BIOENG-442  Biomaterials
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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 immunomodulation

Learning Prerequisites
Recommended courses
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, literature review

Expected student activities
reading key literature before each course as preparation
group case study
critical literature review as exercise

Assessment methods
exercise: 15%
group project: 15%
written exam: 70%

Supervision
Office hours  Yes
Assistants  Yes
Forum  Yes

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

Ressources en bibliothèque
• Principles of tissue engineering / Lanza
• Comprehensive Biomaterials / Ducheyne

Notes/Handbook
Will be provided on moodle webpage before each lecture

Moodle Link
• http://moodle.epfl.ch/course/view.php?id=681