PMB
Department of Plant and Microbial Biology

Course information for
# Microbial Biotechnology
Syllabus-MB455-555.pdf

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| **Course #** | **MB 455/555** |
| **Semester** | Spring 2022 |
| **Instructor** | José Manuel Bruno-Bárcena<br>4554 Gardner Hall Addition<br>North Carolina State University<br>Raleigh, NC 27695<br><br>Phone : 919-513-1495<br>Fax : 919-515-7867<br>Email : jbbarcen@ncsu.edu<br>Web Site : https://cals.ncsu.edu/plant-and-microbial-biology/people/jbbarcen/ |
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| | Guest instructors will also present lectures |
| **Requisite** | Prerequisite: MB 351 and GN 311 |
| **Credit Hours** | 3 |
| **Restrictions** | |
| **GEP Status** | None |
| **Location** | 00206 Marye Anne Fox Science |
| **Date** | January 11th - April 25th |
| **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** | Please be aware that the situation regarding COVID-19 is frequently changing, and the delivery mode of this course may need to change accordingly, including from in-person to online. Regardless of the delivery method, we will strive to provide a high-quality learning experience.<br><br>This is a full semester class. Students are required to attend weekly lectures during the weeks the course is taught. However, your course might not have a traditional meeting schedule in Spring 2022. Be sure to pay attention to any updates to the course schedule as the information in this syllabus may have changed. Please discuss any questions you have with the instructor. |
| **Classroom Seating** | To support efficient, effective contact tracing, please sit in the same seat when possible and take note of who is sitting around you; instructors may also assign seats for this purpose. |
| **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 to produce 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** | 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 |

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| | 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 semester students will be regularly tested on their understanding of the material presented to them in the form of quizzes or by submitting the collected lecture notes (textbook 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.<br>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 (http://www.sciencemag.org/) or Nature (http://www.nature.com/) 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 (http://jb.asm.org/misc/ifora.shtml) 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<br>● *Basic Biotechnology*, Third Edition 2006. Colin Ratledge, Bjørn Kristiansen Editors. ISBN 0521840317, Cambridge University Press.<br>● *Demain AL, Davies JE, editors in chief 1999. Manual of Industrial Microbiology and Biotechnology. ASM Press Washington, D.C. second edition.*<br>● *Microbial Biotechnology,* Second Edition, 2007. Alexander N. Glazer, Hiroshi Nikaido. ISBN 9780521842105, Cambridge University Press.<br>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:<br>• Describe "omics" and metabolic pathway engineering approaches to engineer microbes for the over-production of metabolic intermediates and to generate novel compounds.<br>• 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.<br>• Explain how microbial enzymes and genetically engineered microbes are used in industrial biocatalysts.<br>• Explain the advantages and disadvantages of production of peptides, proteins, glycoproteins, in Gram negative, Gram positive, yeast expression systems.<br>• Mathematically describe microbial growth and product formation in batch, fed-batch, continuous culture, and immobilized cells. Explain how each of these methods is used in microbial biotechnology, environmental remediation etc.… |
| **Lecture Outlines by Topical Areas** | **Week 1** - January 11th<br>Course introduction, scope, and concepts to be presented this semester.<br>**Safety in Biotechnology**. **Emerging Infectious Diseases, Public Health**<br>**Week 2** - January 18th<br>Metagenomics in Biotechnology: understanding and exploiting microbial diversity.<br>**Invited Speaker**: Dr. Andrea Azcarate-Peril - Director Microbiome facility UNC<br>**Week 3** - January 25th<br>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 |

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| | patenting? How does genome information place in the public domain work? Who can use it?<br>**Invited Speaker**: Dr. Logan Buck - Womble Carlyle Sandridge & Rice, LLP<br>**Week 4** - February 1st<br>Culture Collections and Gene Banks. Microbial resources. Establishment of culture collections. Taxonomic Terminology. How are the strains preserved? Patent depository. Seed lot and cell bank system.<br>**Week 5** - February 8th<br>Microbial growth kinetics: batch cultures, continuous cultures, and fed-batch culture. Biofilms immobilized enzymes and immobilized cells as biocatalysts.<br>**Week 6** - February 15th<br>**Week 7** - February 22nd<br>Bioterrorism/bioweapons-related policymaking and Opportunities<br>**Week 8** - March 1st<br>Overview of protein expression strategies – choosing a heterologous host. Protein folding and inclusion bodies – the problem of protein refolding. Protein expression in *E. coli* and other Gram-negative hosts.<br>**Week 9** - March 8th<br>**Midterm Exam. Graduate Student Final Paper Due**<br><br>**Week 10** - March 22nd<br>Microbial monitoring during bacterial vaccine manufacturing processes and rapid microbial identification in a pharmaceutical Quality Control (QC) microbiology laboratory.<br>**Invited Speaker**: Dr. Matthew R. Evans.<br>**Week 11** - March 29th<br>Industrial enzymes for biopolymer degradation: starch, pectin, and biomass applications. Industrial biocatalysis: sweetener, detergent, textile, and lipid hydrolysis applications.<br>**Invited Speaker:** Alan House Ph.D. Franklinton Novozymes North America.<br>**Week 12** - April 5th<br>Thermo-bacteriology: Thermal microbial destruction kinetic. Decimal reduction time.<br>**Week 13** - April 12th<br>Pathways of microbial biotech product development, compliance, and regulation.<br>**Invited Speaker**: Dr. Scott Shore - Shore Biotechnology Consulting, LLC<br>**Week 14** - April 19th<br>A case study of Agrochemical Biodegradation and The Soil Microbiome<br>**Week 15 -** April 25th **Last Day of Classes Final Exam to be determined** (8:30-11:00 am) |
| **Course Grading** | Class Assignments and Point Value — MB 455: 60 points; 30 points; 40 points; 40 points; 0 points; 170 points — MB 555: 60 points; 30 points; 50 points; 50 points; 60 points; 250 points<br>Ask questions during class. Class attendance and participation will help you understand the material being presented and will be considered in your final grade.<br>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<br>http://www.ncsu.edu/policies/academic_affairs/pol_reg/REG205.00.5.php |

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| **Grading Scale** | A+ = 97.0-100%<br>A = 92.0-96.9%<br>A- = 89.0-91.9%<br>B+ = 86.0-88.9%<br>B = 82.0-85.9%<br>B- = 79.0-81.9 %<br>C+ = 76.0-78.9%<br>C = 72.0-75.9%<br>C- = 69.0-71.9%<br>D+ = 66.0-68.9%<br>D = 62.0-65.9%<br>D- = 59.0-61.9%<br>F = < 59.0%<br>  |
| **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.<br>**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:<br>http://www.ncsu.edu/policies/academic_affairs/grades_undergrad/REG02.50.3.php<br>**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:<br>http://www.ncsu.edu/policies/academic_affairs/grades_undergrad/REG02.50.3.php<br>Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.18.F at:<br>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)*<br>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:<br>https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/<br>Please refer to this course's attendance, absence, and deadline policies for additional details. If you are quarantined or otherwise need to miss class because you have been |

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| | advised that you may have been exposed to COVID-19, you should not be penalized regarding attendance or class participation. However, you will be expected to develop a plan to keep up with your coursework during any such absences. If you become ill with COVID-19, you should follow the steps outlined in the health and participating section above. COVID 19-related absences will be considered excused; documentation need only involve communication |
| **Personal Protective Equipment** | As a member of the NC State academic community, you are required to follow all university guidelines for personal safety with face coverings, physical distancing, and sanitation. Face coverings are required in this class and in all NC State buildings. Note that face coverings must meet safety specifications, be worn correctly, and be socially appropriate as per the Code of Student Conduct (https://studentconduct.dasa.ncsu.edu/code/) and Free Speech Guidelines (https://www.ncsu.edu/free-speech/). In addition, students are responsible for keeping their course/work area clean. Please follow the cleaning guidelines described by your instructor. |
| **Health and Participation in Class** | We are most concerned about your health and the health of your classmates and instructors/TAs.<br>● If you test positive for COVID-19, or are told by a healthcare provider that you are presumed positive for the virus, please work with your instructor on health accommodations and follow other university guidelines, including self-reporting: https://healthypack.dasa.ncsu.edu/coronavirus/. Self-reporting is not only to help provide support to you, but also to assist in contact tracing for containing the spread of the virus.<br>● If you feel unwell, even if you have not been knowingly exposed to COVID-19, please do not come to class.<br>● If you are in quarantine, have been notified that you may have been exposed to COVID-19, or have a personal or family situation related to COVID-19 that prevents you from attending this course in person (or synchronously), please connect with your instructor to discuss the situation and make alternative plans, as necessary.<br>● If you need to make a request for an academic consideration related to COVID-19, such as a discussion about possible options for remote learning, please talk with your advisor for the appropriate process to make a COVID-19 request. |
| **Health and Well-Being Resources** | These are difficult times, and academic and personal stress is a natural result. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are many resources on campus to help you:<br>● Counseling Center (https://counseling.dasa.ncsu.edu/)<br>● Health Center (https://healthypack.dasa.ncsu.edu/)<br>● If the personal behavior of a classmate concerns or worries you, either for the classmate's well-being or yours, we encourage you to report this behavior to the NC State CARES team: (go.ncsu.edu/NCSUcares).<br>● If you or someone you know are experiencing food, housing, or financial insecurity, please see the Pack Essentials Program (https://dasa.ncsu.edu/pack-essentials/). |
| **Community Standards Related to COVID-19** | We are all responsible for protecting ourselves and our community. Please see the community expectations |
| **Students with Disability Policy** | Reasonable accommodations will be made for students with verifiable disabilities. To take advantage of available accommodations, students must register with Disability Services for Students ( 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:<br>( 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 |

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| | 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 or 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." |