UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: GENETIC ENGINEERING AND BIOTECHNOLOGY
Code: 13319
Type: CORE COURSE
ECTS credits: 6
Degree: 341 - UNDERGRADUATE DEGREE PROGRAMME IN BIOCHEMISTRY
Academic year: 2023-24
Center: 501 - FACULTY OF ENVIRONMENTAL SCIENCES AND BIOCHEMISTRY
Group(s): 40
Year: 3
Duration: First semester
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site:
Bilingual: N

Lecturer: **Mª CARMEN FENOLL COMES** - Group(s): **40**

Building/Office	Department	Phone number	Email	Office hours
Sabatini/029	CIENCIAS AMBIENTALES		carmen.fenoll@uclm.es	Monday, Tuesday and Wednesday. 13-15h (prior appointment by email)

Lecturer: **MARTA CARMEN GUADAMILLAS MORA** - Group(s): **40**

Building/Office	Department	Phone number	Email	Office hours
Sabatini/017.2	CIENCIA Y TECNOLOGÍA AGROFORESTAL Y GENÉTICA		Marta.Guadamillas@uclm.es	Monday, Tuesday and Wednesday. 13-15h (prior appointment by email)

Lecturer: **Mª DEL MAR MARTIN TRILLO** - Group(s): **40**

Building/Office	Department	Phone number	Email	Office hours
ICAM/0.20	CIENCIAS AMBIENTALES		mariamar.martin@uclm.es	Monday, Tuesday and Wednesday. 13-15h (prior appointment by email)

2. Pre-Requisites

No requirements have been established.
However, it is convenient that students have passed the subjects of *Fundamentals of Cellular Biology, Biochemistry, Microbiology* and *Genetics and Evolution* (first year), *Gene expression and its regulation*, *Structure and function of macromolecules* and *Signaling, control and cellular homeostasis*
(second year).

3. Justification in the curriculum, relation to other subjects and to the profession

Knowledge and skills developed in *Genetic Engineering* are essential in any field of modern Biochemistry. They have direct applications in professional areas as basic research, diagnosis and molecular monitoring, pharmaceutical and agro-alimentary industries, and any biotechnological activity. The acquisition of these skills enables to design different strategies to generate genetic modified organisms, applicable to several fields (health, agrofood, biotechnological industries,…)

Genetic Engineering is fundamental to understand the experimental basis of concepts developed in other courses related to molecular biology. Biotechnology introduces to a specific and productive application of Genetic Engineering, related to other optative courses (Biotechnology and Biomedicine itineraries).

4. Degree competences achieved in this course

Course competences

Code	Description
E01	Express themselves correctly in basic biological, physical, chemical, mathematical and computer terms.
E18	To know the principles of the manipulation of nucleic acids, as well as the techniques that allow the study of the gene function and the development of transgenic organisms with applications in biomedicine, industry, environment, agriculture, etc.
E31	To know and know how to apply the regulations on quality control and management and the legal and ethical bases involved in the development and application of the molecular life sciences.
G01	To possess and understand the knowledge in the area of Biochemistry and Molecular Biology at a level that, based on advanced textbooks, also includes cutting-edge aspects of relevance in the discipline
G02	To know how to apply the knowledge of Biochemistry and Molecular Biology to professional practice and to possess the necessary intellectual skills and abilities for this practice, including the capacity for: information management, analysis and synthesis, problem solving, organization and planning and generation of new ideas.
G03	Be able to collect and interpret relevant data, information and results, draw conclusions and issue reasoned reports on relevant social, scientific or ethical issues in connection with advances in Biochemistry and Molecular Biology.
G04	To know how to transmit information, ideas, problems and solutions in the field of Biochemistry and Molecular Biology to a specialized and non-specialized public.
G05	Develop those strategies and learning skills necessary to undertake further studies in the area of Biochemistry and Molecular Biology and other related areas with a high degree of autonomy.
G06	Acquire skills in the handling of computer programs including access to bibliographic, structural or any other type of databases useful in Biochemistry and Molecular Biology.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Solve and design experiments in the field of Molecular Biology.

To know the model organisms used in biotechnology, their potential and characteristics.

Acquire the basic concepts necessary for the use of recombinant DNA technology.

To understand the potential applications of molecular biotechnology in agriculture, food, medicine, environment and industry and the main current trends and future challenges.

Acquire the necessary scientific criteria to develop professional ethics in the application of genetic engineering and biotechnology.

Become familiar with the scientific literature and with the search for and communication of scientific information.

Become familiar with experimental techniques for studying gene function.

To know the techniques used to obtain genetically modified microorganisms, plants and animals.

Understand the molecular basis and applications of different methods of interrupting the specific expression of gene function.

Additional outcomes

To obtain an introductory training in holistic and reverse genetic experimental approaches in the fileds of genomics and genetic engineering

6. Units / Contents

Unit 1: INTRODUCTION

Unit 1.1 Genetic Engineering and modern Biotechnology. Multidisciplinary approach, current developmental fields and future perspectives. Theoretical basis, development and applications of recombinant DNA technologies.

Unit 2: BASIC TECHNIQUES IN GENETIC ENGINEERING

Unit 2.1 NUCLEIC ACID MANIPULATION. DNA manipulative enzymes. 2.1.1 Nucleases. Modifying and restriction mechanisms. Applications of restriction enzymes. 2.1.2 DNA ligases. DNA polymerases. Terminal modifying enzymes.

Unit 2.2 BASIC TECHNIQUES IN GENETIC ENGINEERING I: 2.2.1. Isolation, extraction and purification of nucleic acids. 2.2.2. Analysis techniques: electrophoresis. Labeling of nucleic acids. Hybridation of nucleic acids and proteins (Southern, Northern and Western blot).

Unit 2.3 BASIC TECHNIQUES IN GENETIC ENGINEERING II: 2.3.1. Polymerase chain reaction (PCR). Variations of classical techniques: RT-PCR and quantitative PCR. Applications of PCR. 2.3.2. Nucleic acid sequencing.

Unit 2.4 PRINCIPLES OF DNA CLONING. 2.4.1. Recombinant DNA. Cloning strategies: obtaining DNA, DNA ligation, transformation. Clone selection. 2.4.2. Prokaryotic cloning vectors. Plasmids: identification, features and types. Plasmid incompatibility. Cosmids. Cloning strategies: DNA obtaining, DNA ligation, transformation. Clone selection. Protein engineering.

Unit 2.5 GENETIC TRANSFORMATION IN PLANTS. 2.5.1 Model species. Vectors and methods of transfection and stable transformation 2.5.2. Selection and propagation of transgenic lines. Chloroplast transformation.

Unit 2.6 GENETIC TRANSFORMATION IN ANIMALS. 2.6.1. Model species. Vectors and methods of transfection and stable transformation. 2.6.2.Selection and propagation of transgenic animals.

Unit 3: STRATEGIES BASED ON GENETIC ENGINEERING FOR GENE AND FUNCTIONAL ANALYSIS.

Unit 3.1 GENE IDENTIFICATION. 3.1.1. Construction of genomic libraries. Types and features. cDNA libraries. 3.1.2.Screening methods.

Unit 3.2 GENE EXPRESSION: 3.2.1.Transcript detection and quantification (Northern, RT-PCR). 3.2.2. Reporter genes. 3.2.3. Differential gene expression analysis. Microarrays and RNA-seq.

Unit 3.3 GENE FUNCTION ANALYSIS BY MUTAGENESIS I: 3.3.1. Mutagenesis. Random mutagenesis. Directed mutagenesis. 3.3.2. Directed molecular evolution. Protein engineering.

Unit 3.4 GENE FUNCTION ANALYSIS BY MUTAGENESIS II: Reverse Genetics. Holistic (genomic) strategies in animals and plants. 3.4.1. Random insertional mutagenesis: collections of insertion lines and gene trapping. 3.4.2. Site-directed insertional mutagenesis: Cre-Lox-based systems.

Unit 3.5 ANALYSIS OF GENE FUNCTIONS BY PRECISION GENE EDITION. 3.5.1. Meganucleases (TALEN, Zn fingers). 3.5.2. CRISPR/Cas9 system.

Unit 3.6 ANALYSIS AND MODIFICATION OF GENE EXPRESSION in animals and plants. 3.6.1. Analysis of specific promoters: gene reporters. 3.6.2. Identification of new promoters: promoter traps collections. 3.5.3. Subcellular localization and protein dynamics. 3.5.3. RNA interference (RNAi) mediated gene silencing. 3.5.4. Ectopic (GAL4/UAS) or conditional (XVE/Olex) gene expression.

