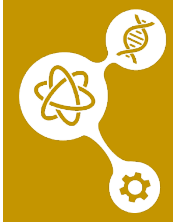
Academic year
2026/2027

Course Guide:

INDUSTRIAL BIOCHEMISTRY



FACULTY OF
CHEMICAL SCIENCES

1. IDENTIFICATION

Degree Programme	Bachelor's Degree in Chemical Engineering.			Course Code	801565
Course Name	Industrial Biochemistry			ECTS	6
Subject Area	Industrial Bioprocesses				
Module	Chemical Technology				
Course Type	Optional	Year	Fourth Year	Semester	First Semester
Department	Biochemistry and Molecular Biology				

Teaching Staff

Activity	Lecturer	Email	Office
Lectures/Seminars/Tutorials	MIGUEL ARROYO SÁNCHEZ	marroyos@ ucm.es	Departmental Section of the Faculty of Biology. Annex building. Floor 1. Office 8.
Lectures/Seminars/Tutorials	JAVIER ROCHA MARTÍN	javrocha@ucm.es	Departmental Section of the Faculty of Biology. Annex building. Floor 1. Office 16.

Practice laboratory of the Department of Biochemistry and Molecular Biology (Faculty of Biological Sciences)

Group	Lecturer	Email	Office
A	JESÚS FERNÁNDEZ LUCAS	jesusf08@ucm.es	Departmental Section of the Faculty of Biology. Annex building. Floor 1. Office 16.

2. OBJECTIVES

General objective

The aim of this course is to provide an in-depth study of the biotechnological processes with the greatest impact on modern industry. The course provides the biochemical foundations necessary to understand how biological systems are exploited for industrial applications, enabling students to analyse, evaluate and design biotechnological processes within the context of modern chemical and biochemical industries.

Specific objectives

- To provide students with a comprehensive understanding of the biotechnological methods used for the production and improvement of industrial products, including the quality criteria and safety requirements governing the manufacture of biotechnological products.
- To introduce the most relevant analytical applications of biomolecules and their future development potential, while examining the fundamental strategies used to minimise the environmental impact of biotechnological production processes. Students will also gain an understanding of the role of separation operations in industrial chemical processes.
- To integrate the principles of Green Chemistry and Sustainability into the analysis and design of industrial biotechnological processes, promoting the use of renewable feedstocks, biocatalysts and environmentally friendly technologies, as well as the efficient use of resources and the minimisation of waste generation.

3. PRIOR KNOWLEDGE AND RECOMMENDATIONS

Prior knowledge

Successful completion of this course requires students to possess the knowledge and competences normally acquired through the course "Introduction to Biochemistry". Although enrolment is not formally dependent upon prior completion of this course, a solid understanding of its fundamental concepts is strongly recommended, as they provide the essential background needed to engage effectively with the contents of "Industrial Biochemistry".

Recommendations

Students are advised to have a basic command of English that enables them to read and understand scientific literature, search for and evaluate information from a variety of sources, and communicate effectively in both written and spoken English. These skills will facilitate access to specialised resources and support independent learning throughout the course.

4. CONTENTS

Brief description

Description of the different types of prokaryotic and eukaryotic organisms used in industrial production processes. Study of the behaviour of industrial microorganisms: characteristics, growth and product formation. Utilisation of raw materials through fermentation processes. Basic principles of the metabolic pathways involved in industrial production processes and their main regulatory mechanisms. Genetic engineering techniques for the improvement of production strains. Production of primary and secondary metabolites. Industrial applications of enzymes and whole cells. Methods for the production and recovery of enzymes of industrial interest. Cell and enzyme immobilisation techniques for the development of biocatalysts. Bioenergy production and environmental remediation through biotechnological processes.

Course syllabus

1. Introduction to biotechnological processes.
2. Main microorganisms of industrial interest.
3. Microbial metabolism.
4. Cultivation of microorganisms. Fermentation concept. Fermentation kinetics. Degradative possibilities of hydrocarbon sources.

5. Raw materials used in industrial fermentations.
6. Impact of biotechnology in the food industry.
7. Renewable energy sources.
8. Industrial production of enzymes: industrial applications. Immobilization. Biosensors.
9. Microbiological production of primary metabolites. Citric acid. Amino acids. Use of wild and mutant strains.
10. Industrial production of secondary metabolites. Production of antibiotics. Producer microorganisms. Stages prior to the marketing of a new antibiotic. General technology of antibiotic production.
11. Bioconversions. Industrial production of steroids of pharmacological interest: direct fermentation and enzymatic transformation.
12. Production of biopolymers. Polysaccharides (dextrans and xanthans). Bioplastics.
13. Genetic engineering and improvement of microbial strains.
14. Environmental decontamination.

5. COMPETENCES

General competences

CG1-TQ1	Use concepts and principles for the autonomous learning of new methods and theories.
CG4-TQ1	Apply concepts of biotechnology, mass transfer, separation processes and chemical reaction engineering. Design reactors and evaluate the transformation of raw materials and energy resources.
CG5-TQ1	Analyse, design, simulate and optimise processes and products.

