240EQ321 - Biophysics

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: Spanish

Teaching staff
Coordinator: LUIS JAVIER DEL VALLE MENDOZA
Others: JUAN JESUS PEREZ GONZALEZ
JOSEFA DE LOURDES CAMPOS LOPEZ
LOURDES URPI GARRIGA
DOMINGO MARTINEZ DE ILARDUYA SAEZ DE ASTEASU
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. Easily integrate technical team and creative interdisciplinary any chemical company or research center.

General:
4. Ability to apply the scientific method and the principles of engineering and economics, to formulate and solve complex problems in processes, equipment, facilities and services, in which the material changes its composition, state or energy content, characteristic of chemical industry and other related sectors which include the pharmaceutical, biotechnology, materials, energy, food or environmental.

5. Communicate and discuss proposals and conclusions in forums multilingual, skilled and unskilled, in a clear and unambiguous.

6. 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.

7. Possess independent learning skills to maintain and enhance the competencies of chemical engineering to enable the continued development of their profession.

8. Ability to analyze and synthesize to the continued progress of products, processes, systems and services using criteria of safety, affordability, quality and environmental management.
The subject of Biophysics aims to provide students a basic knowledge in physics and physic-chemistry which govern the biological systems. In regard to this, the first content of the subject discusses various concepts of physical chemistry that are relevant to understand the physiological and structural biological systems. The following contents of the subject are relative to various techniques of physics and physical chemistry (e.g., hydrodynamics, spectroscopy, scattering and diffraction, etc.), introduced in the biology field, and are now indispensable tools for the study of biological systems and their macromolecular components. Finally, the last content of the subject is dedicated to structural and functional simulation of macromolecules by applying calculations based on molecular dynamics.

### Learning objectives of the subject

The subject of Biophysics aims to provide students a basic knowledge in physics and physic-chemistry which govern the biological systems. In regard to this, the first content of the subject discusses various concepts of physical chemistry that are relevant to understand the physiological and structural biological systems. The following contents of the subject are relative to various techniques of physics and physical chemistry (e.g., hydrodynamics, spectroscopy, scattering and diffraction, etc.), introduced in the biology field, and are now indispensable tools for the study of biological systems and their macromolecular components. Finally, the last content of the subject is dedicated to structural and functional simulation of macromolecules by applying calculations based on molecular dynamics.

### Study load

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

MD.1. Apprenticeship contract.
MD.2. Lectures.
MD.5. Project-based learning, problems and cases.
# Content

<table>
<thead>
<tr>
<th>Introduction to biophysics</th>
<th>Learning time: 34h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 7h</td>
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<tr>
<td></td>
<td>Practical classes: 2h</td>
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<tr>
<td></td>
<td>Theory classes: 7h</td>
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<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 16h</td>
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</tbody>
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## Description:

1.4) Physical basis of bioelectric phenomena. Electrostatics. Electrodynamics.

## Related activities:

Recommended reading. Exercises and Problems.

## Specific objectives:

Consolidate different knowledge of physical chemistry regarding to biological systems which will be basic for the development of the subject.
### Absorption spectroscopy, fluorescence and circular dichroism.

**Description:**
2.2) Circular dichroism: secondary structure analysis of biomacromolecules.
2.3) Infrared spectroscopy (FTIR): identification and analysis of secondary structure of biomacromolecules.
2.4) Optical microscopy: perfilometry. Fluorescence Microscopy: epifluorescence and confocal
2.5) Flow Cytometry.

**Related activities:**
- Exercises. Selected readings.
- Activity 1. Analysis of macromolecules by spectroscopic methods.

**Specific objectives:**
Students will analyze and discuss with biophysical foundations results obtained by spectroscopic methods on the structure and function of biomolecules.

### Nuclear magnetic resonance

**Description:**
3.1) Radioactivity. Nuclear structure, properties of the nucleus. Radioactivity, half-life, dosimetry
3.2) Use of radioactive and non-radioactive isotopes in the human body. Harmful effects
3.3) Nuclear magnetic resonance

**Related activities:**
- Selected readings.
- Exercises and problems

**Specific objectives:**
By the end of this chapter, the students will have to be able to analyse a nuclear magnetic resonance spectrum.
## Crystallography and X-ray diffraction

### Description:
- 4.1) Crystallization.
- 4.2) Data Collection X-ray diffraction
- 4.3) Treatment of diffraction data: space group determination, indexing and scaling of the data.

### Related activities:
- Selected readings.
- Activity 2. Determine the structure of a biomacromolecule.

### Specific objectives:
The student must know the methodology to determine the structure of a biomacromolecule using X-ray diffraction of a single crystal.

### Learning time:
- 21h
  - Theory classes: 4h
  - Practical classes: 2h
  - Self study: 9h

## Molecular modeling and structure determination based on molecular dynamics

### Description:
- 5.1) Molecular modeling and applications in bioengineering.
- 5.4) Molecular recognition. Electrostatic properties of biomolecules. Docking: How to know where a connection will be made (search algorithms, scoring functions, clustering results, limitations, examples). Calculation of binding constants.

### Related activities:
- Activity 3: Introduction to structural simulation of biomolecules using molecular dynamics.

### Specific objectives:
Ability to analyze and compare different experimental and computational data for the determination of the structure and function of macromolecules.

### Learning time:
- 18h
  - Theory classes: 4h
  - Practical classes: 1h
  - Self study: 8h
Qualification system

The final mark for the course will be calculated according to different evaluation systems, as follows:
Final Mark = 55% (IE.3) + 40% (IE.4) + 5% (IE.7)
Where: IE.3) Test after each course content; IE.4) formal reports of activities; and IE.7) Mark teachers discretion.

Regulations for carrying out activities

By the end of each lesson of the subject, a test (IE.3) will take place using the virtual portal ATENEA based on Moodle, or otherwise it will correspond to a written exam.
The students will be obliged to present the formal reports of the activities (IE.4).
The qualification of the discretionary valuation (IE.7) will be established by all the Professors taking part in the subject.

Bibliography

Basic:


