Course guide
240EQ222 - 240EQ222 - Genetic Engineering

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Unit in charge: Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Optional subject).

Academic year: 2022 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: LUIS JAVIER DEL VALLE MENDOZA

Others: JUAN JESUS PEREZ GONZALEZ
DAVID ZANUY GOMARA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

2. Designing products, processes, systems and services for the chemical industry as well as the optimization of other already developed technology based on various areas of chemical engineering, understanding of processes and transport phenomena, separation operations and engineering chemical reactions, nuclear, electrochemical and biochemical.
3. Manage the Research, Development and Technological Innovation, based on the transfer of technology and property rights and patents.
4. Adapting to structural changes in society motivated by phenomena such factors or economic, energy or natural to solve the problems and to provide technological solutions with a high commitment to sustainability.
5. Easily integrate technical team and creative interdisciplinary any chemical company or research center.

Generical:
6. Communicate and discuss proposals and conclusions in forums multilingual, skilled and unskilled, in a clear and unambiguous.
7. Lead and define multidisciplinary teams capable of solving technical and management needs changes in national and international contexts.
8. Integrate knowledge and handle complexity, making judgments and decisions, from incomplete or limited information, including reflections on the social and ethical responsibilities of professional practice.
9. Possess independent learning skills to maintain and enhance the competencies of chemical engineering to enable the continued development of their profession.
10. Ability to analyze and synthesize to the continued progress of products, processes, systems and services using criteria of safety, affordability, quality and environmental management.

TEACHING METHODOLOGY

Subject in process of extinction. There is no teaching, the students that enroll it do so only with the right to an exam.

LEARNING OBJECTIVES OF THE SUBJECT

The course gives a detailed overview of methodologies and techniques of molecular biology allow the isolation, handling and/or modification of DNA sequences in order to obtain a genetically modified protein or structurally alter the genome of an organism.

The course program begins with an overview of Mendelian genetics, inheritance patterns and evolutionary genetics. Later, these concepts allow understanding and improving the designs of their own strategies of genetic engineering depending on the biological system that is used to express the new gene construct that is, as the genetic modifications introduced genetically engineered cells are fixed, individuals and populations. Then, the program includes a description of the fundamental techniques of genetic engineering that serve as tools for obtaining and manipulating nucleic acids. An additional chapter is related to the specific methods of genetic engineering in microorganisms, plants and animals. Finally, applications of genetic engineering in the biomedical area will be treated in a separate chapter. To consolidate and complete some concepts of the subject have included some activities related to bioinformatics as a tool for DNA sequence analysis and design cloning strategies. An additional activity on bioethics and patents in the environment of genetic engineering has been considered due to the social implications and economic factors that may result from the research and development in genetic engineering.

STUDY LOAD

Type	Hours	Percentage
Hours large group	40,5	36.00
Self study	72,0	64.00

Total learning time: 112.5 h

CONTENTS

1. Mendelian genetics and evolutionary basis for genetic engineering.

Description:
1.1) Mitosis. Meiosis. Genes. Alleles. Mendel's laws. Patterns of inheritance: dominant, recessive sex-linked codominance, influenced by gender.
1.2) Darwin and the theory of evolution. Natural selection and adaptation.
1.3) The ideal population and Hardy-Weinberg
1.4) The genetic variability of populations: phenotypic variation and molecular variability.
1.5) Deviations from random mating and inbreeding.
1.6) The finite population genetics: genetic drift.
1.7) The mutation. Migration and gene flow.
1.8) The genetic variability: genetic differentiation among populations, genetic distances and phylogenetic trees.
1.9) Molecular evolution: Rates of nucleotide and amino acid substitution, molecular clocks and the neutral theory of molecular evolution. The genetics of speciation.

Specific objectives:
Students are expected to integrate genetic engineering and its applications within a comprehensive framework for the segregation of genetic material to individual and population level, and understanding how genetic engineering can influence the gene pool of an individual in a population.

Related activities:
Exercises and Problems. Recommended reading

Full-or-part-time: 16h
Theory classes: 5h
Practical classes: 2h
Self study : 9h

2. Tools and methods of application in genetic engineering and biotechnology.

Description:
2.1) Introduction to genetic engineering and biotechnology. Recombinant DNA methodology. Overview of the recombinant DNA technique. Restriction enzymes, DNA polymerases, RNA polymerases, ligases. Nucleic acid hybridization. Design and labeling of probes. Southern and northern blot, and hybridization in situ.
2.2) Restriction enzymes and gene cloning. Structure and types of restriction enzymes. Restriction maps. Cloning of DNA sequences. Cloning vectors: plasmids, phages, cosmids. Transformation. Identification of recombinants. Cloning strategies.
2.3) PCR. Description of the PCR technique. PCR variations. Cloning of DNA sequences. Nested-PCR. RT-PCR. Preparation of nucleic acid probes by PCR. DNA sequencing of PCR.
2.4) libraries and Microarray. Construction and screening of libraries of DNA and DNA copy. Genome sequencing. Microarrays and gene chips.

