Genetic Engineering of Microorganisms

Code: 101977
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500890 Genetics	OT	4

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

It is recommendable to have studied or are studying Molecular Biology of Prokaryotes.

Objectives and Contextualisation

The main objective of this course is that the student will be able to design procedures for the genetic manipulation of microorganisms.

Therefore during the development of the subject, the student must reach the following capacities:
• To know how to identify different types of microbial vectors, recognize their applications and design new ones
• To know how to apply methodologies and strategies of cloning
• To recognize the implication of the characteristics of each microorganism (immunity systems, recombination capacity, codon usage, etc.) in the proposed experimental design
• to know how to choose the most appropriate genetic transfer technique in each proposed case
• To be able to design efficient strategies for obtaining, enriching and selecting mutants
• To know how to build gene fusions and recognize their possible applications
• To recognize the main characteristics of potential bacterial targets for drugs, vaccines, and diagnostic reagents development.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Apply knowledge of theory to practice.
- Apply scientific method to problem solving.
- Be able to analyse and synthesise.
- Describe and identify the structural and functional characteristics of nucleic acids and proteins including their different organisational levels.
- Design and execute complete protocols of the standard techniques that form part of molecular genetics instruments: purification, amplification and sequencing of genomic DNA from biological sources, genetic engineering in microorganisms, plants and animals.
- Develop self-directed learning.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Reason critically.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- Use and manage bibliographic information or computer or Internet resources in the field of study, in one's own languages and in English.

Learning Outcomes

1. Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
2. Apply knowledge of theory to practice.
3. Apply scientific method to problem solving.
4. Be able to analyse and synthesise.
5. Describe the processes of replication, transcription, translation and regulation of genes in prokaryotes and eukaryotes.
6. Design applicable protocols for the genetic manipulation of microorganisms.
7. Develop self-directed learning.
8. Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
9. Reason critically.
10. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
11. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
12. Use and manage bibliographic information or computer or Internet resources in the field of study, in one's own languages and in English.

Content

The content of the course consists of the following topics:

Unit 1. DNA introduction systems in bacteria. Natural transformation in gramnegative and grampositive bacteria. State of competence. Molecular mechanisms associated with natural transformation. Induced transformation. Electrotransformation. Design and optimization of transformation systems in bacteria lacking natural transformation. Other Systems of DNA transference.

Unit 2. DNA vectors and cloning strategies in bacteria. Requirements of cloning vectors. Expression vectors. T-type vectors. Mobilizable vectors. Suicide vectors. Shuttle vectors. Integrational vectors. Genetic

characteristics of vector accepting cells. Construction of DNA libraries *in vitro* and *in vivo*. Cloning by complementation: anabolic or catabolic genes. Regulatory gene isolation methods. Obtaining virulence genes. Cloning of toxic genes.

Unit 3. Bacterial gene fusions. Transcriptional and translational fusions. Gene fusions in polycistronic units. Fusion vectors: general characteristics. Random gene fusions. Methods for the construction of gene fusions. Construction of gene fusions by PCR, OE-PCR and Gibson assembly. Applications and examples of gene fusions.

Unit 4. Mutagenesis in bacteria. Random mutagenesis *in vivo*. Use of chemical or physical methods. Criteria and methods for the selection and enrichment of mutants. Transposons. Minitransposons. Plasposons. Transposomes. Methods for the identification and confirmation of mutants. *In vitro* mutagenesis of cloned genes.

Unit 5. Gene substitution in bacteria and generation of knockouts. Obtaining mutants by gene disruption and by gene substitution. Lambda Red system. Obtaining scarless mutants. Counter selection systems. I-SceI system. Use of CRISPR/Cas9 technology to obtain mutants. Methods for the identification and confirmation of mutants. Systems for the reintroductionof altered genes in the bacterium of origin. Insertion into the chromosome of new genes or constructs.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Participatory master classes	30	1.2	5, 6
Seminars	12	0.48	2, 3, 4, 7, 9, 12
Type: Supervised			
Tutorship	1	0.04	5, 6
Type: Autonomous			
Preparation of posters and questionnaires	34	1.36	2, 3, 4, 7, 9, 12
Reading recommended texts	20	0.8	12
Study and other autolearning activities	50	2	2, 4, 7, 9, 12

The course is organized in two modules:

Theoretical module: where participatory master classes are combined with problem-based learning sessions where theoretical concepts are worked through the resolution of practical cases.