Unit 3.7 ANALYSIS OF INTERACTIONS BETWEEN MACROMOLECULES. 3.7.1. DNA-protein interaction: IN VITRO (EMSAs), IN VIVO (ChIP) and functional assays (Y1H and transactivation). 3.7.2. Protein-protein interactions. Bimolecular fluorescence complementation (BiFC).

Unit 4: BIOTECHNOLOGY BASED ON GENETIC ENGINEERING

Unit 4.1 Medical and veterinary applications.

Unit 4.2 Applications in agriculture and food.

Unit 4.3 Environmental and industrial applications.

Unit 5: LABORATORY PRACTICE

Unit 5.1 GMOs IDENTIFICATION BY PCR

Unit 5.2 CLONING AND IDENTIFICATION OF RECOMBINANT PLASMIDS

Unit 5.3 DESIGN OF A CLONING EXPERIMENT

ADDITIONAL COMMENTS, REMARKS

Unit 4 will be developed through group work on bibliography suggested by the teachers. The works will be presented orally in the last course sessions.

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	E01 E18 E31 G01 G02	1.16	29	N	-	Lectures by professor (2-4h per week).
Other off-site activity [OFF-SITE]	Project/Problem Based Learning (PBL)	E18 E31 G02 G03	0.56	14	Y	N	Delivery of problems and case studies proposed by teachers. The activity is non-recoverable.
Problem solving and/or case studies [ON-SITE]	Project/Problem Based Learning (PBL)	E01 E18 E31 G02 G03	0.2	5	Y	N	Problem solving by students. This activity is non-recoverable.
							Realization of laboratory practices. It

Laboratory practice or sessions [ON-SITE]	Practical or hands-on activities	E01 E18 G02 G03 G05	0.72	18	Y	Y	is a compulsory and non-reschedulable activity. Students will have to pass an exam, which is recoverable in the extraordinary and finalization exams.
Writing of reports or projects [OFF-SITE]	Group Work	E01 E18 G01 G03 G06	0.16	4	Y	N	Elaboration of a group presentation about a relevant scientific paper or topic, related to unit 4. Non-recoverable.
Study and Exam Preparation [OFF-SITE]	Self-study	E01 E18 E31 G01 G03	2.88	72	N	-	
Final test [ON-SITE]	Assessment tests	E01 E18 E31 G01 G03	0.08	2	Y	Y	Written exam to assess knowledge on the main contents of the second part of the subject (if the mid-term test is passed) or of all the contents (otherwise). A minimum mark of 4.0 is required. The activity is recoverable in the extraordinary and the finalization exams.
Mid-term test [ON-SITE]	Assessment tests	E01 E18 E31 G01 G03	0.08	2	Y	N	Written exam to assess knowledge on the main contents of the first part of the course. A minimum mark of 4.0 is required to pass this activity (recoverable).
Project or Topic Presentations [ON-SITE]	Combination of methods	E01 E18 G01 G03 G04	0.16	4	Y	N	Group presentation about scientific papers or topics related to unit 4. This activity is non-reschedulable.
		Total:	**6**	**150**			
		Total credits of in-class work: 2.4					**Total class time hours: 60**
		Total credits of out of class work: 3.6					**Total hours of out of class work: 90**

As: Assessable training activity
Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Assessment of problem solving and/or case studies	10.00%	0.00%	Problem solving and case studies delivered will be assessed. This activity is non-recoverable.
Laboratory sessions	10.00%	10.00%	Realization of laboratory practices is compulsory. A minimun mark of 4.0 is required. Recoverable in the second resit.
Oral presentations assessment	10.00%	10.00%	Synthesis ability, overall understanding and creativity will be assessed.
Mid-term tests	35.00%	0.00%	A minimum mark of 4.0 is required to pass this test. Recoverable.
Final test	35.00%	80.00%	Mandatory and recoverable activity. A minimum mark of 4.0 is required to pass the activity.
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

The default modality assigned to the student will be the continuous evaluation. Any student may request a change to the non-continuous evaluation modality (before the end of the class period) by sending an e-mail to the professor, provided that he/she has not completed the evaluable activities corresponding to 50% total qualification.
Autonomous learning capacity will be evaluated, as well as critical reasoning, through various tests as indicated in the table.
To pass the course is required:
-A minimum mark of 4.0 in the final test.
-Practical lessons attendance and a minimum mark of 4.0 in practical lessons.
-A minimum global qualification of 5.

