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, qinguo.fan@umassd.edu,
Tracie Ferreira, office hours: TEX 212: M 12-1pm, W 12-1pm, Th 3-4pm, tferreira@umassd.edu

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- YouTube (http://www.youtube.com/watch?v=52tFxg0O-bs)
http://www.altenergy.org


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

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


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


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)

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Homework</td>
<td>26%</td>
</tr>
<tr>
<td>Term research report</td>
<td>20%</td>
</tr>
<tr>
<td>Quizzes (13 x 3% ea.)</td>
<td>39% (the two with the lowest score are not counted)</td>
</tr>
<tr>
<td>Final Exam</td>
<td>15%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Dr. Fan</th>
<th>TOPIC</th>
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<tbody>
<tr>
<td>Jan 31 (Mon)</td>
<td>Reduce, Reuse Recycle and sustainability</td>
</tr>
<tr>
<td>Feb 1 (Wed)</td>
<td>Waste management</td>
</tr>
<tr>
<td>Feb 3 (Fri)</td>
<td>Clean manufacture and production, <strong>quiz 1</strong></td>
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<tr>
<td>Feb 6 (Mon)</td>
<td>Solar energy</td>
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<tr>
<td>Feb 8 (Wed)</td>
<td>Fuel cells</td>
</tr>
<tr>
<td>Feb 10 (Fri)</td>
<td>Other alternative energies, <strong>quiz 2</strong></td>
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<tr>
<td>Feb 13 (Mon)</td>
<td>Biomaterials</td>
</tr>
<tr>
<td>Feb 15 (Wed)</td>
<td>Controlled release medicines</td>
</tr>
<tr>
<td>Feb 17 (Fri)</td>
<td>Sutures, <strong>quiz 3</strong></td>
</tr>
<tr>
<td>Feb 20 (Mon)</td>
<td>no class (holiday)</td>
</tr>
<tr>
<td>Feb 21 (Tues)</td>
<td>Monday's schedule, Bones and teeth</td>
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<tr>
<td>Feb 22 (Wed)</td>
<td>Joint replacement</td>
</tr>
<tr>
<td>Feb 24 (Fri)</td>
<td>Dental implants, <strong>quiz 4</strong></td>
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<tr>
<td>Feb 27 (Mon)</td>
<td>Heart valves</td>
</tr>
<tr>
<td>Feb 29 (Wed)</td>
<td>imbedded biosensors and actuators</td>
</tr>
<tr>
<td>March 2 (Fri)</td>
<td>Other prosthetics, <strong>quiz 5</strong></td>
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<tr>
<td>March 5 (Mon)</td>
<td>Eye</td>
</tr>
<tr>
<td>March 8 (Wed)</td>
<td>Intraocular lenses</td>
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<tr>
<td>March 9 (Fri)</td>
<td>Eye implants, <strong>quiz 6</strong></td>
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<tr>
<td>March 12 (Mon)</td>
<td>Engineering ethics</td>
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<tr>
<td>March 14 (Wed)</td>
<td>Governmental regulations</td>
</tr>
<tr>
<td>March 16 (Fri)</td>
<td>The FDA, <strong>quiz 7</strong></td>
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March 17-25 | **SPRING BREAK!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!**

<table>
<thead>
<tr>
<th>Dr. Ferreira</th>
<th>Topic</th>
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<tbody>
<tr>
<td>March 26 (Mon)</td>
<td>bacteria vs eukaryotic</td>
</tr>
<tr>
<td>March 28 (wed)</td>
<td>evolution</td>
</tr>
<tr>
<td>March 30 (Fri)</td>
<td><strong>quiz 8</strong>, bacterial &quot;potential&quot;</td>
</tr>
<tr>
<td>April 2 (Mon)</td>
<td>harnessing microorganisms</td>
</tr>
<tr>
<td>April 4 (wed)</td>
<td>slime molds</td>
</tr>
</tbody>
</table>
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)  (last day to withdraw)
April 16 (mon)         **No class Patriots Day**
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)