

IDENTIFICATION DETAILS

Degree:	Biotechnology		
Scope	Biology and Genetics		
Faculty/School:	Experimental Sciences		
Course:	BIOREACTORS		
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Туре:	Compulsory	ECTS credits:	6
Year:	3	Code:	2035
			
Teaching period:	Fifth semester		
Subject:	Riotochnological Process Engineering		
	Biolecinological Process Engineering		
Module:	Biotechnology Tools		
Teaching type:	Classroom-based		
Language:	Inglés		
Total number of student study hours:	150		

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SUBJECT DESCRIPTION

Bioreactors are adequately conditioned vessels in order to carry out transformations by means of biological systems. They constitute one of the most important tools of Biotechnological Process Engineering and Industrial Biotechnology to obtain knowledge, goods, and services. The aim of this course is providing basic tools so that the

student can manage within this discipline. This considers acquiring skills dealing with biological reactor description and design and realising the importance of bioreactor diversity and versatility regarding biotechnological applications. This course also looks for providing the student with the necessary knowledge to obtain and manage cell cultures and their possible applications in areas such as agrobiotechnological and biomedical research and the design of advanced therapies such as cell regeneration and tissue engineering.

This course, as the other disciplines within this degree, aims at equipping our students with knowledge and skills that help them to participate in the generation of new processes and biotechnological products that contribute to the common good and the development of society from the respect for life and the environment in which it develops. Likewise, and as reflected in the proposed thinking, the student is encouraged to be able to integrate the anthropological, ethical, and philosophical aspects that do not limit the explanation of reality to a single source of knowledge.

GOAL

The main aim of the course is teaching the basic guidelines for obtaining and maintaining cell cultures, looking for a broad and updated knowledge on the applicable techniques, and the acquisition of skills dealing with description and design of biological reactors, as well as presenting the diversity and versatility of bioreactors for biotechnological applications. The specific aims of the course are:

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Indicating and tagging the influence and contributions of the new technologies in Molecular and Cellular Biology on the pharmaceutical sector.

Learning about the requirements of microorganisms and established cell lines in large-scale cultivation and fermentation.

Understanding how the basic knowledge generated in the laboratory using different models are turned into biotechnological applications for the benefit of society

Working properly in a laboratory involving biological material (bacteria, fungi, viruses, animal and plant cells.) including safety and handling biological waste.

Being able to properly design and execute an experimental protocol based on theoretical knowledge from different courses.

Identifying and defining laboratory instruments and materials.

PRIOR KNOWLEDGE

In order to obtain the best academic progress, proper basis on the first-year subjects, such as Mathematics, Physics, Cell Biology, General Chemistry and Biochemistry are advised. Sufficient knowledge on Physiology, Metabolic Biochemistry, Microbiology and Biochemical Engineering from the second year are also recommended. SECTION I: THE BASICS OF CELL CULTURE Lesson 1.- Introduction to cell culture 1.1 Historical background 1.2 Applications 1.3 Biology of animal cells in culture 1.4 Types of animal cell culture Lesson 2.- Growth pattern of cultured cells and culture conditions 2.1 Growth media, culture vessels and surfaces 2.2 Propagation and subculturing 2.3 Quantification of cell culture growth. Population doubling level (PDL) and population doubling time (PDT) 2.3 Aseptic techniques and contamination types 2.4 Cryopreservation 2.5 Biosecurity and basic equipment in animal cell culture Practical session.- Subculture of adherent cells Lesson 3.- Isolation and maintenance of mammalian primary cultures and cell lines 3.1 Basic guidelines for cell culture set up 3.2 Cell morphology 3.3 Cloning methods 3.4 Characterisation and authentication of cell lines SECTION II: ANIMAL CELL CULTURE ANALYSES Lesson 4.- Generation of genetically modified cell cultures 4.1 Methods of cell transfection 4.2 Methods of cell transduction 4.3 Methods of selection Lesson 5.- Specific techniques for cell culture analyses 5.1 Viability, cytotoxicity and surveillance 5.2 Cell transformation 5.3 Cell migration and invasion 5.4 Apoptosis and necrosis SECTION III: BIOREACTORS DESIGN PRINCIPLES Lesson 6.- Introduction to bioprocess engineering Lesson 7.- Bioprocess Kinetics 7.1 Enzyme Kinetics 7.2 Metabolic stoichiometry 7.3 Whole-cells kinetic model Lesson 8.- Bioreactor design principles 8.1 Ideal mixed-tank bioreactor 8.2 Ideal plug flow bioreactor 8.3 Energy balance 8.4 Deviations from the ideal behavior Practical session.- Steady state simulation of continuous stirred tank bioreactor Lesson 9.- Phenomenology in bioprocesses 9.1 Mass Transfer Phenomena 9.2 Fluid dynamic within the bioreactor 9.3 The role of aeration and agitation in bioreactors Practical session.- Determination of the volumetric mass transfer coefficient Lesson 10.- Bioreactor configurations

