390455 - MPBS - Materials Properties in Biological Systems

This course will first introduce basic knowledge of materials properties, types of materials, microstructure and basic characterization methods. The main bulk and surface properties of different materials will be presented and related to engineering applications. Some basic concepts on aging, degradation, durability and reusability of materials will be also presented. The principles of materials selection in engineering applications will be also discussed.

Secondly, several examples of biomaterials and biological materials will be presented. The composition and structure of typical biological materials will be related to their physical and biochemical properties and their applications in engineering design. In this block, some selected biological materials will be studied. The study of the complex structure of natural materials will be connected with their structural and functional properties. Some examples of bio-inspired materials will give an introduction to this rapidly growing new field of Materials Science. The interaction between materials and biological systems will be discussed by presenting some examples of biomaterials for medical applications and the effects of different types of substrates and membranes on different types of biological systems (microorganisms, cells, gens, etc.).

Learning objectives of the subject

This course will first introduce basic knowledge of materials properties, types of materials, microstructure and basic characterization methods. The main bulk and surface properties of different materials will be presented and related to engineering applications. Some basic concepts on aging, degradation, durability and reusability of materials will be also presented. The principles of materials selection in engineering applications will be also discussed.

Secondly, several examples of biomaterials and biological materials will be presented. The composition and structure of typical biological materials will be related to their physical and biochemical properties and their applications in engineering design. In this block, some selected biological materials will be studied. The study of the complex structure of natural materials will be connected with their structural and functional properties. Some examples of bio-inspired materials will give an introduction to this rapidly growing new field of Materials Science. The interaction between materials and biological systems will be discussed by presenting some examples of biomaterials for medical applications and the effects of different types of substrates and membranes on different types of biological systems (microorganisms, cells, gens, etc.).

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>60h</th>
<th>40.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study:</td>
<td></td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>

Coordinator: Ventura Casellas, Heura
Pineda Soler, Eloy
Prats Soler, Clara
Ardanuy Raso, Monica

Teaching methodology

Lectures, discussion sessions, laboratory sessions and seminars.
## Content

### Materials properties and characterization

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 50h</th>
</tr>
</thead>
</table>
1.2 Bulk properties. Functional and structural properties.  
1.3 Surface properties. Catalysis, absorption, dissolution and bioresorbable materials.  
1.4 Ageing, fatigue and corrosion. Durability and reusability of materials.  
1.5 How to choose the right material? Merit indices and selection of materials in engineering design. | Theory classes: 14h  
Laboratory classes: 6h  
Self study: 30h |

<table>
<thead>
<tr>
<th>Related activities:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>Team work</td>
</tr>
</tbody>
</table>

### Biomaterials 1

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 50h</th>
</tr>
</thead>
</table>
| 2.1 Structure and growth of natural materials.  
2.2 Biopolymers. Synthesis and characterization techniques.  
2.3 Phase transitions in biological substances and biopolymers.  
2.4 Crystallization in biological substances.  
2.5 Bio-inspired materials. Surface properties and bottom-up synthesis techniques. | Theory classes: 11h  
Laboratory classes: 9h  
Self study: 30h |

<table>
<thead>
<tr>
<th>Related activities:</th>
<th></th>
</tr>
</thead>
</table>
| Lectures | Seminars  
Laboratory: Biopolymer characterization  
Team work |
Biomaterials 2

Description:
3.1 Biofilm formation, structure and properties.
3.2 Interaction of biomaterials with microorganisms and cells.
3.3 Biomaterials for medical applications.
3.4 Cell mechanics and dynamics. Growth and properties of biological tissues.

Related activities:
Lectures
Seminars
Team work

Learning time: 50h
Theory classes: 15h
Laboratory classes: 5h
Self study: 30h

Qualification system
N1: Written report and oral presentation of the course project.
N2: Practicum reports.
N3: Summaries of the attended seminars and written tests.
Nfinal = 0.40 N1 + 0.35 N2 + 0.25 N3

Bibliography
Basic: