### Course Information for Microbial Biotechnology

**Syllabus-MB455-555.pdf**

<table>
<thead>
<tr>
<th>Course #</th>
<th>MB 455/555</th>
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<tbody>
<tr>
<td>Semester</td>
<td>Spring 2020</td>
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</tbody>
</table>
| Instructor | José Manuel Bruno-Bárcena  
4554 Gardner Hall Addition  
North Carolina State University  
Raleigh, NC 27695 |
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| Fax | 919-515-7867 |
| Email | jbbarcen@ncsu.edu |
| Web Site | http://www4.ncsu.edu/~jbbarcen |

Guest instructors will also present lectures.

**Requisite**
Prerequisite: MB 351 and GN 311

**Credit Hours**
3

**Restrictions**
Electronic devices must be turned off in the classroom.

**GEP Status**
None

**Location**
Room 02213 Gardner Hall

**Date**
January 7th - April 23rd

**Class Hours**
Lecture - Tuesdays, 8:30 AM - 11:15 AM

**Office Hours**
Tuesday, 12:50-14:30

**Course Website**
http://moodle.wolfware.ncsu.edu/

**Delivery Format**
This is a full semester class. Students are required to attend weekly lectures during the weeks the course is taught.

**Course Description**
This is an advanced undergraduate/ beginning graduate level overview of selected topics in microbial biotechnology. This course covers how microbes are used to manufacture components of food and consumer products, biologics and biomaterials using recombinant DNA and is organized following the steps in discovery and development of biologics. An introduction to microbial growth kinetics is included as well as discussions on generating products from genetically modified microorganisms (GMOs, and how the U.S. Food and Drug Administration (FDA) regulate these products. A minor portion of this class will also present schemes for choosing microbial hosts & vector expression systems for the production of heterologous peptides, proteins, or post translational-modified proteins and how this affects overall process strategy. Methods for production of industrial enzymes and selected applications of enzyme technology; for the pharmaceutical, chemical industries and for environmental remediation are presented.

**Technology Requirements**
In order to complete the course, all students will be required to have access to an active internet connection. If you do not have Adobe Acrobat Reader installed on your computer, you will need to go to the following web site and follow the instructions to download a free version:
http://www.adobe.com/products/acrobat/readstep2.html

**Course Structure**
This lecture course will cover theory of Microbial Biotechnology. One week after the completion of each lecture students will be required to submit written reports (1 page minimum) describing the objectives of the lecture, concepts covered and notes covering the discussions in the lecture. During the course of the semester students will be regularly tested on their understanding of the material presented to them in the form of quizzes (text book reading assignments and additional reading assignments provided by instructor). At the end of the course students will complete a final exam that will cover all the topics discussed during the course. Students taking MB 555 will have the additional requirement of a major term paper. The subject of this final paper will be to search and select from Science...
an experimental upstream approach for producing one active pharmaceutical ingredient (API) using microbes (GMO or non GMO). The paper should be written following the ASM journal instruction for authors. It should contain at least five written pages, font 12, double-spaced. The reference pages will not be counted as the written pages. The graduate students will be graded as described below.

**Text Requirements**

There is no single advanced undergraduate and graduate level text for all of the topics covered in this course. However, reading sections from several books are highly recommended for his class. The following books may be available on reserve in the D. H. Hill library


This reference will also be available in the Reserve Room of the D. H. Hill Library.

**Learning Outcomes**

At the end of this course, students will:

- Describe “omics” and metabolic pathway engineering approaches to engineer microbes for the over-production of metabolic intermediates and to generate novel compounds.
- Explain the importance of patents for commercial development of a microbial bioprocess; the impact of GMO versus non-GMO organism in processes, the pathway of biologics development and how the U.S. Food and Drug Administration (FDA) regulate the steps of development of a human therapeutic.
- Explain how microbial enzymes and genetically engineered microbes are used in industrial biocatalysts.
- Explain the advantages and disadvantages of production of peptides, proteins, glycoproteins, in Gram negative, Gram positive, yeast expression systems.
- Mathematically describe microbial growth and product formation in batch, fed-batch, continuous cultures and immobilized cells. Explain how each of these methods is used in microbial biotechnology and environmental remediation.

**Lecture Outlines by Topical Areas**

**Week 1 - January 7th**
Course introduction, scope, and concepts to be presented this semester.

**Safety in Biotechnology. Emerging Infectious Diseases, Public Health**

**Week 2 - January 14th**
Metagenomics in Biotechnology: understanding and exploiting microbial diversity.

**Invited Speaker:** Dr. Andrea Azcarate-Peril - Director Microbiome facility UNC

**Week 3 - January 21st**
Genetics and Patenting. What are patents, and how do they work? Why patent? What are some of the potential arguments in favor of gene patenting? What are some of the potential arguments against gene patenting? What laws govern gene patenting? How does genome information placed in the public domain work? Who can use it?

**Invited Speaker:** Dr. Logan Buck - Womble Carlyle Sandridge & Rice, LLP

**Week 4 - January 28th**

**Week 5 - February 4th**
Microbial growth kinetics: batch cultures, continuous cultures, and fed-batch culture. Biofilms immobilized enzymes and immobilized cells as biocatalysts.

**Week 6 - February 11th**
Week 7 - February 18\textsuperscript{th}
Overview of protein expression strategies – choosing a heterologous host. Protein folding and inclusion bodies – the problem of protein refolding. Protein expression in \textit{E. coli} and other Gram-negative hosts.

Week 8 - February 25\textsuperscript{th}
Protein expression and secretion. Glycoprotein expression in non-conventional and methylotrophic yeast.

Week 9 - March 3\textsuperscript{rd} \textbf{Midterm Exam. Graduate Student Final Paper Due}

Week 8 - March 12\textsuperscript{th} \textbf{Spring Break!!!}

Week 11 - March 17\textsuperscript{th}
Microbial monitoring during bacterial vaccine manufacturing processes and rapid microbial identification in a pharmaceutical Quality Control (QC) microbiology laboratory.
\textbf{Invited Speaker}: Dr. Matthew R. Evans.

Week 12 - March 24\textsuperscript{th}
Industrial enzymes for biopolymer degradation: starch, pectin, and biomass applications. Industrial biocatalysis: sweetener, detergent, textile, and lipid hydrolysis applications.
\textbf{Invited Speaker}: Alan House Ph.D. Franklinton Novozymes North America.

Week 13 - March 31\textsuperscript{st}
Thermo-bacteriology: Thermal microbial destruction kinetic. Decimal reduction time.  

Week 14 - April 7\textsuperscript{th}
Pathways of microbial biotech product development, compliance, and regulation. 
\textbf{Invited Speaker}: Dr. Scott Shore - Shore Biotechnology Consulting, LLC

Week 15 - April 14\textsuperscript{th}
Risk management solutions to indoor biological contamination
\textbf{Invited Speaker}: Doris Betancourt, Ph.D. National Risk Management Research Laboratory Air Pollution Prevention Control Division

Week 16 - April 21\textsuperscript{th} \textbf{Last Day of Classes Final Exam to be determined} (8:30-11:00 am)

\textbf{Course Grading}

<table>
<thead>
<tr>
<th>Class Assignments and Point Value</th>
<th>MB 455</th>
<th>MB 555</th>
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<tbody>
<tr>
<td>Class participation &amp; Class notes</td>
<td>60 points</td>
<td>60 points</td>
</tr>
<tr>
<td>Quizzes</td>
<td>30 points</td>
<td>30 points</td>
</tr>
<tr>
<td>Midterm Examinations (1)</td>
<td>40 points</td>
<td>50 points</td>
</tr>
<tr>
<td>Final examination</td>
<td>40 points</td>
<td>50 points</td>
</tr>
<tr>
<td>Final paper</td>
<td>0 points</td>
<td>60 points</td>
</tr>
<tr>
<td></td>
<td>170 points</td>
<td>250 points</td>
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Ask questions during class. Class attendance and participation will help you understand the material being presented and will be considered in your final grade. Students are not allowed to take this course for "credit only". In order to receive recognition for an audit, graduate students are required to complete all assignments and earn a grade of C- or better. Conversion from letter grading to audit grading is subject to university deadlines. Refer to the Registration and Records calendar for deadlines related to grading. For more details, refer to http://www.ncsu.edu/policies/academic_affairs/pol_reg/REG205.00.5.php
Grading Scale

