Degree competences to which the subject contributes

Specific:
1. Knowledge on several types of materials' structure, as well as analysis characterisation and techniques of materials.
2. Knowledge on mechanical, electronic, chemical and biologic behaviour of materials, and capacity to apply this behaviour into design, calculation and modelling of aspects of elements, components and equipment.

Transversal:
3. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.

Teaching methodology
- Participative lectures
- Invited lectures
- Lab practices
- Online questionnaires
- Cooperative learning: group work

Learning objectives of the subject

Once this subject is finished, the student must be able to:
- Describe the natural materials, or biological materials , including both the vegetal and animal tissues from the perspective of its composition, structure and properties
- Examine the interest these materials have got from the perspective of optimization and efficiency in the techniques of design and process, the contributions of the biomimetic approach in the design and process of the advanced materials.
- Describe the different types of biomaterials used in medical applications, for the substitution with/or regeneration of tissues, with diagnostic or therapeutical purposes.
- Identify the outstanding characteristics and the interaction mechanisms between the biomaterial and the receptor organism.
- Identify and describe the techniques which allow to evaluate the biocompatibility of materials
295706 - MNB - Natural Materials and Biomaterials

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>45h</th>
<th>30.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
### Content

<table>
<thead>
<tr>
<th>Part 1: Natural Materials</th>
<th><strong>Learning time:</strong> 40h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 13h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 24h</td>
</tr>
</tbody>
</table>

**Description:**

**STRUCTURE-PROPERTIES RELATIONSHIP IN NATURAL MATERIALS**
- Natural materials definition and relevance.
- Hierarchical structure.
- Design and function.
- Multifunctionality and design optimisation.
- Biomimetic approach.
- Nacre and silk.

**NATURAL COMPOSITE MATERIALS. BIOLOGICAL PLANT TISSUES: WOOD.**
- Composition and structure.
- Wood and water.
- Physical and mechanical properties of wood.
- Wood durability.

**NATURAL COMPOSITE MATERIALS COMPOSTOS: BIOLOGICAL ANIMAL TISSUES**
- Cells and extracellular matrix.
- Classification of animal tissues.
- Soft tissues: tendons, ligaments, and cartilage.
- Muscles.
- Blood vessels.
- Composition, structure, and properties.
- Hard tissues: bone and teeth.
- Composition, structure, and properties.

**Related activities:**
- Attendance to theory classes
- Attendance to laboratory classes
- Self study

**Specific objectives:**
- After finishing this part, the student must be able to:
  - Describe the composition, structure, and properties of the most important natural materials, specifically of the main plant and animal tissues.
  - Identify the benefits of the biomimetic approach in the design of advanced materials.
## Part 2: Biomaterials

<table>
<thead>
<tr>
<th>Learning time: 47h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 13h</td>
</tr>
<tr>
<td>Laboratory classes: 6h</td>
</tr>
<tr>
<td>Self study : 28h 30m</td>
</tr>
</tbody>
</table>

### Description:
**MATERIALS FOR CLINICAL APPLICATIONS**

**BIOMATERIAL-TISSUE INTERACTIONS**

### Related activities:
- Attendance to theory classes
- Attendance to laboratory classes
- Self study

### Specific objectives:
After finishing this part, the student will be able to:
- Identify the common traits and the distinctive features of the different materials used in clinical applications.
- Describe the basic principles that govern biocompatibility of biomaterials.
- Define the fundamental criteria that a material must meet to be used in medical applications.
- Recognise the biological principles that affect the host-material interactions, and correlate them with the in vivo performance of biomaterials.

## Part 3: Biomaterials Applications

<table>
<thead>
<tr>
<th>Learning time: 25h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 10h</td>
</tr>
<tr>
<td>Self study : 15h</td>
</tr>
</tbody>
</table>

### Description:
**BIOMATERIALS APPLICATIONS IN IMPLANTS AND BIOMEDICAL DEVICES**
Orthopaedic surgery and traumatology applications; Odontology and maxillofacial surgery applications; Digestive surgery applications; Cardiovascular applications; Drug delivery applications; Topical applications. Tissue Engineering applications.

### Related activities:
- Attendance to invited talks by medical doctors
- Cooperative work: group project and presentation

### Specific objectives:
After finishing this part the student will be able to:
- Recognise and select the most adequate materials for the design of medical devices and implants.
### Planning of activities

| THEOREY CLASSES | Hours: 65h  
Theory classes: 26h  
Self study: 39h |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Lectures given by the professors of the subject, with powerpoint presentations and participation of the students.</td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td>Power point presentations uploaded in the virtual campus</td>
</tr>
</tbody>
</table>
| **Descriptions of the assignments due and their relation to the assessment:** | Lecture attendance  
Online or class questionnaires  
Exams  
Laboratory notebook |
| **Specific objectives:** | After attending the lectures, the student will be able to identify the main aspects and the most relevant issues of the structure, design and properties of natural materials and biomaterials. |

| LABORATORY CLASSES | Hours: 13h 30m  
Practical classes: 9h  
Self study: 4h 30m |
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<thead>
<tr>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The student will carry out experimental laboratory classes on the characterisation of animal and plant tissues and on the processing and characterisation of biomaterials</td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td>Guidelines of the laboratory classes</td>
</tr>
</tbody>
</table>
| **Descriptions of the assignments due and their relation to the assessment:** | Laboratory notebook  
Tests (in person or online) |
| **Specific objectives:** | The student will be able to describe and apply the experimental protocols used for the characterisation of natural materials and for the processing and characterisation of some biomaterials. |

| INVITED TALKS | Hours: 6h  
Theory classes: 6h |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The course includes three invited talks by medical doctors and surgeons on clinical aspects of the application of biomaterials in different medical areas</td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td>-</td>
</tr>
</tbody>
</table>
Specific objectives:
The student will be able to identify the main requirements and the limitations of biomaterials in some specific clinical applications

SUPERVISED GROUP WORK

<table>
<thead>
<tr>
<th>Hours: 28h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>Self study: 24h</td>
</tr>
</tbody>
</table>

Description:
The students will perform a work in small groups (3-4 students) on material selection for a specific implant or biomedical device

Support materials:
Guideline for the group work

Descriptions of the assignments due and their relation to the assessment:
Power point presentation and oral defence of the work

Specific objectives:
The student will be able to analyse in terms of material selection a specific implant or biomedical device, and to make an oral presentation on the conclusions achieved.

Qualification system

Final mark = 0.50* Final exam + 0.10*partial exam + 0.10*continuous evaluation tests + 0.15* laboratory sessions+ 0.15* group work

Re-evaluation:
Final mark = 0.60* Re-evaluation exam + 0.10*partial exam + 0.10*continuous evaluation tests + 0.15* laboratory work + 0.15* group work

The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessment and Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)

Regulations for carrying out activities

- All activities are compulsory
- The tests and continuous evaluation activities will be distributed throughout the course as the different subjects of the course are addressed. There will not be prior notice.
- The group work will be presented orally, with the help of a power point presentation. Evaluation will be performed on the basis of the oral presentation.
Bibliography

Basic:


Complementary:
