1. Logistics
Instructor:
Dr. Sagnik Basuray
387 Tiernan Hall
sagnik.basuray@njit.edu

Class Time: M: 6:00 PM – 9:00 PM
Class Location: KUPF 117
Lab Location: Tiernan 109
Office Hours: Tiernan Room 387, Tuesdays from 3:00 P.M to 5:00 P.M.
TA: Nida Riaz (nsr22@njit.edu)

Text: Introduction to Biotechnology (3rd Edition) by William J. Thieman (Author), Michael A. Palladino (Author).....And hand-outs, lecture notes and presentations will be available on Moodle
Communication:
A Moodle website for the course provides assignments, required materials, and a schedule of lectures

2. Course Information
Description:
The course will cover basic scientific knowledge and its application in biotechnology. We will start with an introduction to molecular biology (cells, proteins, DNA) and its practical applications with some historical examples. The fundamentals of Chemical engineering processes will be used to provide sufficient tools and basic knowledge to understand biotechnology. During the course, some simple formulas for calculations related to molecular biology useful in biotechnology will be introduced as and when possible. Further simple demonstration and live experiments will be conducted to show the students the working principles of the different recombinant DNA techniques and how they are used. We will discuss in details the emerging areas of biotechnology, for example Plants, Forensics, Sequencing, Regulatory pathways and agencies. Towards the end of the course, we will see how the application of Nanotechnology and Electronics is changing the face of the biotechnology industry from cancer detection to wearables. In addition to that, ethical, legal and social issues related to some provocative themes and issues in Biotechnology like genetically modified (GM) food or organisms (GMO), genetic testing, stem cells among others will be touched on.

Course Objectives:
The anticipated knowledge, skills and/or attitude to be developed by the student are:
- Understand what “biotechnology” means and what it encompasses
- Appreciate the diversity of molecular biology; from eukaryotic and prokaryotic cells, to the concept of gene, nucleotide structure, type of RNA and replication process.
- Develop an appreciation of the different molecular biology techniques from recombinant DNA technology to proteomics
- Have fundamental understanding and be able to broadly categorize biotechnological processes based on the products formed and/or the process or substrates used
- Have an understanding of the common methods of application and significance of biotechnology and its resultant industries from medicine to human genome project
- Appreciate the multidisciplinary nature of biotechnology
- Have an awareness of the regulatory framework regarding biotechnology and some of the current and future ethical issues surrounding biotechnology

Prerequisites:
Undergraduate classwork in CHEM 122 – Fundamentals of Chemical Principles or CHEM 126 – General Chemistry II

Besides the technical objectives (Instructional Objectives) that will be distributed weekly, the Learning Objectives of CHE 380 are as follows:

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Assessed</th>
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<tbody>
<tr>
<td>Apply knowledge of math, science, and chemical engineering to biotechnology</td>
<td>Homework, Experiments, Exam and Projects</td>
</tr>
<tr>
<td>Identify, formulate, and solve biotechnology problems</td>
<td>Homework and exams</td>
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<tr>
<td>An understanding of professional and ethical responsibility</td>
<td>Homework and exams</td>
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<td>Communicate effectively</td>
<td>Homework and exams</td>
</tr>
<tr>
<td>Understand the impact of engineering solutions in a global and societal context.</td>
<td>Homework and exams</td>
</tr>
<tr>
<td>A knowledge of contemporary issues</td>
<td>Homework and exams</td>
</tr>
<tr>
<td>Integrate engineering and biological sciences</td>
<td>Homework, Exams, exams, and project</td>
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Goals:
The course aims to fulfill several academic and professional goals.
- Address students’ research needs
- Improve scientific communication. Cultivate critical thinking
- Allows students to understand, relate and appreciate the field of biotechnology.

3. Schedule of Classes, Assignments

**Topic**

**Section 1: The workers of Biotechnology**

Genes and Genome, The molecules of Life
- Eukaryotic and Prokaryotic cells
- Cell structure, definition
- Concept of gene as genetic materials
- Structure of nucleotide
- Type of RNA and protein Synthesis

Recombinant DNA technology
- Mutations and DNA Cloning
- Restriction Enzymes, Plasmid DNA
- Bacterial Transformation
- Polymerase Chain Reaction

**Experiment 1:**
Length of DNA molecules – Introduction to Gel Electrophoresis
Application of Recombinant DNA technologies
- Gel electrophoresis
- DNA sequencing

