240EM033 - Biomedical Materials

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 702 - CMEM - Department of Materials Science and Metallurgy
Academic year: 2018
Degree: MASTER'S DEGREE IN MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Teaching unit Compulsory)
MASTER'S DEGREE IN MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Teaching unit Compulsory)
ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Teaching unit Optional)
ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Teaching unit Optional)
ECTS credits: 4,5
Teaching languages: Spanish

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

Teaching staff
Coordinator: MARTA PEGUEROLES NEYRA
Others: Pegueroles Neyra, Marta

Degree competences to which the subject contributes

Specific:
CEMCEM-01. (ENG) Aplicar coneixements de matemàtiques, física, química, biologia i altres ciències naturals, obtinguts mitjançant estudi, experiència i, pràctica, amb raonament crític per a establir solucions viables a problemes tècnics.
CEMCEM-04. (ENG) Realitzar estudis de caracterització, avaluació i certificació de materials segons les seves aplicacions

Transversal:
02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
06 URI N2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

Teaching methodology

- Participative lectures.
- Cooperative learning: group work

Learning objectives of the subject

The aim of the course is that students acquire knowledge of the applications of biomaterials in medicine and dentistry and thus be able to relate properties and biological response of biomaterials, and apply the selection criteria best suited for each application. In addition, students will become familiar with the various techniques of characterization in vitro and in vivo biological biomaterials, as well as interpretation of results obtained using different techniques.
## Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group:</th>
<th>27h</th>
<th>24.00%</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>13h 30m</td>
<td>12.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>72h</td>
<td>64.00%</td>
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</tbody>
</table>
### 240EM033 - Biomedical Materials

#### Content

<table>
<thead>
<tr>
<th>Biological characterisation of biomaterials</th>
<th>Learning time: 18h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h 30m</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 1h 30m</td>
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<tr>
<td></td>
<td>Self study: 12h</td>
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</tbody>
</table>

**Description:**
- Type of cell cultures: Primary cultures, cell lines, secondary cultures, co-cultures
- Basic cell responses: adhesion, proliferation, differentiation and cell death
- Evaluation of cytotoxicity. Tests measuring the metabolic activity using enzymes: LDH, MTT
- Assays based on the principle of cell exclusion. Immunofluorescence. ELISA assay detecting cell markers. PCR
- Bacterial cultures
- Characterization blood-biomaterial interactions, thrombogenicity

<table>
<thead>
<tr>
<th>In vivo characterisation of biomaterials</th>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 6h</td>
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</tbody>
</table>

**Description:**
- Design of an in vivo animal testing
- Animal models
- Analysis of the in vivo results

<table>
<thead>
<tr>
<th>Biomedical materials for cardiovascular applications</th>
<th>Learning time: 17h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 10h</td>
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</tbody>
</table>

**Description:**
- Cardiovascular Diseases. Endothelization and thrombogenicity
- Heart valves
- Vascular Grafts
- Cardiovascular Stents
- Pacemakers
## Biomedical Materials for Orthopaedic and Dental Applications

<table>
<thead>
<tr>
<th>Learning time: 25h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Guided activities: 2h</td>
</tr>
<tr>
<td>Self study: 15h</td>
</tr>
</tbody>
</table>

### Description:
- The use of biomaterials for bone replacement. Osseointegration
- Hip Prosthesis. Knee replacements
- Osteosynthesis material: plates and screws
- Intervertebral discs
- Materials for bone regeneration: bioceramics and bioactive glasses
- Biomaterials for repair and regeneration of cartilage
- Tissue engineering applied to orthopedic and maxillofacial surgery

## Biomedical Materials for Adhesives, Sealants and Sutures

<table>
<thead>
<tr>
<th>Learning time: 13h 30m</th>
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<tbody>
<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Guided activities: 2h</td>
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<tr>
<td>Self study: 7h 30m</td>
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</tbody>
</table>

### Description:
- Mechanisms of adhesion: mechanical interlocking, adsorption, diffusion, electrostatic forces
- Composition and characteristics of adhesive materials. Adhesives soft tissues. Adhesives for hard tissue
- Natural and synthetic Sutures

## Biomedical Materials for Ophthalmologic Applications

<table>
<thead>
<tr>
<th>Learning time: 7h 30m</th>
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<tbody>
<tr>
<td>Theory classes: 2h</td>
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<tr>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Self study: 4h 30m</td>
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</table>

### Description:
- Anatomy of the eye
- Soft and hard contact lenses
- Intraocular lenses
- Corneal Implants. Implants for glaucoma
Biomedical applications for skin regeneration

**Description:**
- Structure of the dermis
- Absorbable and permanent implants
- Tissue engineering applied to regeneration of skin

**Learning time:** 7h 30m
- Theory classes: 2h
- Laboratory classes: 1h
- Self study: 4h 30m

Biomedical materials for controlled drug delivery

**Description:**
- Control of the release of a drug: between effectiveness and toxicity
- Control of the release by diffusion
- Control Systems to release water penetration device
- Chemically controlled devices

**Learning time:** 14h
- Theory classes: 4h
- Laboratory classes: 2h
- Self study: 8h

Qualification system

\[ N_{\text{final}} = 0.50 \, N_{\text{ef}} + 0.30 \, N_{\text{ep}} + 0.2 \, N_{\text{tg}} \]

**Nfinal:** final mark
**Nef:** mark final exam
**Nep:** mark parcial exam
**Ntg:** mark grup work

In case of reevaluation, the mark of the reevaluation exam replaces the mark of the final exam in the above equation. 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)
Bibliography

Basic:


Others resources:

Audiovisual material

Presentacions en PPT disponibles a Atenea
Support material for the lectures