Specific objectives:
Students will learn about the basic tools to work with DNA and general methods for cloning DNA sequences (structural gene sequences and DNA).

Related activities:
Exercises and Problems. Recommended reading.
Activity 1: Analysis in-silico restriction maps.
Activity 2: Design of primers (primers) for PCR.

Full-or-part-time: 19h
Theory classes: 6h
Practical classes: 2h
Self study : 11h

3. Cloning and expression of genes

Description:
3.1) Structure and design of cloning vectors and expression vectors. Factors affecting the cloning and expression of genes in recombinant systems. Fusion proteins and purification.
3.2) directed mutagenesis and protein engineering. Procedures for site-specific mutagenesis. Random mutagenesis. Protein engineering to generate new proteins.

Specific objectives:
The student will acquire knowledge on advanced strategies of genetic engineering to make biotech products. Selection of vectors, cloning strategies, optimization of sequences, mutagenesis and expression of DNA sequences.

Related activities:
Exercises and Problems. Recommended reading.
Activity 4: in-silico analysis of DNA sequences

Full-or-part-time: 14h
Theory classes: 4h
Practical classes: 2h
Self study : 8h

4. Genetic engineering in microorganisms, plants and animals.

Description:
4.1) Methods for transformation of yeasts: Saccharomyces cerevisiae as a model. Yeast vectors: types of plasmids and their applications. The system of two three hybrids.
4.2) Plant Biotechnology. Transgenic plants. Cultivation of plants in vitro. Cloning vectors. Plant transformation systems. Transgenic plants.
4.3) Animal Biotechnology. Recombinant DNA technology in mammalian cells. Transfection and culturing of mammalian cells. Types of vectors, plasmids, virus, polymers. Expression of exogenous genes in mammalian cells. Transgenic animals. Knock-out and knock-in gene in transgenic mice. Cloned animals.

Specific objectives:
Students will acquire an overview and update on genetic engineering techniques in various biological systems. Also be involved so that students develop a scientific-technical reasoning cases around socially recognized as transgenesis and gene therapy.

Related activities:
Exercises and Problems. Recommended reading.
Activity 5: Regulation, ethics and genetic engineering patents.

Full-or-part-time: 18h
Theory classes: 6h
Practical classes: 2h
Self study : 10h

5. Genetic engineering and biomedicine: application to molecular diagnosis.

Description:
5.1) Biotechnology applied to medicine.
5.2) Recombinant vaccines: subunit and live recombinant vectors.
5.3) gene therapy. Therapeutic agents. Suppression of gene expression: antisense RNA, ribozymes, RNA interference (RNAi).
5.4) Biotechnological processes for high performance.

Specific objectives:
This unit deals with biotech expertises that enable the production of products and services.

Related activities:
Exercises and Problems. Recommended reading.

Full-or-part-time: 15h
Theory classes: 4h
Practical classes: 2h
Self study : 9h

GRADING SYSTEM

Subject in process of extinction. There is only one final test that corresponds to 100% of the final grade of the subject.

BIBLIOGRAPHY

Basic:
- Brown, T. A. Gene cloning and DNA analysis : an introduction [on line]. 6th ed. Oxford: Wiley-Blackwell, 2010 [Consultation: 22/05/2020]. Available on: http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10387072. ISBN 9781444318616.
- Sambrook, J. ; Russell, D. Molecular cloning : a laboratory manual. 3rd ed. Cold Spring Harbor: Cold Spring Harbour Press, 2001. ISBN 0879695765.
- Purves, W.K. ; Sadava, D. ; Orians, G.H. ; Heller H.C. Vida : la ciencia de la biología. 8ª ed. Buenos Aires [etc.]: Editorial Médica Panamericana, 2009. ISBN 9789500682695.
- Fontdevila, Antonio ; A. Moya. Evolución : origen, adaptación y divergencia de las especies. Madrid: Síntesis, 2003. ISBN 849756121X.
- Etxeberria, Xabier. Temas básicos de ética. Bilbao: Desclée de Brouwer, 2002. ISBN 8433016679.