Non-continuous evaluation:

For those students who express their interest to the teacher, in the above cited conditions. Autonomous learning capacity will be evaluated, as well as critical reasoning, through various tests as indicated in the table.
The final grade for the course will be calculated taking into account the percentages in the table above. The subject will be passed with a 5.
In any case, to pass the subject it will be necessary to:
To pass the course is required:
-A minimum mark of 4.0 in the final test.
-Practical lessons attendance and a minimum mark of 4.0 in practical lessons.
-A minimum global qualification of 5.

Specifications for the resit/retake exam:

The same criteria will be followed as for the ordinary test.
The grades obtained in the different theoretical and practical tests, carried out throughout the course will be kept for the resit exam

Specifications for the second resit / retake exam:

To pass this call there will only be a final test that will account for 100% of the grade, as long as the laboratory practices have been carried out

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours	**hours**

Unit 1 (de 5): INTRODUCTION

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	1
Group 40:	
Initial date: 11-09-2023	**End date:** 11-09-2023

Unit 2 (de 5): BASIC TECHNIQUES IN GENETIC ENGINEERING

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	14
Problem solving and/or case studies [PRESENCIAL][Project/Problem Based Learning (PBL)]	3
Group 40:	
Initial date: 12-09-2023	**End date:** 06-10-2023

Unit 3 (de 5): STRATEGIES BASED ON GENETIC ENGINEERING FOR GENE AND FUNCTIONAL ANALYSIS.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	14
Problem solving and/or case studies [PRESENCIAL][Project/Problem Based Learning (PBL)]	2
Final test [PRESENCIAL][Assessment tests]	2
Mid-term test [PRESENCIAL][Assessment tests]	2
Group 40:	
Initial date: 09-10-2023	**End date:** 15-12-2023

Unit 4 (de 5): BIOTECHNOLOGY BASED ON GENETIC ENGINEERING

Activities	**Hours**
Project or Topic Presentations [PRESENCIAL][Combination of methods]	4
Group 40:	
Initial date: 18-12-2023	**End date:** 22-12-2023
Comment: Final test will be taken in the Ordinary exam period.	

Unit 5 (de 5): LABORATORY PRACTICE

Activities	**Hours**
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	18
Group 40:	
Initial date: 16-10-2023	**End date:** 10-11-2023

Global activity

Activities	**hours**
Mid-term test [PRESENCIAL][Assessment tests]	2
Class Attendance (theory) [PRESENCIAL][Lectures]	29
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	18
Project or Topic Presentations [PRESENCIAL][Combination of methods]	4
Final test [PRESENCIAL][Assessment tests]	2
Problem solving and/or case studies [PRESENCIAL][Project/Problem Based Learning (PBL)]	5
Total horas:	60

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
MD Rausell, Carolina Latorre, Amparo real	Técnicas de Ingeniería Genética	Síntesis		9788491710714	2017	
Brown, T	Genomas. 3ª Edición	Panamericana		978-9500614481	2008	
Glick, B; Pasternak, J and Patten, C	Molecular Biotechnology. 4th Edition	ASM Press		978-1555814984	2010	
Herráez, A	Biología Molecular e Ingeniería Genética. 2ª Edición	ELSEVIER		978-84-8086-647-7	2012	
Kreuzer, H y Massey A	ADN recombinante y Biotecnología	Acribia		84-200-1025-1	2004	
Nair, AJ	Introduction to Biotechnology and genetic engineering	Jones and Barlett Publishers		978-1934015162	2008	
Perera, J; Tormo, A y Garcia, JL	Ingeniería genética. Volumen I: Preparación, análisis, manipulación y clonaje de DNA.	Síntesis		84-7738-966-7	2002	
Perera, J; Tormo, A y Garcia, JL	Ingeniería genética. Volumen II: Expresión de DNA en sistemas heterólogos	Síntesis		84-7738-966-7	2002	
Primrose S and Twyman, R	Principles of Gene Manipulation and Genomics. 8th edition	Balckwell		978-1405156660	2012	Prevista su publicación
Primrose S and Twyman, R	Principles of Gene Manipulation and Genomics. 7th edition	Blackwell		978-1405135443	2006	
Renneberg, R	Biotecnología	Reverte		978-8429174830	2008	
Thiemann, W y Palladin, M	Introducción a la Biotecnología.2ª edición	Pearson education		978-8478291175	2010	