Genetic Engineering of Microorganisms

Code: 100981
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500502 Microbiology	OB	3

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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 Microbiology, Genetics, Molecular Biology of Eukaryotes, Virology and Molecular Biology of Prokaryotes.

Objectives and Contextualisation

The primary goal of this course is to ensure that students can continue to design methods for the genetic manipulation of microorganisms.

During the course, the learning objectives are:

- Analyze various microbial vectors, assess their applications, and construct new ones.
- Implement cloning methodologies and strategies.
- Understand how each microorganism's characteristics (such as immune systems, recombination abilities, and other functions) affect the experimental design.
- Choose the most appropriate genetic transfer technique for each case.
- Develop effective strategies for the generation, enrichment, and selection of mutants.
- Create genetic fusions and understand their diverse applications.
- Identify the key features of bacterial targets for drug development, vaccines, and diagnostic tests.

Learning Outcomes

1. CM11 (Competence) Propose strategies for molecular cloning, mutant generation and genetic improvement using omics analysis with ethical responsibility and gender perspective to provide innovative responses to the needs and demands of society.
2. CM12 (Competence) Integrate knowledge and skills of molecular biology and genomics to develop and present academic work in the field of microbiology, either in English or in one's own language or others and working individually and in groups.
3. KM18 (Knowledge) Identify the methods of study of nucleic acids for their sequencing, modification and interpretation of their expression products.
4. SM15 (Skill) Use bibliography and databases related to molecular biology and genomics, both in English and in one's own language.
5. SM16 (Skill) Relate the factors that control the different levels of gene expression with adaptation to existing environmental conditions and their application in biotechnology.
6. SM18 (Skill) Relate the processes of transfer and conservation of genetic information with its diverse applications in genetic engineering.

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.

Unit 6. Application of omics to the genetic engineering of microorganisms. Sequencing and NGS. Transcriptomics. Proteomics. The metaomics' strategies: metagenomics, metatranscriptomics, metabolomics.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Participatory Master Classes	30	1.2	CM11, CM12, KM18, SM15, SM16, SM18, CM11
Seminars	14	0.56	CM12, SM15, SM18, CM12
Type: Supervised			
Tutorship	1	0.04	CM12, SM16, CM12
Type: Autonomous			
Preparation of posters and questionnaires	38	1.52	CM11, CM12, KM18, SM15, SM16, SM18, CM11
Reading recommended texts	15	0.6	CM12, KM18, SM15, CM12
Study	50	2	CM12, SM15, CM12

The course is organized in two modules:

Theoretical module: where participatory masterclasses 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	CM11, CM12, KM18, SM15, SM16, SM18
Discussion and participation in the classroom	5%	0	0	CM11, CM12, KM18, SM16, SM18
Poster	25%	0	0	CM11, CM12, KM18, SM15, SM16, SM18
Resolution of questionnaires	7.5%	0	0	CM11, CM12, KM18, SM15, SM16, SM18
Written test (resolution of practical cases)	50%	2	0.08	CM11, CM12, KM18, SM15, SM16, SM18

team-work or individual self-evaluation	2.5%	0	0	CM12, SM15, SM18

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 the 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 to the student in the Moodle classroom of the subject.

Software

There is no specific software for this subject

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	731	Spanish	second semester	morning-mixed
(PAUL) Classroom practices	732	Spanish	second semester	morning-mixed
(TE) Theory	73	Catalan/Spanish	second semester	morning-mixed