240EQ222 - Genetic Engineering

**Coordinating unit:** 295 - EEBE - Barcelona East School of Engineering

**Teaching unit:** 713 - EQ - Department of Chemical Engineering

**Academic year:** 2018

**Degree:** MASTER’S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Teaching unit Optional) MASTER’S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Teaching unit Optional)

**ECTS credits:** 4.5

**Teaching languages:** English

---

**Teaching staff**

**Coordinator:** 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.

**General:**
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**

MD2. Master lectures
MD3. Autonomous learning
MD4. Cooperative learning
MD5. project based learning, problems and cases

---

**Learning objectives of the subject**
The course gives a detailed overview of methodologies and techniques of molecular biology allowing 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**

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 40h 30m</th>
<th>36.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>72h</td>
<td>64.00%</td>
</tr>
</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 16h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Mendelian genetics and evolutionary basis for genetic engineering.</strong></td>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 9h</td>
</tr>
</tbody>
</table>


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.

## Related activities:

Exercises and Problems. Recommended reading

## 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.
240EQ222 - Genetic Engineering

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

<table>
<thead>
<tr>
<th>Learning time: 19h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Self study: 11h</td>
</tr>
</tbody>
</table>

**Description:**
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.

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

**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).

### 3. Cloning and expression of genes

<table>
<thead>
<tr>
<th>Learning time: 14h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Self study: 8h</td>
</tr>
</tbody>
</table>

**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.

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

**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.
240EQ222 - Genetic Engineering

4. Genetic engineering in microorganisms, plants and animals.

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
</table>
| 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.  

<table>
<thead>
<tr>
<th>Related activities:</th>
</tr>
</thead>
</table>
| Exercises and Problems. Recommended reading.  
Activity 5: Regulation, ethics and genetic engineering patents. |

<table>
<thead>
<tr>
<th>Specific objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
</table>
| 5.1) Biotechnology applied to medicine.  
5.2) Recombinant vaccines: subunit and live recombinant vectors.  
5.4) Biotechnological processes for high performance. |

<table>
<thead>
<tr>
<th>Related activities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercises and Problems. Recommended reading.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>This unit deals with biotech expertises that enable the production of products and services.</td>
</tr>
</tbody>
</table>
240EQ222 - Genetic Engineering

**Qualification system**

The final qualification of the course will be calculated according to different evaluation systems:

Final qualification = 0,4*(IE.1) + 0,35*(IE3) + 0,2*(IE4) + 0,05*(IE7)

Where:
- IE1) Written exam by the end of the semester
- IE3) Test by the end of each unit of the course
- IE4) Formal reports of the activities
- IE7) Discretionary valuation by the professors

**Regulations for carrying out activities**

The tests (IE3) will be carried out by the end of each unit of the course using the digital campus Atenea based in Moodle. The students who have not delivered all the formal reports of the activities (IE4), are automatically excluded from the final exam (IE1).

The qualification of the discretionary valuation (IE7) will be established by all the Professors taking part in the course.

**Bibliography**

**Basic:**


