	PROCESO PARA EL DESARROLLO DE LAS ENSEÑANZAS DE LA FACULTAD DE CIENCIAS DE LA UEx	
	Curso académico: 2025-26	Código: P/CL009_FC_D002

PLAN DOCENTE DE LA ASIGNATURA

Identificación y características de la asignatura				
Code	502692		Créditos ECTS	6
Course name (English)	Enzyme Biotechnology			
Course name (Spanish)	Biotecnología de Enzimas			
Degree programs	Degree in Biotechnology			
Faculty/School	Faculty of Science			
Semester	6	Carácter	Compulsory	
Module	Biotech			
Matter	Enzyme Biotechnology			
Lecturer/s				
Name	Office	E-mail	Web page	
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Área de conocimiento	Biochemistry and Molecular Biology			
Departamento	Biochemistry and Molecular Biology and Genetics			
Profesor/a coordinador/a (si hay más de uno)	Ángel Emilio Martínez de Alba			

Competencies/Learning Outcomes

1. Core Competences (CB)

CB1 - Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.

CB2 - Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.

CB3 - Students have the ability to gather and interpret relevant data (usually within their area of study) in order to make judgements that include reflection on relevant social, scientific or ethical issues.

CB4 - Students are able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

CB5 - That students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

2. General competences (GC)

GC1 - Ability to successfully follow postgraduate courses that specifically qualify them in teaching, research or professional fields.

GC2 - Ability to autonomously generate, acquire and process information related to Biotechnology.

GC3 - Ability to plan, execute and criticise knowledge processes in the field of their activity.

GC4 - Ability to apply knowledge of basic sciences and technologies to biological and health systems.

GC5 - Ability to identify, formulate and solve problems within broad, multidisciplinary contexts, by integrating knowledge and participating in multidisciplinary teams.
GC6 - Ability to analyse and assess the social and environmental impact of technical solutions, understanding ethical and professional responsibility in the field of Biotechnology.
GC7 - Ability to solve problems with initiative, decision-making, autonomy and creativity.
GC8 - Ability to transfer theoretical learning to a practical context.
GC9 - Capacity for self-evaluation in order to be aware of the need to keep knowledge, skills and attitudes up to date through a process of continuous training.

3. Transversal competences (TC)

TC1 - Apply the knowledge acquired in the degree to work in a professional and rigorous manner, as well as perform safely in a laboratory.
TC2 - Use and apply information and communication technology (ICT) in the training and professional field.
TC3 - Possess and understand information from advanced textbooks and access knowledge from the forefront of the field of study of the degree.
CT4 - Develop learning, organisation and planning skills, necessary both for undertaking further studies with a high degree of autonomy and for professional performance.
CT5 - Interpret, analyse and synthesise relevant data and information that enable students to develop ideas, solve problems and issue critical reasoning on important social, scientific or ethical issues.
CT6 - Effectively transmit results and conclusions to both specialised and non-specialised audiences.
TC7 - Express oneself correctly in writing and orally in one's native language, as well as sufficiently mastering a foreign language, preferably English.
CT8 - Lead or work in a team, adapting positively to different contexts and situations.
CT9 - Respect fundamental rights and equality between men and women, as well as acquiring an ethical commitment to respect life and the environment.

4. Specific competences (SC)

SC1 - Acquire basic knowledge of biology, chemistry, physics, mathematics and statistics necessary to understand biotechnological processes.
SC3 - Understand the basic principles that determine the molecular structure and chemical reactivity of simple biomolecules.
SC4 - Understand the principles that determine the structure of biological macromolecules (including proteins and nucleic acids), as well as biological supramolecular complexes, and be able to explain the relationships between structure and function.
SC5 - Understand the chemical and thermodynamic principles of molecular recognition and biocatalysis, as well as the role of enzymes and other proteins in determining the functioning of cells and organisms.
SC10 - Have an integrated vision of cellular functioning (including metabolism and gene expression), covering its regulation and the relationship between the different cellular compartments.
SC17 - Knowing how to apply experimental laboratory protocols in the field of Biosciences.
SC18 - Possessing the mathematical, statistical and computer skills to obtain, analyse and interpret data, and to understand simple models of biological systems and processes at the cellular and molecular level.