Specific competences

CE20-BI1	Describe the fundamental principles of biochemical processes, metabolic pathways and their regulation involved in the industrial bioprocesses that underpin Industrial Biotechnology (White Biotechnology) and sustainable development.
CE20- BI2	Describe the general characteristics of prokaryotic and eukaryotic organisms used in the industrial production of valuable compounds and identify the main stages of a biotechnological process.
CE20- BI3	Distinguish between different immobilisation methods and evaluate their potential, advantages and performance for the development of industrial biocatalysts.
CE20- BI4	Apply knowledge of the basic principles of Genetic Engineering for industrial purposes.
CE20- BI5	Explain the sequence of stages involved in a bioprocess.

Cross-cutting competences

CT1-TQ1	Develop analytical and synthesis skills.
CT2-TQ1	Solve problems in the field of Chemical Engineering Technology.
CT5-TQ1	Consult, use and critically analyse bibliographic sources in the field of Chemical Engineering Technology.

CT5-TQ2	Consult, use and critically analyse specialised databases and information resources available through the Internet.
CT8-TQ1	Demonstrate critical and self-critical thinking skills.
CT11-TQ1	Learn independently and autonomously.
CT12-TQ1	Develop awareness of the social and environmental impact of engineering solutions.

6. WORKLOAD DISTRIBUTION BY ACTIVITY

Activity	In-class (hours)	Self-study (hours)	Credits
Lectures	35.5	59.5	3.8
Seminars	2	8	0.4
Tutorials	2	3	0.2
Practical sessions	10	15	1
Coursework and examination preparation	6	9	0.6
Total	55.5	94.5	6

7. METHODOLOGY

The course adopts a blended learning approach that combines independent study with collaborative learning activities. All scheduled teaching is delivered within a single group and is structured around lectures, seminars, tutorials and practical laboratory sessions.

Lectures provide the core theoretical framework of the course. These sessions are primarily delivered in a lecture-based format and are designed to present the fundamental concepts, principles and experimental evidence underpinning Industrial Biochemistry in a clear and systematic manner.

Seminars and tutorials are intended to consolidate and extend the knowledge acquired during lectures through the discussion of selected topics, complementary materials and scientific literature relevant to the course. Students will work both individually and in small groups, making use of academic sources to prepare summaries and written assignments in English. These sessions also provide opportunities for discussion, critical analysis, problem-solving and personalised academic guidance, while enabling continuous monitoring of student progress.

Practical laboratory sessions are designed to reinforce key theoretical concepts through hands-on experimental work. Students will perform laboratory experiments, determine and analyse relevant process parameters, and critically evaluate the results obtained. The outcomes of the practical work will be presented and discussed in the form of written laboratory reports.

The UCM Virtual Campus will be used as the main digital learning environment for the course. It will provide access to teaching materials, recommended resources and course-related information, while also serving as the principal platform for communication between staff and students.

8. BIBLIOGRAPHY

No single textbook will be used as the primary reference for this course. Instead, students are encouraged to consult a range of recommended textbooks and additional resources, some of which are listed below:

Basic bibliography

- Renneberg, R. "Biotechnology for beginners", Ed. Reverté, 2012.
- Schmid, R.D.; Schmidt-Dannert, C. "Biotechnology: an illustrated primer." Wiley-VCH, 2016.
- Smith, J.E. "Biotechnology". Ed. Acribia, 2006.
- Okafor, N. "Modern Industrial Microbiology and Biotechnology", Science Publishers, 2007. [Available as an e-book]
- Madigan, M.T.; Martinko, J.M.; Bender, D.A.; Buckley, D.H.; Stahl, D.A. "Brock Biology of Microorganisms", 14th ed., Editorial Pearson Educación S.A., 2015. [Available as an e-book].

Complementary bibliography

- Aehle, W. "Enzymes in industry: productions and applications", 3rd ed., Wiley-VCH, Weinheim, 2007.
- Brahmachari, G.; Demain, A.L.; Adrio, J.L. (eds.). "Biotechnology of Microbial Enzymes". Academic Press, 2017. [Available as an e-book]
- Buchholz, K.; Kasche, V.; Bornscheuer, U.T., "*Biocatalysts and enzyme technology*". 2nd ed., Weinheim, Wiley-VCH, 2012.
- Hopwood, D.A.: "Streptomyces in Nature and Medicine: the antibiotic makers." Oxford University Press, Oxford, 2007. [Available as an e-book]
- Parés, R.; Juárez, A. "Biochemistry of microorganisms", Ed. Reverté, 2015.
- Ratledge, C.; Kristiansen, B. "*Basic Biotechnology*", 3rd ed., Cambridge University Press, Oxford, 2006.
- Thieman, W.J.; Palladino, M.A. "Introduction to Biotechnology". 2nd ed., Editorial Pearson Educación S.A, 2010.

