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
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: 30%
• 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
• Comprehensive Biomaterials / Ducheyne
• Principles of tissue engineering / Lanza

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

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