nat Rev Microbiol. 2009 May;7(5):375-81. Epub 2009 Mar 30. Review.

Samiec M, Skrzyszowska M. Transgenic mammalian species, generated by somatic cell cloning, in biomedicine, biopharmaceutical industry and human nutrition/dietetics--recent achievements. Pol J Vet Sci. 2011;14(2):317-28. Review.

Laible G. Enhancing livestock through genetic engineering--recent advances and future prospects. Comp Immunol Microbiol Infect Dis. 2009 Mar;32(2):123-37. Epub 2008 Feb 19. Review.

Garg T, Singh O, Arora S, Murthy R. Scaffold: a novel carrier for cell and drug delivery. Crit Rev Ther Drug Carrier Syst. 2012;29(1):1-63.

Krawiec JT, Vorp DA. Adult stem cell-based tissue engineered blood vessels: A review. Biomaterials. 2012 Apr;33(12):3388-400. Epub 2012 Feb 4.

Macaya D, Spector M. Injectable hydrogel materials for spinal cord regeneration: a review. Biomed Mater. 2012 Feb;7(1):012001. Epub 2012 Jan 13.

<http://www.buzzle.com/articles/pros-and-cons-of-genetic-engineering.html>

http://www.sumanasinc.com/webcontent/animations/content/stemcells_scnt.html

<http://www.news.wisc.edu/20290>

<http://news.nationalgeographic.com/news/2012/02/120229-women-health-ovaries-eggs-reproduction-science/>

http://www.21stcenturysciencetech.com/articles/winter01/stem_cell.html

http://www.pharmahorizons.com/industry_reporte.pdf

Example assignments:

The cluster 2B learning outcomes are assessed throughout the course. Course evaluation will include short (5-10 question) weekly, multiple choice quizzes and multiple writing assignments. Several writing assignments are described below and grading rubrics are attached.

Three writing assignments will be assigned to promote investigation into current areas of bioengineering. Learning outcomes #1 and 3 will be assessed through these assignments. Emphasis will be placed on students identifying how each innovation impacts the social, economic, political and in some cases environmental issues of the current day. Furthermore, students will be expected to search scientific literature and cite sources thoroughly and in proper format. Sequential assignments are designed to promote more in depth understanding of topics as the semester progresses.

1. Early semester assignment:(grading rubric attached)

Search and read online and complete a review paper with "150" words for one of the following topics: references should be cited.

- A. alternative energy sources B. Dental Implant

2. Mid Semester Assignment:

Search and read online and complete a review paper with "500" word for each topic listed below: references should be cited

- A. Biofilm energy production potential B. Total Joint Arthroplasty

3. *Late semester assignment:*

Search and read online and complete a review paper with "500" word for each topic listed below: references should be cited.

- A. Genetically engineered crops B. Stem Cells and organ engineering

4. Final Assignment (grading rubric attached)

This assignment is designed to be a synthesis of course concepts and assessment of course learning outcome 2.

Students are expected to develop an action plan for a topic of interest from the course. Provide introductory material outlining the topic. Propose an experiment testing a specific hypothesis you have generated based on your research. Discuss possible outcomes.

Example: Edible vaccine design proposal.

You are expected to formulate a proposal to develop a new vaccine that can be administered through eating a genetically modified food. Using the following article as a reference, <http://www.scribd.com/doc/30280208/Plant-Derived-Vaccines>, You are expected to describe how molecular cloning can be use to generate a hybrid food that can be used as a vaccine. You must chose a disease causing agent (ie: bacteria or virus), clone an antigenic protein into a food of choice based on our lectures. You will also be required to outline how you will test that the vaccine has generated an immune response indicating success. You must utilize the steps of the scientific method when composing this proposal. You should also indicate how, if successful, your new vaccine will be economically beneficial, how lower cost will facilitate political and social improvements in underdeveloped regions both here in America and the broader implications in third world countries.

Examples of other short homeworks:

Simulated on-line laboratory exercises

The students will be required to work through on-line laboratory exercises to solidify experience with the scientific method. Initially on-line modules from http://www.occc.edu/biologylabs/Documents/Scientific%20Method/Scientific_method.htm will be used with UMD created modules to be developed. These will provide a foundation for critical thinking that the students will need for their final project.

The sequence of these assignments will allow the students to gain experience in critical thinking and identification of current challenges facing society. The assignments will refine their writing skills and prepare them for the more in depth end of term project. The broad scope of these

topics and the use of numerous written assignments will support the goals of the University Studies Cluster 2.

Evaluation (Approximate Distribution)

Homework	26%
Term research report	20%
Quizzes (13 x 3% ea.)	39% (the two with the lowest score are not counted)
Final Exam	15%

No make-up exams will be allowed. Any assignments including homework, quizzes and term reports should be submitted in time. Late submissions will not be graded. A grade of "Incomplete" may be given only after a student requests it in exceptional circumstances at the instructor's discretion. The final exam is cumulative.

Students should be aware that suspect assignments (e.g., those without works cited section, or with large departures in style) will be submitted to SafeAssign by the instructor for the purpose of detecting possible plagiarism. Submitted assignments will be included in the UMass Dartmouth dedicated databases of assignments. These databases of assignments will be used solely for the purpose of detecting possible plagiarism in the grading process during this term and in the future. Students must provide an electronic copy of their assignments to the instructor for submission to the service when plagiarism is suspected, in order to receive a grade on the assignment and to avoid possible sanctions.