9. EVALUATION

Participation in the different learning activities associated with the course is compulsory. To be eligible for the final assessment, students must attend and participate in at least 70% of the scheduled contact activities.

The final mark will be calculated as a weighted average of the assessment components listed below. The weighting of each component will remain unchanged for all assessment periods.

❖ WRITTEN EXAMINATION: 65%

Assessment of the theoretical content of the course will be conducted through a single final written examination. The examination will include questions requiring the application of concepts and principles covered during the course, together with problem-solving and practical questions related to the course content.

❖ PERSONAL WORK AND GUIDED ACTIVITIES: 15%

Students will complete assignments set by the lecturer throughout the course.

For seminar activities, students will be required to present their work and respond to questions from both the lecturer and their peers. Assessment will consider the quality of the work submitted, the clarity and effectiveness of the presentation, and the ability to engage in critical discussion.

For tutorial activities, students will be assessed on their analysis and discussion of scientific papers and on their responses to questions related to the topics covered in the course.

❖ PRACTICAL LABORATORY WORK: 15%

Attendance at all laboratory sessions is compulsory.

Assessment of practical work will be based on students' performance during laboratory sessions, including their ability to address the proposed experimental tasks, analyse the results obtained, and prepare a laboratory report of an appropriate scientific standard.

Students who have successfully completed the practical laboratory work in a previous academic year may apply for exemption from repeating them, provided that no more than two academic years have elapsed since their completion.

❖ ATTENDANCE AND ACTIVE PARTICIPATION: 5%

Regular attendance and active participation in all teaching and learning activities will contribute positively to the final mark. Repeated unexplained absence may result in a reduction of the mark awarded for this assessment component.

Students must obtain a minimum mark of 4.0 out of 10 in the final written examination to pass the course.

Marks awarded for continuous assessment activities (including practical laboratory work, tutorials and seminars) will be communicated to students sufficiently in advance of the final examination to allow adequate planning of their study workload.

The final mark will be calculated as the weighted average of all assessment components. However, students must satisfy the minimum performance requirements established for each assessment component. Where these requirements are not met, the final mark recorded will be the weighted average obtained, subject to a maximum mark of 4.5 out of 10.

In accordance with university regulations, a minimum period of seven calendar days will be respected between the publication of any assessment results and the date of the final examination. The minimum period of seven days will always be respected between the publication of any mark, if applicable, and the date of the final exam of the subject.

ACTIVITY SCHEDULE

UNIT	ACTIVITY	HOURS	GROUPS	START	END
Topics 1, 2, 3, 4 and 5	Lectures	15.5	1	1st Week	4th Week
	Tutorials	1	2	3rd Week	
Topic 6	Lectures	4	1	4th Week	5th Week
Topic 7	Lectures	2	1	5th Week	6th Week
Topic 8	Lectures	4	1	6th Week	8th Week
	Seminars	1	1	8th Week	9th Week
Topic 9	Lectures	2	1	9th Week	10th Week
Topic 10	Lectures	4	1	10th Week	12th Week
Topic 11	Lectures	1	1	12th Week	13th Week
Topic 12	Lectures	1	1	13th Week	13th Week
	Seminars	1	1	14th Week	14th Week
Topic 13	Lectures	1	1	14th Week	15th Week
	Tutorials	1	2	15th Week	
Topic 14	Lectures	1	1	15th Week	15th Week

*Scheduled tutorials are subject to possible modifications according to the joint planning of the course.

SUMMARY OF ACTIVITIES

TEACHING ACTIVITY	ASSOCIATED COMPETENCES	TEACHING ACTIVITY	STUDENT ACTIVITY	EVALUATION	P	NP	TOTAL	C
Lectures	CG1-TQ1, CG4-TQ1, CG5-TQ1 CE20-BI1, CE20-BI2, CE20-BI3, CE20-BI4, CE20-BI5 CT1-TQ1, CT2-TQ1, CT5-TQ1, CT5-TQ2, CT8-TQ1, CT11-TQ1, CT12-TQ1	Exposition of theoretical concepts. Raising of issues.	Taking notes, formulating and answering questions.	Assessment of the answers to questions related to the theoretical concepts explained.	35.5	59.5	95	35%
Practical laboratory work		Exposition of concepts and development of skills in the laboratory.	Preparation of the laboratory notebook and the report of experimental results.	Assessment of skills and quality of the report.	10	15	25	
Seminars		Application of theory to the resolution of issues. Proposal of topics.	Preparation of the work proposed by the teacher. Formulation and answering of questions.	Assessment of work, exposure and development.	2	8	10	
Tutorials		Direction and supervision of the student's study and activities. Raising of issues.	Resolution of the issues raised.	Assessment of the resolution of the issues raised.	2	3	5	
Exams/directed assignments		Proposal, supervision and correction of the written exam. Student qualification.	Preparation and completion of the written exam.		6	9	15	65%

P: In-class activities

NP: Non-classroom activities (self-study)

C: Assessment weighting