SC20 - Acquire the ability to transmit information in the field of Biosciences, including mastery of specific terminology.
SC26 - Identify the possibilities of biotechnological transfer from basic experimentation.
SC27 - Assess the socio-economic impact and bioethical implications of biotechnological processes.
SC29 - Knowing and understanding the biotechnological aspects of the biochemical, pharmaceutical, food and environmental industries, as well as biomedicine, animal and plant production.
SC30 - Knowledge of the main fields of greatest biotechnological demand.
SC31 - Ability to develop technical and scientific skills in the context of a research laboratory or company.
SC35 - Identifying and providing solutions to technological and scientific demands in the fields of the biochemical, pharmaceutical, food and environmental industries, as well as in biomedicine, animal and plant production.
SC36 - Identify emerging technologies and evaluate their possible impact on current bioprocesses.

Contents

Course outline

Enzyme Biotechnology provides basic concepts necessary for the manipulation of enzymes and the optimisation of enzymatic processes. This course contributes to the student's knowledge and understanding of the fundamental concepts of enzyme kinetics. This course deals with the structures of the two groups of biocatalysts, proteins and nucleic acids, which participate in complex enzyme kinetics. This course studies the kinetic characterisation of enzyme activities and the behaviour of compounds that activate and inhibit the action of enzymes, allosterism, as well as the obtaining, production and purification of enzymes. The effect of environmental factors on enzyme catalysis and how enzymes can be optimised for use in biotechnological applications are discussed, including the preparation of immobilised enzymes and the development of biosensors and bioproduction using enzyme bioreactors. Finally, enzyme applications in the food, pharmaceutical and chemical industries are presented.

Course syllabus

Name of lesson 1: Introduction to enzyme biotechnology
Contents of lesson 1: Potential of biotechnological production processes. General characteristics of enzyme-based production processes. New enzyme-based production processes.
Description of the practical activities of lesson 1: Not applicable.

Name of lesson 2: Enzymatic catalysis
Contents of lesson 2: General properties of enzymes. Classification. Specificity. Enzyme cofactors. Activation energy. Catalytic mechanisms. Transition state.
Description of the practical activities of lesson 2: Practical exercise 1. Development of enzyme activity measurement procedures.

Name of lesson 3: Enzyme kinetics
Contents of lesson 3: Monosubstrate enzyme kinetics. Two-substrate reactions: single displacement and double displacement (ping-pong) reactions. Determination of the bisubstrate mechanism by kinetic measurements.
Description of the practical activities of lesson 3: Practical exercise 2. Enzyme kinetics and inhibition.