Seminar module: in which through collaborative learning, students work on different aspects of actual experimental designs present in recent scientific articles. At the beginning of the course, students choose, following the guidelines set by the teaching staff, a scientific article related to the field of genetic engineering of microorganisms from which they make a poster. The schedule of activities like classroom work sessions, exhibition, and discussions, as well as the delivery dates of the proposed activities will be defined at the beginning of the course by the teachers.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Classroom and virtual classroom submissions	10%	0	0	1, 2, 3, 4, 7, 8, 9, 10, 11
Discussion and participation in the classroom	5%	0	0	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Poster	25%	0	0	2, 3, 4, 5, 6, 7, 9, 12
Resolution of questionnaires	7.5%	0	0	2, 3, 4, 5, 6, 7, 9, 12
Written test (resolution of practical cases)	50%	3	0.12	2, 3, 4, 5, 6, 9
team-work or individual self-evaluation	2.5%	0	0	2, 3, 4, 5, 6, 7, 9, 12

Seminar module evaluation
The evaluation of the seminars is done through the evaluation of different activities related to a scientific article:

A) Autonomous deliveries that will be delivered through the Moodle classroom and deliveries in the classroom work sessions. With a maximum rating of 2 points out of 10.

B) The poster and questionnaire associated with the chosen scientific article. With a maximum rating of 5 points out of 10.

C) The defense of the poster during its classroom exhibition. With a maximum rating of 1 point out of 10.

D) The resolution of the questionnaires related to the presented seminars. With a maximum rating of 1.5 points out of 10.

E) Individual and workgroup self-evaluation. With a maximum rating of 0.5 points out of 10.

To pass this module the student must obtain a grade equal or superior to 5.

Theoretical module evaluation
The evaluation of this activity is done through an individual written exam. The maximum rating of this section is 10 points out of 10.
To pass this module it is necessary to obtain a score equal to or greater than 5 points.

If the grade obtained is less than 5, the student must take the retake examination.

To be eligible for the retake process, the student should have been previously evaluated in a set of activities equaling at least two-thirds of the final score of the course or module.

Students who have passed the module may submit to a grade improvement test waiving the grade obtained previously in the individual written exam. The scheduled date for the second chance test is that of the second

chance examination. Students wishing to take the grade improvement test must communicate it by mail to the teacher responsible for the subject at least 72 hours before the day scheduled for the second chance examination.

The final grade of the course will be theaverage of the grades obtained in both modules, being necessary to have passed separately each of them.
The student will be graded as "Non-evaluable" if the weight in of all conducted evaluation activities is less than 67% of the final score.

Single assessment

The evaluation of the theoretical module consists of a single test that will be the same as that of the type of continuous assessment, this test will account for 50% of the final grade for the subject and the same system of evaluation will be applied for recovery than for continued evaluation.

The evaluation of the activities of the seminar module will mean 50% of the final grade for the subject. The students who take advantage of the single evaluation may deliver all the evidence together (including the oral presentation) on the same day as the one set for the synthesis test. The single assessment test will be carried out coinciding with the same date set in the calendar for the last continuous assessment test.

Bibliography

As reference bibliography of basic concepts it is recommended:

Larry Snyder i Wendy Champness. Molecular Genetics of Bacteria (3rd or 4th Edition). ASM press (ISBN: 978-1-55581-399-4 and ISBN:978-1-55581-627-8).

https://bibcercador.uab.cat/permalink/34CSUC_UAB/15r2rl8/cdi_askewsholts_vlebooks_9781118685112

Jeremy W. Dale and Simon F. Park. Molecular Genetics of Bacteria, (5th Edition) Wiley-Blackwell (ISBN: 978-0-470-74184-9).

Other recommended texts as well as links of interest will be available in the Moodle classroom of the subject.

Software

Not applicable.

Language list

Name	Group	Language	Semester	Turn
(SEM) Seminars	441	Spanish	second semester	morning-mixed
(SEM) Seminars	442	Spanish	second semester	morning-mixed
(TE) Theory	44	Catalan/Spanish	second semester	morning-mixed