

Spring 2020

Course name: Engineering biomaterials and implantable devices

Credit Points: 2

Course structure: Lectures - 2 hrs.

Prerequisites by course: 22400 - Materials Engineering

Prerequisites by topic: Basic knowledge of chemistry, materials structure, mechanical behavior of materials

Course description

This interdisciplinary course provides introduction to various types of biomaterials for a wide range of biomedical applications, primarily in implants for orthopaedic and cardiovascular surgeries. The course focuses on the current issues and future directions in the design, fabrication, characterization and performance of biomaterials and implantable devices. Throughout the course, the biological performance of implantable devices and the diverse elements controlling tissue and cellular responses to implanted materials will be discussed.

Topics covered

- Biocompatibility issues: inflammation and wound healing, body response to implants, tissue regeneration vs. fibrosis, hypersensitivity and carcinogenicity of biomaterials
- Thromboresistance and hemocompatibility of biomaterial surfaces
- Materials used in synthetic vascular grafts and prosthetic heart valves
- Metallic biomaterials: structure-properties-processing relationship, corrosion in body fluids, corrosion-related implant failures
- Inert and bioactive ceramic biomaterials, calcium phosphates, bioglasses, proof testing of ceramic biomaterials
- Joint replacements, cemented and cementless fixation, wear of articulating components, aseptic loosening
- Materials-related implant failures and implant device recalls

Course grading

Final exam: 100%

Textbook:

1. Park J.B. and Lakes R.S., Biomaterials - An Introduction, 3rd Ed., Springer, New York, 2007.

Additional suggested literature:

1. B.D. Ratner, A.S. Hoffman, F.J. Schoen, J.E. Lemons, Biomaterial science: an introduction to materials in medicine, 3rd Edition, Academic Press, 2012

2. J. Black, Biological performance of materials: fundamental of biocompatibility, CRC Press, 4th edition, 2006
3. Wise D.L., Trantolo D.J., Altobelli D.E., et al., Encyclopedic Handbook of Biomaterials and Bioengineering, Marcel Dekker, New York, 1993

Learning outcomes:

On completion of the course, the student should be able to:

- Give examples of application areas for different types of biomaterials.
- Apply knowledge from basic material courses to identify material properties that are critical for implantable devices
- Explain basic physical, chemical and mechanical processes that may occur on biomaterials for short term and long term implantations, distinguish between reactions in blood and in tissue
- Describe corrosion and degradation processes that occur for different biomaterials and their consequences
- Select a proper type of biomaterial for a given application.