Name of lesson 4: Enzyme inhibition Contents of lesson 4: Competitive, acompetitive, non-competitive and mixed inhibition. Irreversible inhibitors. Description of the practical activities of lesson 4: Practical exercise 3. Effect of temperature on enzyme activity.
Name of lesson 5: Allosteric control of enzyme activity Contents of lesson 5: Allosteric control of enzyme activity. Theoretical models of allosterism. Allosteric control of aspartate transcarbamylase activity. Description of the practical activities of lesson 5: Not applicable.
Name of lesson 6: Enzyme reaction mechanisms Contents of lesson 6: Proteases: mechanism of action of chymotrypsin. Serine proteases. Other proteases. Other examples of mechanisms. Description of the practical activities of lesson 6: Not applicable.
Name of lesson 7: Effect of environmental factors on enzyme activity Contents of lesson 7: Effect of pH on enzyme activity. Effect of temperature on enzyme activity and stability. Effect of ionic strength. Enzymatic processes in non-conventional solvents. Description of the practical activities of lesson 7: Practical exercise 4. Effect of substrate and pH on enzyme activity.
Name of lesson 8: Production and purification of enzymes of biotechnological interest. Contents of lesson 8: Sources of enzymes: Animal and plant tissues. Micro-organisms. Processes affecting enzyme yield. Enzyme production process. Preparative chromatographic techniques for enzyme purification. Description of the practical activities of lesson 8: Not applicable.
Name of lesson 9: Enzyme applications in solution Contents of lesson 9: Areas of application. Advantages and disadvantages of their use. Example applications of enzymes in solution: In food industry, in starch processing, in detergents. Description of the practical activities of lesson 9: Not applicable.
Name of lesson 10: Enzyme immobilization and applications Contents of lesson 10: Principles. Immobilization supports. Binding methods. Adsorption. Covalent bonding. Trapping: principles of ionotropic trapping. Applications: Hydrolysis and transformation of carbohydrates. Synthesis of amino acids, peptides and amides. Applications of lipases. Characterization of immobilized biocatalysts. Description of the practical activities of lesson 10: Not applicable.
Name of lesson 11: Applied biocatalysis Contents of lesson 11: Starch processing. Production of glucose-fructose syrup. Obtaining biofuel from biomass. Production of ethanol from starch. Obtaining biofuel from lignocellulose. Use of enzymes in the food industry. Use of enzymes in the detergent industry. Enzyme applications in the textile industry. Description of the practical activities of lesson 11: Not applicable.
PRACTICAL TRAINING PROGRAMME 1. Development of enzyme activity measurement procedures. 2. Enzyme kinetics and inhibition. 3. Effect of temperature on enzyme activity. 4. Effect of substrate and pH on enzyme activity.

Educational activities

Student workload in hours by lesson		Lectures	Practical activities				Monitoring activity	Homework
Lesson	Total	L	HI	LAB	COM	SEM	SGT	PS
1	4	1						3
2	11	4		2				5
3	13	5		2				6
4	12	5		2				5
5	11	4						7
6	11	4						7
7	13.5	4		2				7.5
8	10	3						7
9	14	5				2		7
10	16	4				3	1	8
11	12.5	4				2	1	5.5
Assessment	22	2						20
TOTAL	150	45		8		7	2	88

L: Lectures (85 students)
HI: Hospital internships (7 students)
LAB: Laboratory or field practices (15 students)
COM: Computer room or language laboratory practices (20 students)
SEM: Problem classes or seminars or case studies (40 students)
SGT: Scheduled group tutorials (educational monitoring, ECTS type tutorials)
PS: Personal study, individual or group work and reading of bibliography

Teaching Methodologies

1. Lectures on content Explanation and discussion of content.
2. Problem solving, analysis and discussion. Carrying out, presentation and defence of work/projects.
3. Learning through experimentation. Description: teaching-learning method based on the scientific method in which the student raises hypotheses, experiments, collects data, searches for information, applies models, contrasts the hypotheses and draws conclusions.
4. Individual or group monitoring of learning activities.
5. Autonomous work by the student.

Learning outcomes

To understand the kinetic bases of complex biocatalytic processes. To be able to establish the strategy and determine the methodologies to be used to obtain and purify enzymes of biotechnological interest. Know the main types of enzyme immobilisation and establish the criteria to determine which is the most suitable for particular cases. To learn about particular cases of enzyme systems with solvents or biocatalysts that are unconventional at the biological level, but of great biotechnological interest. To learn about the main biotechnological applications of enzymes at an industrial level.

Assessment systems

In accordance with the regulations on the assessment of learning outcomes and competences acquired by students in official UEx degrees (Rector's Resolution of 26/10/2020 published in DOE no. 212 of 03/11/2020), students may choose between the two assessment systems:

1st option: Continuous assessment

To opt for this type of assessment, students must attend theory classes, seminars and laboratory practice. Absences must be justified. In order to benefit from the continuous assessment, the student must have attended at least 70% of the theoretical classes, participate in the proposed activities, and it is compulsory to attend all the laboratory practice.

Exam: individual test that can take different forms (development or long answer, short answer, multiple-choice, exercises, problems, virtual self-assessments, etc.) or be a combination of these (60-100% weighting).