Homework 1

Readings/HW
- Section 2.1
- Section 2.1
- Section 2.2
- Section 2.3
- Section 2.4
- Section 3.1
- Section 3.1
- Section 3.1
- Section 3.3
- Section 3.4
- Section 3.4, 3.5
Whole Genome Sequencing  
Bioinformatics  
Human Genome Project  

**Experiment 2:**  
The Length of DNA Molecule using Restriction Nuclease Mapping of DNA  

**Experiment 3:**  
Identifying Genomic and Plasmid DNA Sequences in E. Coli by Colony PCR  

**Homework 2**  

**First Mid-Term**  

**Proteins**  
- What is Protein?  
- Structure of Protein  
- Protein as product  

**Experiment 4:**  
Serum Proteins and the Western Press-Blot  

**Section 2: Biotechnology Industry**  
Microbial Biotechnology  
- Characteristics of Gram positive and Gram negative bacteria - Structure  
- Fermentation process and industry  
- Enzyme – Structure and properties  
- Vaccine  

**Homework 3**  

**Section 3: The future of Biotechnology**  
Modern topics in Biotechnology  
- Nanotechnology – Drug delivery, environmental pollution  
- Bio-diagnostics and microarrays  
- Bio-diagnostics and Microfluidics and nanofluidics – Point-of-Care and Lab-On-A-Chip devices  
- Bio-sensors and bioterrorism  
- Bio-mass and biofuel  
- Bio-electronics – Sequencing, DNA origami, DNA computing  
- Artificial Tissues, Stem Cell Therapy – The future of medicine  

**Experiment 5:**  
Tissue Printing  

**Second Mid-Term**  

**Section 4: Applications of the Biotechnology Industry**  
Plant Biotechnology  
- Protoplast fusion,  
- Chloroplast engineering,  
- Transformation  
- GM plants – ethical, political and scientific issues.  

Animal Biotechnology  
- Animal model as applied to human  
- Cloning  
- Human Antibody and Animals  

Class Notes, Section 11.1  
Class Notes, Section 7.2, 7.3  
Class Notes, Section 7.4  
Class Notes, Section 5.8  
Class Notes, Section 5.6  
Class Notes  
Class Notes  
Class Notes  
Class Notes  
Class Notes  

Aquatic Biotechnology
- Fisheries and environment
- Aquaculture

The Biotechnology Legal Framework
- Patents
- Regulatory Framework
- Future

**Experiment 4:**
The ELISA Immunoassay

Note: The professor reserves the right to change the syllabus as needed. Where necessary, the reading from the book will be supplemented by class notes, reading assignments and other literature.

**4. Course Policies**

**GRADING**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Problem Sets</td>
<td>20% (4 homeworks, each 5 points)</td>
</tr>
<tr>
<td>Exam 1 and Exam 2: (Mid-Term 1)</td>
<td>20% (Best of 1 Mid-Term)</td>
</tr>
<tr>
<td>Exam 3: (Finals)</td>
<td>25%</td>
</tr>
<tr>
<td>Class Participation:</td>
<td>5% (pop quizzes, 1 point each)</td>
</tr>
<tr>
<td>Experiment Participation:</td>
<td>5% (5 experiments, 1 point each)</td>
</tr>
<tr>
<td>Final Project:</td>
<td>20%</td>
</tr>
<tr>
<td>Final Experiment:</td>
<td>5%</td>
</tr>
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</table>

**CLASS PARTICIPATION**
Your participation grade will take into account:
- The quality of questions to and responses to questions from course instructor
- Preparation for, and interaction with, instructor on specialty topics
- Use of Moodle and participation in discussion board topics as assigned
- Punctuality, attendance, and prior negotiation of approved absences for causes other than illness
- **Pop quizzes** will be given randomly throughout the semester. Students who read the assigned readings will have no problems passing the quizzes.

**HOMEWORK**

1. Homework assignments will be uploaded on Moodle if assigned on a Friday which will be due by class time **the following Friday at the start of the class**. Typically, it will be a mix of problems: reading assignments, perform calculations, and literature search.
2. Late Problem Sets will not be accepted. Problem Sets are considered late if received later than the start of class. No extensions, since you have all of the assignments on Moodle.
3. Problem Sets should be turned in on paper. Write your name, assignment number on the top to get the credit.
4. Any question that requires diagrams, graphs, etc. has to be made by you. Do NOT copy and paste a figure from a digital source. However feel free to draw it using any software.
5. If you use a reference (published paper, textbook, website) to find information, including diagrams, graphs, etc., list the source as a reference at the end of the problem you used it in. Use AIChE style for referencing. Not including a reference where a reference is needed will carry a penalty of a 1 point.
6. Students are encouraged to work together on homework assignments, but you must turn in your own solutions. Also, you must list your collaborators name on the first page of the Problem Set.
7. Each problem will be graded according to the homework guidelines.
8. Lastly, if I cannot read your handwriting, I will give your sets a zero. Make sure you write neatly so I can give you the grade you deserve.
**Homework Grading Guidelines** (will be provided to all Teaching Assistants), the score will be awarded using the following guidelines (adapted from the Chemical Engineering Department at the University of Colorado, Boulder):

