Universidad Francisco de Vitoria UFV Madrid

Teaching guide

IDENTIFICATION DETAILS

Degree:	Biotechnology
Field of Knowledge:	Science
Faculty/School:	Experimental Science
Course:	INDUSTRIAL MICROBIOLOGY I
Type:	Compulsory
ECTS credits:	3
Year:	3
Code:	2049
Teaching period:	Sixth semester
Area:	Applied Biotechnology
Module:	Biotechnological Processes and Products
Teaching type:	Classroom-based
Language:	English
Total number of student study hours:	75

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SUBJECT DESCRIPTION

Industrial Microbiology aims to obtain microbial products with a useful application for the society, being thus part of the applied sciences. The course Industrial Microbiology I begins with a historical overview of the use and domestication of microorganisms, focusing on those groups of microorganisms of particular interest for the biotechnological industry. The potential use of specific microorganisms to obtain products of interest will be analyzed as well as the techniques used to modify and increase the industrial productivity. Every aspect of the large-scale microbial fermentation process will be analyzed and some industrial processes that provide everyday consumer goods will be studied in detail.

Industrial Microbiology is the discipline that employs microorganisms, usually grown on a large scale, for the production of valuable commercial products and for the performance of important chemical transformations. Louis Pasteur's discovery of fermentation processes embodied a colossal advance for science as it promoted the study of fermentative and non-fermentative processes generating products of high industrial interest, seeding the basis of Industrial Biotechnology. Indeed, alcoholic fermentation processes for obtaining beer and wine were followed by processes engaged in the production of pharmaceutical goods and drugs (antibiotics), food additives (amino acids), enzymes and chemicals such as butanol and citric acid. These processes are based on strengthening some microbial metabolic pathways in order to promote a larger production. Until recently, the microbiologist was responsible for modifying microorganisms by classic genetic methods in order to improve the process and get a higher yield of the desired product. The outbreak of recombinant DNA technologies brought new methods of genetic manipulation of microorganisms, endorsing the production of new microbial products, most of which are not naturally produced by the microorganisms.
Industrial Microbiology course I will focus on the study of microorganisms which are of particular interest for the industry, their main characteristics and how they can be manipulated in order to enlarge productivity. We will study both classic and newly-developed methods and techniques for genetic improvement which allow the manufacture of genetically modified microorganisms. Anthropological and ethical implications of generating new microbial variants will be discussed, in addition to the need to regulate and control its use and dissemination. Besides, we will study how the scale and parameters involved in microbial fermentations can be controlled and adjusted in order to ensure an adequate and boosted functioning of the system. Examples of classic industrial fermentation processes which employ microorganisms will be studied in detail, as well ass some case studies of actual fermentations. The aim of the Industrial Microbiology course is to learn how to analyse and handle the experimental data to set up and optimize an industrial process under the best possible conditions.

GOAL

El objetivo de esta asignatura es que los alumnos adquieran los conocimientos necesarios para el diseño y control de procesos industriales basados en el uso de microorganismos.

The aim of this course is that students acquire the required knowledge about the design and control of industrial processes based on the employment of microorganisms.

The specific aims of the subject are:

Identify and learn about the main microorganisms of interest for the biotechnological industry and its application

Understand the structure and functioning of the biotechnological industry

Design processes with industrial application based on the employment of microorganisms

Recognize and perceive the ethical, anthropological and social implications of the manipulation and use of microorganisms

PRIOR KNOWLEDGE

Prior knowledge on Microbiology I, Microbiology II, Biochemical Engineering, Molecular Genetics and Regulation of Gene Expression, Bioreactors, Biocatalysis is essential to be able to course this subject

COURSE SYLLABUS

SECTION I. INTRODUCTION.
Chapter 1. Introduction.
General concepts of Industrial Microbiology. History: from industrial microbiology to microbial biotechnology.

SECTION II. MICROORGANISMS AND INDUSTRY.

Chapter 2. Microorganisms interesting for industry.
Isolation of microbial strains, screening and selection. Methods of conservation and preservation. Prokaryotic microorganisms. Eukaryotic microorganisms.

Chapter 3. Microbial products interesting for industry.
Primary and secondary metabolites. Microbial biotransformations. Regulation of gene expression in microorganisms of industrial interest.

Chapter 4. Strain improvement and development: classical and molecular biotechnology.
Mutagenesis and selection of mutants. Protoplast fusion. Recombinant DNA technology. Genetic manipulation and industrial production.

Chapter 5. Industrial fermentations.
Culture media. Processing of lignocelullose waste. Sterilization. Types of bioreactors. Operation approaches: continuous and batch processes. Methods of separation and recovery of the final products.

SECTION III. INDUSTRIAL PROCESSES AND PRODUCTS

Chapter 6. Microbial enzymes.
Types of enzymes and industrial applications. Large scale production and purification.

Chapter 7. Chemical industry.
Biofuel production. Production of organic solvents useful for industry. Polyhydroxyalkanoates.

Chapter 8. Food industry.
Production of alcoholic beverages. The cheese. Additives and nutritional supplements: amino acids, organic acids, vitamins, polysaccharides, etc. Microbial biomass

Chapter 9. Pharmaceutical industry and medical devices.
Antibiotic production. Biopolymers. Steroid biotransformation. Production of recombinant proteins of therapeutic interest.

Chapter 10. Environmental biotechnology.
Wastewater treatment. Bioremediation. Microorganisms in agriculture.

EDUCATION ACTIVITIES

-Lecture sessions. Will be held by the corresponding teacher employing IT support. Sketches and summaries designed by the teacher will be included in each unit, which may also contain figures and images taken from books and publications. Besides, some sessions might be held by other teachers or professionals from other institutions according to their expertise in certain topics included in the subject's syllabus. In order to maximize the utilization of the assets of the lecture sessions, prior study of the unit (or at least a first read) is highly recommended. Students will study autonomously employing the recommended bibliography and all related material which will be available at the Aula Virtual of the course. These documents will include self-evaluating questions in addition to a review of prior knowledge (acquired in other subjects from earlier courses) required to achieve a complete and correct understanding and comprehension of the contents of the subject. During lecture sessions questions about what has been explained will be formulated and doubts will be solved too.

-Team work. Students will carry out projects in groups of 3-4 pupils. The main aim of these projects is to develop an entrepreneurial proposal within the biotechnological industry sector in which a microbial strains' (or any microbial-based product of interest) improvement strategy is integrated within a designed industrial process program pursuing the maximization of its production. The design of improved strains will be executed by means of genetic modifications employing knowledge acquired in the course of Recombinant DNA Technology. It is intended to, from a scientific basis, promote the economic value of a microbial-based product of industrial interest. Students will work with English-written bibliography depicting any biotechnological process (or product of industrial interest) which involve microbes. Therefore, students should acquire full understanding of the research described in the scientific articles and checked bibliography in order to be able to later raise their project, present it to the rest of the class and write a report on it. Besides, inclusion of innovative proposals which may increase the quality of the process or the product of interest will be graded. Those students not enrolled in the course of Recombinant DNA Technology will perform an akin project but without the compulsory requirement of involving genetic modifications of the microorganisms.

-Supplementary activities. Visits to industries from diverse biotechnological areas (food, pharmaceutical and environmental fields) will be proposed. These visits, for instance, to the Mahou brewery, Pharmamar biotechnological company or any of the wineries within Madrid area such as Bodega Andrés Díaz or Bodegas Castejón, will be announced with the main aim of providing the students a real view of an actual large-scale production system based on microorganisms. Also, activities such as seminars given by researchers from other institutions which will deal with topics of interest for the subject,will be advanced. These seminars may contribute

to put into dialogue our science with other mankind disciplines.

-Individual and collective tutorials.These tutorials will be arranged with the teacher who will advise and mentor each student in the topics demanded and aspects needed the most. These tutorials will seek the obtention of the greatest possible performance of the student and ensure the acquisition of the skills related to the subject. At least one tutorial will be considered compulsory concerning the teamwork project performance, preferentially once the group has chosen the topic and defined the objective of their project. The tutor will give his/her conformity and advise an adequate schedule for its execution.

DISTRIBUTION OF WORK TIME

CLASSROOM-BASED ACTIVITY	INDEPENDENT STUDY/OUT-OF-CLASSROOM ACTIVITY
36 hours	39 hours
Lectures 20h Teamwork presentations 6h Industry visits 4h Tutorials 2h Evaluation 4h	Personal study of the course 25h Individual work or teamwork tasks 14h

SKILLS

Basic Skills

Students must have demonstrated knowledge and understanding in an area of study that is founded on general secondary education. Moreover, the area of study is typically at a level that includes certain aspects implying knowledge at the forefront of its field of study, albeit supported by advanced textbooks

Students must be able to apply their knowledge to their work or vocation in a professional manner and possess skills that can typically be demonstrated by coming up with and sustaining arguments and solving problems within their field of study

Students must have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgments that include reflections on pertinent social, scientific or ethical issues

Students must be able to convey information, ideas, problems and solutions to both an expert and non-expert audience

Students must have developed the learning skills needed to undertake further study with a high degree of independence

General Skills

To be familiar with the applications of biotechnology in the healthcare, food, agrobiotechnological, environmental and chemical fields.

To recognise the mutual influence existing between science, society and technological development in order to strive for a sustainable future.

To develop an ability to search for, take in, analyse, sum up and relate information.

Specific skills

To describe the biotechnological processes applicable to the chemical and environmental industry.

To be familiar with microorganisms having industrial significance and understand their biotechnological potential.

To identify the main products of microbial origin with biotechnological applications in various social and economic areas.

To be familiar with the requirements of microorganisms and the cellular lines established to carry out large-scale fermentations.

To understand how the basic knowledge generated within a laboratory in various models may transform into biotechnological applications for the benefit of society.

To understand the social and environmental challenges of a globalised world in order to contribute to sustainable development.

Capacity for written and oral communication of the knowledge acquired.

To be able to apply the theoretical knowledge acquired for solving problems and practical cases linked to the various subjects.

LEARNING RESULTS

Design a working methodology to set up a biotechnological process employing microorganisms

Determine the microorganisms requirements and the parameters to consider in order to perform large scale fermentations

Understand classical biotechnological processes drive by microorganisms

Apply microbiology techniques to scout and isolate microbes of industrial interest

Identify microbial skills which feature them as suitable for biotechnological processes

Analyse and improve settled biotechnological processes

Understand the employment of genetically modified organisms in industrial processes

Know the steps involved in a microbe-based product/process project of interest for the biotechnological industry

Expose and justify a biotechnology-based project employing microorganisms

LEARNING APPRAISAL SYSTEM

Learning assessment of the contents of this subject will take into account the work done by the student throughout the semester in the different activities:

- Theory Exam. It consists of multiple choice questions (70%) and short questions to develop (30%). The score on this test will account for 60% of the final grade.

- Team work. The search of literature, development and defence of the project, together with the design of the audiovisual support and its written report, will be graded on the basis of dedication, study and accuracy among the components of the teamgroup. Therefore, an oral presentation of the project and a written report should be submitted to the teacher and these documents should include proved evidence of the design, development and performance of the project in addition to the innovative proposals generated. Topics will be proposed by the teacher who will guide the progress of the projects through tutorials. The marks obtained will account for 35% of the final grade.

- Attendance and participation in theoretical lectures, visits to companies and tutorials. Attendance to scheduled supplementary activities related to the course, practical exercises drawn up in class and contributions or relevant questions directed to boost the activities and lecture's session progress will be highly valued. Attendance to the programmed tutorials and visits to companies will be compulsory. This item will mean 5% of the final grade.

The final grade of the course is obtained by applying the percentages previously indicated to the marks obtained in the different modules under evaluation. To get a positive mark and pass the course, at least 50% of the points assigned to the exam must be obtained.

* No minimum grade is required unless it is otherwise specified (theory exam block). However, if after applying all

the percentages the course results as failed, these sections can be retaken by delivering a written report and/or an offered activity.
**Each of the passed sections will be conserved until the extraordinary call of the same academic course, but not for the following ones.
***Students who are in their second call or following ones, or those who are under any academic exemption foreseen by the university, they can choose wether taking the specific primary system (or if neccessary) an alternative one in which the following percentages will be applied:

- Final theory exam (60%)
- Project delivery, exclusively written, in which a project proposal following similar characteristics to the aforementioned introduced is explained and developed (40%)

This decision requires an email notification to the teacher in charge during the first weeks of the semester. In absense of such report, evaluation by the alternative system will be assumed.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

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Waites, M. J. et al. Industrial Microbiology. An Introduction. Blackwell Science.2001.

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