2. Active participation in the classroom: continuous assessment method based on the student's active participation in classroom activities (30% maximum weighting).
3. Resolution of exercises and problems: test consisting of the development and interpretation of appropriate solutions based on the application of routines, formulas or procedures to transform the information initially proposed by the teacher. This activity may be carried out in the classroom or as a non-classroom activity (30% maximum weighting).
4. Preparation of work and its presentation (case studies, projects, etc.): development of work that may range from short and simple to extensive and complex, including projects and reports typical of final year courses. This assessment activity may also include the presentation of the work to demonstrate the learning outcomes (30% maximum weighting).

In order to calculate the final grade for the course, a minimum of 4.0 must be obtained in each of the blocks. The final grade will have to be equal or higher than 5.0 out of 10 to pass the subject.

2nd option: Single global assessment

To opt for this type of assessment the student must request it in writing within the first three weeks of the semester.

This exam consists of theory questions, practical questions and theoretical and/or numerical questions.

Structure of the exam:

a) Written test: multiple-choice questions on all the topics, to assess the understanding of all the concepts explained (70% maximum of the final grade).

b) Short written test which may include one or more problem-type questions or questions related to the whole subject, including laboratory practice (maximum 30% of the final grade). In order to pass the course, a minimum of 5 points out of 10 will be required.

The grading system in force at any given moment will be applied; currently, the one that appears in RD 1125/2003, article 5. The results obtained by the student in each of the subjects of the syllabus will be graded according to the following numerical scale from 0 to 10, to one decimal place, to which the corresponding qualitative grade may be added: 0 - 4.9: Fail (SS), 5.0 - 6.9: Pass (AP), 7.0 - 8.9: Good (NT), 9.0 - 10: Outstanding (SB). The mention of Honours Degree may be awarded to students who have obtained a grade equal to or higher than 9.0. Their number

may not exceed 5% of the students enrolled in a subject in the corresponding academic year, unless the number of students enrolled is less than 20, in which case only one Honours Degree may be awarded.

Bibliography (basic and complementary)

No specific textbook will be used for the development of the subject. The following is a list of recommended texts of a general nature.

Mathews, C.K., Van Holde, K.E., Appling, D.R. and Anthony-Cahill, S.J.: “Biochemistry”. Pearson, 4th ed., 2013. Chapter 11: “Enzymes: biological catalysts”.
Cornish-Bowden, A.: “Fundamentals of Enzyme Kinetics”. Wiley-Blackwell, 4th ed. 2012.
Bisswanger, H.: ‘Practical Enzymology’. Wiley, 3rd ed., 2019.
Grunwald, P.: “Biocatalysis. Biochemical Fundaments and Applications”. Imperial College Press, 2009.
Chaplin, M.F. and Bucke, C.: "Enzyme Technology”. Cambridge University Pres, 1990.
Smith, J.E.: “Biotechnology”. Ed. Acribia, 2004.
Voet, D., Voet, J.G., and Pratt, C.W.: “Principles of Biochemistry”. Editorial Panamericana, 4th ed., 2016. Part III: ‘Enzymes’
Whitehurst, R.J. and Law, B.A. eds. “Enzymes in Food Technology”. CRC Press, 2002.
Berg, J.M., Stryer, L., Tymoczko, J.L., and Gatto, G.J.: “Biochemistry”, 8th ed., 2015. W. H. Freeman and Company, New York.
Nelson, D. L., and Cox, M., and Lehninger, M.: “Principles of Biochemistry”, 7th ed., 2017. W. H. Freeman and Company, New York.

Other resources and complementary educational materials

Journals with access via Science Direct: http://www.sciencedirect.com/science/search
Journal of Molecular Catalysis B. Enzymatic.
Biotechnology Advances
Current opinion in Biotechnology
New Biotechnology
Trends in Biotechnology
Process Biochemistry
Enzyme and Microbial Technology
Journal of Biotechnology