Sample Course Outline

Topics in Environmental engineering

- alternative energy sources
- cleaner industrial outputs
- waste management

Topics in biomedical engineering

prosthetics

- eye, limbs

biomedical devices

- simple implants, heart valves
- knee and hip replacements
- pace makers (implanted electronics)

Topics in governmental regulation

- Ethics
- oversight of human and animal testing
- The FDA (Food and Drug Administration)

Topics in biology

- basic biological activities
- evolution, DNA
- bacteria, eukaryotic cells

Topics in Genetic engineering

- agricultural crop engineering
- cloning, animal genetic engineering
- vaccine development
- pharmacology
- gene chips

Topics in tissue engineering

- stem cells, tissue regeneration
- diabetes
- organ replacement
- the immune system

<i>Dr. Fan</i>	<i>TOPIC</i>
Jan 31 (Mon)	Reduce, Reuse Recycle and sustainability
Feb 1 (Wed)	Waste management
Feb 3 (Fri)	Clean manufacture and production, quiz 1
Feb 6 (Mon)	Solar energy
Feb 8 (Wed)	Fuel cells
Feb 10 (Fri)	Other alternative energies,
	quiz 2
Feb 13 (Mon)	Biomaterials
Feb 15 (wed)	Controlled release
	medicines
Feb 17 (Fri)	Sutures, quiz 3
Feb 20 (Mon)	no class (holiday)
Feb 21 (Tues)	Monday's schedule, Bones and teeth
Feb 22 (Wed)	Joint replacement
Feb 24 (Fri)	Dental implants, quiz 4
Feb 27 (Mon)	Heart valves
Feb 29 (Wed)	imbedded biosensors and actuators
March 2 (Fri)	Other prosthetics, quiz 5
March 5 (Mon)	Eye
March 8 (Wed)	Intraocular lenses
March 9 (Fri)	Eye implants, quiz 6
March 12 (Mon)	Engineering ethics
March 14 (Wed)	Governmental regulations
March 16 (Fri)	The FDA, quiz 7

March 17-25 SPRING BREAK!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

<i>Dr. Ferreira</i>	<i>Topic</i>
March 26 (mon)	bacteria vs eukaryotic
March 28 (wed)	evolution
March 30 (fri)	quiz 8 , bacterial "potential"
April 2 (mon)	harnessing microorganisms
April 4 (wed)	slime molds

April 6 (fri)	quiz 9 , eukaryotic cell function	
April 9 (mon)	cells-tissues-organs	
April 11 (wed)	cell communication	
April 13 (fri)	quiz 10 , immune system (I)	<u>(last day to withdraw)</u>
April 16 (mon)	<u>No class Patriots Day</u>	
April 18 (wed)	immune system, vaccines (II)	
April 20 (fri)	diabetes	
April 23 (mon)	biomechanical devices	
April 25 (wed)**	quiz 11 , tissue regeneration (I)	
April 27 (fri)	stem cells- what is "pluripotent"	
April 30 (mon)	tissue regeneration (II)	
May 2 (wed)	organ replacement	
May 4 (fri)	quiz 12 , cloning	
May 7 (mon)	animal cloning	
May 9 (wed)	crop engineering	
May 11 (fri)	quiz 13 , drug development	
May 14 (mon)	drug manufacturing	

BNG 162 Grading Rubric

Writing Assignment 1. (150 word summary)

Use of proper English and punctuation.

_____ less than 2 errors +20

_____ less than 10 errors +15

_____ more than 10 errors +10

Discuss specifically how these innovations or areas of study impact:

_____ social issues (+15)

_____ economic issues (+15)

_____ environmental OR political (chose one) (+15)

Include discussion regarding the CURRENT future directions for these fields of bioengineering AND how these discoveries are addressing current problems in society.

_____ future directions included (+20)

_____ lack of discussion (+0)

Proper in text citation of your sources

_____ correctly cited (+5)

_____ no citations (+0)

Properly formatted Reference list provided. You are required to have at least 3 sources and one MUST be an article published in a scientific magazine.

_____ 3 references listed correctly (+10)

_____ only 2 sources (+5)

_____ only 1 source and not including an article from a journal (+0)

BNG 162 Grading Rubric

Final term proposal

Inclusion of relevant sections of proposal

Introduction (+35)

___ detailed discussion of current vaccines and why a new vaccine would benefit society (+25)

___ correct citation format within text (+5)

___ inclusion of minimum of two relevant research articles from a journal (+5)

Impact statement (+30)

___ discuss economic benefits of your proposed design (+15/10)

___ discuss how this new discovery will impact social and political aspects of society (+15/10)

___ if applicable discuss how this will impact the environment (0/+5)

Methods (+15)

___ clear hypothesis on what you expect from your work (+5)

___ provide a stepwise protocol on how you will perform your work (+5)

___ describe how you will test if your experiment was successful (+5)

Expected outcomes (+10)

___ clear statement describing your expected outcome based on your introductory/background material. (+10)

Reference list (+10)

___ all references included (+5)

___ all references formatted correctly (+5)