Universitat Autònoma de Barcelona

2020/2021

Genetic Engineering of Microorganisms

Code: 100981
ECTS Credits: 6

Degree	Type	Year	Semester
2500502 Microbiology	OB	3	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Maria Pilar Cortés Garmendia

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 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

- Communicate orally and in writing.
- Comply with principles of bioethics and professional codes of conduct.
- Design and apply methods and strategies for isolating and selecting new microorganisms and for genetically manipulating microorganisms of interest.

- Design and obtain microbial vectors and microorganisms that are useful for making products of interest and for genetically modifying other living beings.
- Design experiments and interpret the results
- Develop critical reasoning skills in the field of study and in relation to the social context.
- Identify the molecular mechanisms of pathogenesis and relate them to the response to infection in order to design and develop strategies for diagnosing and combating diseases caused by microorganisms.
- Obtain, select and manage information.
- Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.

Learning Outcomes

1. Communicate orally and in writing.
2. Comply with principles of bioethics and professional codes of conduct.
3. Design experiments and interpret the results
4. Design strategies for obtaining enriching and selecting mutants.
5. Design strategies for obtaining microbial vectors.
6. Develop critical reasoning skills in the field of study and in relation to the social context.
7. Discern the importance of the different components of microbial vectors.
8. Discern the methods for selecting and detecting vectors.
9. Formulate global strategies for genetic improvement of microbial strains and the cloning of genes of interest.
10. Identify useful microbial cell components for developing strategies for the design of drugs, vaccines and diagnostic reagents.
11. Know the methodologies of cloning and characterisation of nucleic acids.
12. Know the several types of microbial vectors.
13. Obtain, select and manage information.
14. Understand the applications of genetic transfer mechanisms, restriction and modification systems and the genetic elements of microorganisms.
15. Understand the meaning of gene mergers and their applications.
16. Understand the procedures for expression and purification of recombinant proteins.
17. Understand the replication mechanisms of the different types of microbial vectors.
18. Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.

Content

The content of the course consists of the following topics*:

Unit 1. Introduction of exogenous DNA in bacteria for transduction and conjugation. Specialized transduction. Generalized transduction. High transduction frequency bacteriophages. Molecular mechanisms associated with conjugation. Mobilizable vectors and conjugative vectors. Conjugation biparental and triparental. Donor strains.

Unit 2. Bacterial transformation. Natural transformation. State of competition. Molecular mechanisms associated with natural transformation. Induced transformation. Electrotransformation.

Unit 3. DNA vectors in bacteria. Requirements of cloning vectors. Vector expression. T-type vectors. Suicide vectors. Shuttle Vectors. Integrational vectors. Molecular bases of vector replication. Genetic characteristics of vector accepting cells.

Unit 4. Bacterial gene fusions. Operon and protein fusions. Fusion constructing methods. Fusion vectors: general characteristics. Use of transposons and bacteriophages. Applications of gene fusions.

Unit 5. Construction of Genomic DNA Libraries. General concept. Representation. Strategies for obtaining genomic DNA libraries. Phage DNA libraries. Cosmid DNA libraries. BACS, PACS and YACS. Systems by the screening of genomic DNA libraries.

Unit 6. Random Mutagenesis for genetic modification of bacteria. 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 bacterial mutants.

Unit 7. *In vitro* mutagenesis of cloned genes. Methods of introducing point mutations. Insertional mutagenesis: use of transposons. Non-polar mutagenesis of polycistronic transcriptional units. Systems of mutated genes reintroduction. Synthetic genes.

Unit 8.Gene replacement in bacteria. Molecular mechanisms of homologous recombination. Mutant strains obtaining. Mechanisms of recombination based on bacteriophages. CRISPR Systems. Counter-selection systems, obtaining scarless mutants. Methods for the identification and confirmation of mutants.

Unit 9. Application of omics to genetic engineering of microorganisms. Pyrosequencing. SMRT technology. Transcriptomics. Proteomics. The "metaomics": metagenomics, metatranscriptomics, metabolomics.

*Unless the requirements enforced by the health authorities demand a prioritization or reduction of these contents.

Methodology

Genetic Engineering of Prokaryotes course is organized in two modules:

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 as 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.

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

(The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.)

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Participatory Master Classes	30	1.2	15, 17, 16, 14, 12, 11, 6, 4, 5, 8, 7, 10, 9, 2
Seminars	14	0.56	15, 17, 16, 14, 12, 11, 6, 4, 5, 3, 8, 7, 10, 13, 9, 2, 1, 18
Type: Supervised			
Tutorship	1	0.04	15, 17, 16, 14, 12, 11, 6, 4, 5, 3, 8, 7, 10, 13, 9, 2, 18
Type: Autonomous			
Preparation of posters and questionnaires	38	1.52	15, 17, 16, 14, 12, 11, 6, 4, 5, 3, 8, 7, 10, 13, 9, 2, 18
Reading recommended texts	15	0.6	15, 17, 16, 14, 12, 11, 6, 4, 5, 8, 7, 10, 13, 9, 2, 18
Study	50	2	17, 16, 14, 12, 11, 6, 4, 5, 3, 8, 7, 10, 13, 9, 2, 1, 18

Assessment

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. This test will have a maximum qualification of 8 points out of 10 and a score equal to or greater than 4 will be necessary to pass the module.

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

Student's assessment may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Classroom and virtual classroom submissions	10%	0	0	6, 5, 3, 13, 1, 18
Discussion and participation in the classroom	5%	0	0	6, 1
Poster	25%	0	0	15, 17, 16, 14, 12, 11, 8, 7, 10, 13, 2, 18

Resolution of questionnaires in the classroom	7.5%	0	0	15, 17, 16, 14, 12, 11, 6, 4, 5, 8, 7, 10, 9, 1
Written test (resolution of practical cases)	50%	2	0.08	15, 17, 16, 14, 12, 11, 6, 4, 5, 3, 8, 7, 10, 9, 2, 1
team-work or individual self-evaluation	2.5%	0	0	15, 17, 16, 14, 12, 11, 6, 4, 5, 3, 8, 7, 10, 13, 9, 2, 1, 18

Bibliography

As reference bibliography of basic concepts it is recommended:

Larry Snyder and Wendy Champness. Molecular Genetics of Bacteria (3rd gold 4th Edition). ASM press (ISBN: 978-1-55581-399-4 and ISBN: 978-1-55581-627-8). On line version available at UAB library repository:

http://resolver.ebscohost.com.are.uab.cat/openurl?sid=EBSCO:nlebk&genre=book&issn=&ISBN=978155581627

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.