BIOENG-442

Biomaterials

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Cursus	Sem.	Type
Bioengineering	MA4	Opt.
Biomedical technologies minor	E	Opt.
Ing.-chim.	MA2, MA4	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Neuroprosthetics minor	E	Opt.
Robotics	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course covers the fundamental concepts behind the design, function and application of state-of-the-art biomaterials, that is, materials that are designed based on a molecular understanding of their interactions with biological systems.

Content

Part I: Biological fundamentals

- Cells, extracellular matrices and tissues
- Proteins and protein adsorption, immunological aspects of biomaterials
- Stem cells and tissue regeneration
- Angiogenesis

Part II: Biomaterials classes

- Biomaterials for devices, structural and chemically degradable biomaterials
- Micro- and nanoparticles
- Extracellular matrix-mimicking biomaterials
- Hydrogels as biomaterials
- Self-assembly and supramolecular biomaterials
- Biomaterials for gene delivery and vaccination

Part III: Emerging design and applications of biomaterials

- Tailoring materials for stem cell biology
- Biomaterials for tissue engineering
- Biomaterials for modulation of the immune system
- Biomaterials for neuroengineering
- Biomaterials in medical devices

Keywords

Cells, extracellular matrix, tissue, regeneration, angiogenesis, biodegradable materials, hydrogels, drug delivery, micro- and nano-particles, self-assembly, high-throughput screening, stem cell engineering, materials for immunemodulation

Learning Prerequisites

Recommended courses

Materials science for bioengineers (BIOENG-315)
Biology I (BIO-103)
Stem cell biology and technology (BIO-447)

Learning Outcomes

By the end of the course, the student must be able to:

- Elaborate key effectors and their functions driving protein- and cell-materials interactions
- Formulate the basics of inflammation induced by materials in the body
- Elaborate the basics of stem cell function and tissue regeneration, and how materials can influence regeneration
- Systematize the different general applications of biomaterials
- Contextualise specific examples of biomaterials on the basis of application and understands their selection criteria
- Judge the suitability of a material for a certain application based on structure-property relationships
- Formalize the key concepts in the molecular engineering of bioactivity and bioresponsiveness

Transversal skills

- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Make an oral presentation.
- Demonstrate a capacity for creativity.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Evaluate one's own performance in the team, receive and respond appropriately to feedback.
- Communicate effectively, being understood, including across different languages and cultures.
- Use a work methodology appropriate to the task.
- Set objectives and design an action plan to reach those objectives.
- Plan and carry out activities in a way which makes optimal use of available time and other resources.

Teaching methods

- Ex cathedra
- Group case study

Expected student activities

- Reading key literature before each course as preparation
- Group case study

Assessment methods

- Group project: 40%
- Written exam: 60%

Resources

Bibliography

Comprehensive Biomaterials, 1st edition, Paul Ducheyene et al., Elsevier (2011)

Principles of Tissue Engineering, Editors Lanza, Langer &Vacanti, Elsevier (2007)

Ressources en bibliothèque

- Comprehensive Biomaterials / Ducheyne
- Principles of tissue engineering / Lanza

Notes/Handbook

Will be provided on moodle webpage before each lecture