10. Problem completely correct as intended, or completely correct based on an interpretation that could be correctly inferred from the problem statement
9. Substantially complete and correct - but with one minor error like arithmetic
8. Substantially complete and correct - but with multiple minor errors or one major error such as a bad assumption
7. Demonstrates acceptable understanding of the problem, and knowledge of the proper method of solution; but solution is neither complete nor correct
6. Minimum passing grade - appears to understand the problem and have a general idea of the correct method of solution
5. Indication of understanding of the problem, but wrong approach to solution
4. Indication of understanding of the problem. No solution attempted
3. Indication of incomplete understanding of the problem. No solution or completely wrong approach.
2. Something on papers such as a diagram or equation not provided in the problem statement
1. Nothing on paper that was not provided in the problem statement

**EXAM**
The exam questions will range in difficulty from easy to challenging. There will be an appropriate mix of questions from multiple objective type, true/false questions to summary questions. Some questions will involve mathematical computations. I will take improvement during the course into account in the final grade determination. The exam will be cumulative and will be taken during a class period. There will be no make-up tests for students who miss an exam unless there is a legitimate excuse.

**FINAL PROJECT**
Please refer to the project information document on Moodle.

**EXPERIMENTS AND FINAL EXPERIMENTS**
For all the experiments including the final experiments, details will be provided during class and more information on the protocols, procedures for each experiment will be available on Moodle as and when the experiments will be run. Videos of experimental designs will also be provided for self-study.

**GRADES**
The grades will be based on the following grading scale:

<table>
<thead>
<tr>
<th>Percentage Range</th>
<th>Grade</th>
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<tbody>
<tr>
<td>93.00 – 100.00%</td>
<td>A</td>
</tr>
<tr>
<td>85.00 – 92.99%</td>
<td>B+</td>
</tr>
<tr>
<td>75.00 – 84.99%</td>
<td>B</td>
</tr>
<tr>
<td>62.00 – 74.99%</td>
<td>C+</td>
</tr>
<tr>
<td>50.00 – 61.99%</td>
<td>C</td>
</tr>
<tr>
<td>40.00 – 49.99%</td>
<td>D</td>
</tr>
<tr>
<td>&lt;39.99%</td>
<td>F</td>
</tr>
</tbody>
</table>
Statement of Academic Integrity

Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person’s work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards breaches of the academic integrity rules as extremely serious matters. Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor.

4. Plagiarism and Academic Integrity

The approved “University Code on Academic Integrity” is currently in effect for all courses. Should a student fail a course due to a violation of academic integrity, they will be assigned the grade of “XF” rather than the “F” and this designation will remain permanently on their transcript.

All students are encouraged to look over the University Code on Academic Integrity and understand this document. Students are expected to uphold the integrity of this institution by reporting any violation of academic integrity to the Office of the Dean of Students.

The identity of the student filing the report will be kept anonymous. NJIT will continue to educate top tier students that are academically sound and are self-disciplined to uphold expected standards of professional integrity. Academic dishonesty will not be tolerated at this institution.

5. Student Disability Services

NJIT is committed to providing students with documented disabilities equal access to programs and activities. If you have, or believe that you may have, a physical, medical, psychological, or learning disability that may require accommodations, please contact Student Disability Services. Information on the self-identification, documentation and accommodation process can be found on the webpage at: http://www.njit.edu/counseling/services/disabilities.php.

6. Getting Help - General

The IST Helpdesk is the central hub for all information related to computing technologies at NJIT. This includes being the first point of contact for those with computing questions or problems. There are three ways to contact the Helpdesk:

1. Call 973-596-2900, Monday - Friday 8 am - 7 pm.
2. Go to Student Mall Room 48. Monday - Friday 8 am - 7 pm

7. Getting Help - Moodle

In addition to the Helpdesk, NJIT has a number of resources available to help you learn/use Moodle. Please be aware of the following:

2. Student Moodle Tutorials: http://moodle.njit.edu/tutorials/students/index.php
3. Student Moodle FAQs: http://moodle.njit.edu/tutorials/students/faq.php

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