10.1 Mechanical mixing: stirred-tank

10.2 Pneumatic mixing: Bubble column and airlift bioreactor

10.3 Hydraulic mixing: packed and fluidized bed

10.4 Bioreactor configurations for eukaryotic cells

Practical session.- Introduction to stirred tank bioreactors

Lesson 11.- Towards industrial bioprocesses

11.1 Scale-up and scale-down methodologies

11.2 Bioreactor instrumentation and control

11.3 Upstream and downstream operations in bioprocesses

Practical session.- Autonomous group project

EDUCATION ACTIVITIES

Participatory lectures: The course syllabus will be presented by the lecturer, aided by IT methods to promote student participation.

Practical classes: Case studies and laboratory work will be set out by the lecturer.

Tutorials: Tutorial sessions can be organized by the lecturer when required by the student following the scheduled hours. During these sessions the student can raise questions or discussions related to the course. The tutorials will guide the students throughout the learning process and help them to gain a deep understanding of the subject.

The virtual classroom platform will be the communication tool used between participants and teachers. Activities, their nature, evaluation criteria, modalities of participation and delivery will be informed by means of this platform.

DISTRIBUTION OF WORK TIME

TEACHER-LED TRAINING ACTIVITIES	INDIVIDUAL WORK
60 Horas	90 Horas
Participative lectures Workshops and seminars Practical sessions: practical work carried out in the laboratory, resolution of practical cases	Virtual work Theoretical study, and preparation of out-of- classroom activities

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

To acquire firm theoretical, practical, technological and humanistic training needed to develop professional activity.

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

Capacity for problem-solving and decision-making.

To be able to plan time effectively.

To foster a concern for knowledge as a key tool in the personal and professional growth process of a student.

To value sciences as a cultural fact.

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

To develop capacity for and a commitment to learning and personal development.

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Specific skills

Know how to design and optimize both a bioreactor and a biotechnological plant based on solid engineering knowledge.

Calculate and correctly interpret the relevant parameters in transport phenomena and the balances of matter and energy in bioindustrial processes.

Learn about the different techniques and types of cell cultures for application to both research and the biotechnology industry.

Acquire the technological and engineering knowledge necessary for process design.

Organize and plan the work in the laboratory correctly.

Identify and define laboratory instruments and materials.

Know how to describe, quantify, analyze and critically evaluate the results obtained from experimental work carried out in the laboratory.

Know how to apply the theoretical knowledge acquired to solving problems and practical cases related to different subjects.

Know how to work as a team in an effective and coordinated way.

LEARNING RESULTS

Working with eukaryotic cell cultures under the appropriate conditions according to the aseptic method carried out in laminar flow hood.

Identifying basic elements (equipment, supports, culture media,...) and the physicochemical conditions involved in the cultivation of animal cells.

Defining the right method for obtaining, culture and necessary characterization for each different cell type.

Applying cell cultures to study the effect that different drugs or physical conditions can have on cells.

Developing skills on understanding and discussing scientific works

Designing experiments and interpreting results

Defining a bioprocess from the kinetic and stoichiometric points of view

Distinguishing different types of bioreactors and their different modes of operation with reactors

Describing transport phenomena involved in a bioprocess, including: upstream and downstream stages, the different methodologies that allow scaling up, auxiliary services, instrumentation and control needs of a bioreactor||correctly applied design equations for different modes of operation

Interpreting experimental results obtained from a bioprocess carried out in the laboratory

LEARNING APPRAISAL SYSTEM

REGULAR ASSESSMENT SYSTEM

Final mark of Section I and II will be calculated considering the following parts:

Resolution of a practical case proposed by the lecturer (8%). It is not required a minimum score in this task to pass the course. It is not considered a repeat attempt for this task's submission.

Written examination (25%). Comprehension, reasoning, assimilation of the given content, and the ability of linking up different course concepts (theoretical and practical) will be assessed. In order to pass this section, it is required to obtain a mark equal or higher than 5 points out of 10. Students, who do not reach this minimum, should take an exam in the extraordinary summons according to the academic calendar.

Final mark of Section III will be calculated considering the following parts:

Reports of practical sessions (25%). Each report must be graded with a mark equal or higher than 4 points out of 10 to consider the work for the global average. In order to pass this section, average mark of reports must be equal or higher than 5 points out of 10. Students who do not reach this minimum must submit the failed reports again before extraordinary summons exam.

