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

Teaching staff	E-mail
María Paz García García	mariapaz.garcia@ufv.es

SUBJECT DESCRIPTION

La Microbiología Industrial es una disciplina cuyo objetivo es la obtención de productos de origen microbiano útiles para la sociedad, es por tanto una rama de la ciencia aplicada. La asignatura Microbiología Industrial I se inicia con un recorrido histórico de lo que ha sido la utilización y domesticación de los microorganismos por el hombre, para pasar a continuación a estudiar a fondo aquellos grupos de microorganismos mas interesantes desde el punto de vista industrial y biotecnológico. Se analiza el potencial de algunos microorganismos para la obtención de productos de interés y se explican las técnicas que existen para modificarlos e incrementar la productividad industrial. También se estudia a fondo lo que implica una fermentación microbiana a gran escala y se analizan en detalle algunos de los procesos industriales que proporcionan productos de consumo habitual en

la sociedad.

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 analysed as well as the techniques used to modify and increase the industrial productivity. Every aspect of the large-scale microbial fermentation process will be analysed 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 optimise an industrial process under the best possible conditions.

GOAL

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. An industrial pipeline of a microbial-based product: upstream, fermentation and downstream steps. History: from industrial microbiology to microbial biotechnology.

SECTION II. MICROORGANISMS, PRODUCTS & INDUSTRIAL PRODUCTION.
Chapter 2. Substrates for microbes and microbial products
Substrate sources. Culture media & substrate pretreatment. Media & inoculum preparation. Microbial products of industrial interest: Primary and secondary metabolites. Microbial biotransformations.

Chapter 3. Microbes as biocatalysts
Isolation of microbial strains, screening and selection. Methods of preservation. Prokaryotic and Eukaryotic microorganisms of interest. Microbial enzymes with industrial applications.

Chapter 4. Microbial overproduction.
Strain optimization for industrial application. Selection of mutants. Implications in production of the regulation of gene expression in microorganisms of industrial interest.

Chapter 5. Industrial fermentations.
Scale up.Pilot plant production.Operational profiles and types of bioreactors. Sterilisation. Downstream processes

SECTION III. INDUSTRIAL PROCESSES
Chapter 6. Chemical industry.
Biofuel production. Production of organic solvents useful for industry. Polyhydroxyalkanoates.

Chapter 7. Food industry.
Production of alcoholic beverages. Lactic products. Additives and nutritional supplements: microbial biomass, amino acids, organic acids, vitamins, polysaccharides, etc.

Chapter 8. Pharmaceutical industry and medical devices.
Antibiotic production. Biopolymers. Steroid biotransformation. Production of recombinant proteins of therapeutic interest.

Chapter 9. Environmental biotechnology.
Wastewater treatment. Bioremediation. Microorganisms in agriculture.

EDUCATION ACTIVITIES

-Participative 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 utilisation 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.

-Development of grupal projects;Team work. Students will carry out projects in groups of 4 (max.5) pupils. The main aim of these projects is to develop an entrepreneurial & innovative 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. 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.

-Complementary training activities. Depending on how the pandemic situation evolves, different activities under different scenarios have been planned. These activities include possible visits to industries from diverse biotechnological areas (food, pharmaceutical and environmental fields). In prior courses, visits to the Mahou brewery, Pharmamar, GSK biotechnological company, AlgaEnergy pilot plant or some of the wineries within Madrid area such as Bodega Andrés Díaz or Bodegas Castejón, have been scheduled. The main aim of these activities is providing the students a real view of an actual large-scale production system based on

microorganisms.

-Debates,seminars, 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, 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. A second tutorial will be offered near the end of the development of the proposal for final advice. 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.

DISTRIBUTION OF WORK TIME

CLASSROOM-BASED ACTIVITY	INDEPENDENT STUDY/OUT-OF-CLASSROOM ACTIVITY
36 hours	39 hours
Clases expositivas participativas 28h Realización de trabajos de carácter individual y grupal 2,50h Evaluación 2,50h Actividades Formativas complementarias 3h	Estudio autónomo 34h Trabajo virtual en red 5h

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.

Capacity for teamwork and group management.

To have acquired the ability for analytical, synthetic, reflective, critical, theoretical and practical thought.

To recognise the mutual influence existing between science, society and technological development in order to

strive for a sustainable future.

To acquire the molecular biology and biochemistry knowledge needed to develop biotechnological processes and products.

Specific skills

To be familiar with food production and improvement strategies through biotechnological methods.

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.

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

To be able to work in a team in an efficient and coordinated manner.

To develop criteria for problem-solving and decision-making both professionally and personally.

LEARNING RESULTS

Diseñar la metodología de trabajo para poner a punto un proceso biotecnológico utilizando microorganismos.

Determinar los requerimientos de los microorganismos y los parámetros a tener en cuenta para realizar fermentaciones a gran escala.

Comprender los procesos biotecnológicos clásicos llevados a cabo por microorganismos.

Aplicar las técnicas microbiológicas para la búsqueda y aislamiento de microorganismos de interés industrial.

Identificar las capacidades de los microorganismos que les hacen susceptibles de ser usados en procesos biotecnológicos.

Analizar y mejorar procesos biotecnológicos establecidos.

Comprender la utilidad de los microorganismos modificados genéticamente en procesos biotecnológicos.

Conocer las etapas de desarrollo de un producto/proceso industrial de base microbiana.

Exponer y justificar un proyecto de base biotecnológica usando microorganismos.

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.

Ordinary evaluation system:
- Theory Exam. Wtihin the exams period, a written test will be held. The score on this test will account for 65% of the final grade. It is compulsory to achieve at least a 5 in this test to pass the course and to take into account the rest of the grades.

- 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, innovation, study and accuracy among the components of the team group. Therefore, an oral presentation of the project and a written brief summary/brochure of the innovative-entrepreneurial proposal 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 25% of the final grade.

- Active participation in tutorials and theoretical lectures and preparation of programmed tutorials;visits to companies if it is the case. Participation in scheduled supplementary activities related to the course, practical exercises & tests drawn up in class and contributions or relevant questions directed to boost the activities and lecture's session progress will be evaluated here. Efficient attendance to the programmed tutorials is graded too. This item will mean 10% 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 theory 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, conveyed with the teacher.
**Each of the passed sections (team work, participation) will be maintained until the extraordinary call of the same academic course, but not for the following ones. Repeating the course in other academic years implies retaking all the activities to be evaluated again.

Alternative evaluation system (Students repeating course)
This system is only available for 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 ordinary system including attendance to class, (or if necessary) an alternative one in which the following percentages will be applied:
- Final theory exam (80%)
- Project delivery, exclusively written, in which a project proposal following similar characteristics to the aforementioned introduced is explained and developed (20%)

Students must contact the teacher to apply to join the alternative system evaluation. An email notification to the teacher with their appliance during the first 2 weeks of the semester is compulsory. In absence of such report, evaluation by the alternative system will be assumed.

Plagiarism behaviours, as well as the use of illegitimate material in the evaluation exams, will be sanctioned in accordance to what is established in the University's Evaluation Regulations and Coexistence Regulations of the Univeristy.

BIBLIOGRAPHY AND OTHER RESOURCES

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