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<th>Grade</th>
<th>Range</th>
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<tbody>
<tr>
<td>A+</td>
<td>97.0-100%</td>
</tr>
<tr>
<td>A</td>
<td>92.0-96.9%</td>
</tr>
<tr>
<td>A-</td>
<td>89.0-91.9%</td>
</tr>
<tr>
<td>B+</td>
<td>86.0-88.9%</td>
</tr>
<tr>
<td>B</td>
<td>82.0-85.9%</td>
</tr>
<tr>
<td>B-</td>
<td>79.0-81.9%</td>
</tr>
<tr>
<td>C+</td>
<td>76.0-78.9%</td>
</tr>
<tr>
<td>C</td>
<td>72.0-75.9%</td>
</tr>
<tr>
<td>C-</td>
<td>69.0-71.9%</td>
</tr>
<tr>
<td>D+</td>
<td>66.0-68.9%</td>
</tr>
<tr>
<td>D</td>
<td>62.0-65.9%</td>
</tr>
<tr>
<td>D-</td>
<td>59.0-61.9%</td>
</tr>
<tr>
<td>F</td>
<td>&lt; 59.0%</td>
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</tbody>
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Late Assignments

Late assignments without a valid excuse will not be accepted and will receive a score of zero.

Incomplete Grades

Incomplete as a course grade will be awarded only for work not completed during the course due to conditions deemed by the instructor to be beyond the reasonable control of the student.

For undergraduate students, unless an extended deadline is authorized by the instructor or department, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The University policy on incomplete grades is located at:

http://www.ncsu.edu/policies/academic_affairs/grades_undergrad/REG02.50.3.php

For graduate students, if an extended deadline is not authorized by the Graduate School, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions) or (b) by the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The University policy on incomplete grades is located at:

http://www.ncsu.edu/policies/academic_affairs/grades_undergrad/REG02.50.3.php

Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.18.F at:

http://www.fis.ncsu.edu/grad_publicns/handbook/.

Academic Integrity Statement

It is expected that each student will complete his/her own homework, quizzes, and exams with academic integrity. Students shall follow the NCSU Code of Student Conduct (http://www.ncsu.edu/policies/student_services/student_discipline/POL11.35.1.php)

In addition, your signature on any test or assignment means that you neither gave nor received unauthorized aid. In other words, your signature on to-be-graded work in this course communicates an understanding of, and adherence to, the University Honor Pledge: "I have neither given nor received unauthorized aid on this test or assignment."

Attendance Policy

Students are expected to attend class and attendance will be taken. Non-attendance will result in a reduction of a cumulative 5% of the final grade. If there is a need to miss class, notify the instructor prior to the class. It is the student’s responsibility to obtain assignments and information for any missed classes. For NCSU attendance regulations, refer to the academic policy and regulations website at:

http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.3.php
### Students with Disability Policy

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students ( [http://www.ncsu.edu/dso/](http://www.ncsu.edu/dso/) ) at 1900 Student Health Center, Campus Box 7509, 515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at: ([http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.1.php](http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.1.php))

### Anti-Discrimination Statement

NC State University provides equality of opportunity in education and employment for all students and employees. Accordingly, NC State affirms its commitment to maintain a work environment for all employees and an academic environment for all students that is free from all forms of discrimination. Discrimination based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or NC State University policy and will not be tolerated. Harassment of any person (either in the form of quid pro quo or creation of a hostile environment) based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation also is a violation of state and federal law and/or NC State University policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at [http://www.ncsu.edu/policies/campus_environ](http://www.ncsu.edu/policies/campus_environ) or [http://www.ncsu.edu/equal_op](http://www.ncsu.edu/equal_op). Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 515-3148."