Written examination (42%). Comprehension, reasoning, assimilation of the given content, and the ability of linking up different course concepts (theoretical and practical) will be assessed. In order to pass this section, it is required to obtain a mark equal or higher than 5 points out of 10. Students, who do not reach this minimum, should take an exam in the extraordinary summons according to the academic calendar.

* Non-attendance to any of the lab sessions without the corresponding justification will result in failing the course.

** The activities passed in the ordinary call will be saved for the extraordinary call during the same academic year but not for the following.

ALTERNATIVE ASSESSMENT SYSTEM

For the students in second or following summoning, an alternative system calculated under the following percentages will be applied:

Written examination: sections I and II (33%) and section III (47%). Comprehension, reasoning, assimilation of the given content, and the ability of linking up different course concepts (theoretical and practical) will be assessed. In order to pass this section, it is required to obtain a mark equal or higher than 5 points out of 10. Students, who do

not reach this minimum, should take an exam in the extraordinary summons according to the academic calendar. Reports of workshops proposed by the lecturer (20%). The mark corresponding to this successfully evaluated module will be kept until the following academic year. In order to pass this section, it is required to obtain a mark equal or higher than 5 points out of 10. Students, who do not reach this minimum, should take an exam in the extraordinary summons according to the academic calendar.

The decision should be communicated to the lecturer in charge within the first five days of the course. If the lecturer is not advised, the alternative assessment system will be applied.

Plagiarism and the use of illegitimate means in assessment tests will be sanctioned in accordance with the University's Assessment Regulations and Code of Conduct.

ETHICAL AND RESPONSIBLE USE OF ARTIFICIAL INTELLIGENCE

1.- The use of any Artificial Intelligence (AI) system or service shall be determined by the lecturer, and may only be used in the manner and under the conditions indicated by them. In all cases, its use must comply with the following principles:

a) The use of AI systems or services must be accompanied by critical reflection on the part of the student regarding their impact and/or limitations in the development of the assigned task or project.

b) The selection of AI systems or services must be justified, explaining their advantages over other tools or methods of obtaining information. The chosen model and the version of AI used must be described in as much detail as possible.

c) The student must appropriately cite the use of AI systems or services, specifying the parts of the work where they were used and describing the creative process followed. The use of citation formats and usage examples may be consulted on the Library website(<u>https://www.ufv.es/gestion-de-la-informacion_biblioteca/</u>).

d) The results obtained through AI systems or services must always be verified. As the author, the student is responsible for their work and for the legitimacy of the sources used.

2.- In all cases, the use of AI systems or services must always respect the principles of responsible and ethical use upheld by the university, as outlined in the <u>Guide for the Responsible Use of Artificial Intelligence in Studies at UFV</u>. Additionally, the lecturer may request other types of individual commitments from the student when deemed necessary.

3.- Without prejudice to the above, in cases of doubt regarding the ethical and responsible use of any AI system or service, the lecturer may require an oral presentation of any assignment or partial submission. This oral evaluation shall take precedence over any other form of assessment outlined in the Teaching Guide. In this oral defense, the student must demonstrate knowledge of the subject, justify their decisions, and explain the development of their work.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

Luis Montuenga Badia, Francisco J. Esteban Ruiz and Alfonso Calvo González. Techniques in histology and cell biology/Barcelona:Elsevier, 2009.

Pablo E. Gil-Loyzaga. Animal and human cell culture: applications in regenerative medicine/Madrid:Visión Libros,2011.

edited by Victor A. Vinci and Sarad R. Parekh. Handbook of industrial cell culture: mammalian, microbial and plant cells/New Jersey: Humana Press, 2003.

A. Barba Juan, C. Clausell Terol. Solved problems of chemical and biochemical reactors/Castelló de la Plana:Universitat Jaume I. Servei de Comunicació i Publicacions, [2015]

B. Atkinson. Biochemical reactors/Barcelona: Reverté, 2002.

Pauline M. Doran. Bioprocess Engineering Principles/2nd. ed. London:Academic Press, 2012. (Pauline M. Doran. Bioprocess Engineering Principles/2nd. ed. London:Academic Press, 2012., ||John Villadsen, Jens Nielsen, Gunnar Lidén. Bioreaction Engineering Principles/3rd ed. New York: Springer, 2011.)

Additional

Vicenta Muñoz Andrés, Ángel Maroto Valiente. Unit operations and chemical reactors/Madrid:Universidad Nacional de Educación a Distancia, [2013]