



## Course guide

# 390455 - MPBS - Materials Properties in Biological Systems

Last modified: 30/05/2022

**Unit in charge:** Barcelona School of Agri-Food and Biosystems Engineering  
**Teaching unit:** 748 - FIS - Department of Physics.  
702 - CEM - Department of Materials Science and Engineering.

**Degree:** BACHELOR'S DEGREE IN BIOSYSTEMS ENGINEERING (Syllabus 2009). (Optional subject).

**Academic year:** 2022    **ECTS Credits:** 6.0    **Languages:** English

### LECTURER

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**Coordinating lecturer:** Ventura Casellas, Heura  
Pineda Soler, Eloy  
Prats Soler, Clara  
Ardanuy Raso, Monica

**Others:** Rodríguez Rius, Daniel

### TEACHING METHODOLOGY

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Lectures, discussion sessions, laboratory sessions and seminars.

### LEARNING OBJECTIVES OF THE SUBJECT

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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. These examples include the study of structure and properties of natural materials, the synthesis and analysis of biopolymers or the properties of certain living tissues. The interaction between materials and biological systems will be also discussed, presenting some examples of biomaterials for bioprocessing and medical applications.

### STUDY LOAD

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| Type              | Hours | Percentage |
|-------------------|-------|------------|
| Self study        | 90,0  | 60.00      |
| Hours large group | 60,0  | 40.00      |

**Total learning time:** 150 h



## CONTENTS

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### Materials properties and characterization

**Description:**

- 1.1 Introduction to materials properties and characterization.
- 1.2 Bulk and surface properties. Functional and structural properties.
- 1.3 Classes of materials. Microstructures. Synthesis and techniques of characterization.
- 1.3 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.

**Related activities:**

Lectures  
Team work

**Full-or-part-time:** 50h

Theory classes: 14h  
Laboratory classes: 6h  
Self study : 30h

### Biopolymers

**Description:**

- 2.1 Natural materials for engineering applications: biopolymers. Definition, classification and examples. Characterization techniques.
- 2.2 Comprehensive description of PLA, PHA and other bio-based polymers. Structure, properties, and applications.
- 2.3 Biocomposites. Definition and properties. Natural fibers and nanoparticles as reinforcements in biocomposites. Biocomposites production techniques and applications.

**Related activities:**

Lectures.  
Seminars  
Laboratory: Biopolymer characterization  
Team work

**Full-or-part-time:** 50h

Theory classes: 11h  
Laboratory classes: 9h  
Self study : 30h



### Living tissues and biomaterials

**Description:**

3.1. Structure and mechanical properties of living tissues. The role of collagen and elastine. Structure and main properties of connective, muscle, nervous and epithelial tissues. Examples.

3.2. Structure and mechanical properties of eukaryotic cell. Cell membrane and cytoskeleton as a mechanical unit. Cytoskeleton: actin filaments, intermediate filaments and microtubules. Elasticity of cell membrane. Determination of the membrane tension.

3.3. Biomaterials in medicine. Interaction of microorganisms with biomaterials and tissues: biofilms. Biofilms formation, structure and characteristics. Biofilms and chronic infections.

**Related activities:**

Lectures

Seminars

Team work

**Full-or-part-time:** 50h

Theory classes: 15h

Laboratory classes: 5h

Self study : 30h

### GRADING SYSTEM

N1: Written report and oral presentation of the course project.

N2: Practicum reports.

N3: Summaries of the attended seminars and written tests.

$N_{\text{final}} = 0.40 N1 + 0.35 N2 + 0.25 N3$

### BIBLIOGRAPHY

**Basic:**

- Agrawal, C. Mauli. Introduction to biomaterials : basic theory with engineering applications. Cambridge: Cambridge University Press, 2014. ISBN 9780521116909.