COURSE DESCRIPTION CARD - SYLLABUS

Course name
Engineering of medical bioprocesses and biomaterials

Course

Field of study
Chemical and process engineering
Year/Semester
1/2
Area of study (specialization)
Bioprocesses and biomaterials engineering
Profile of study
general academic
Level of study
Second-cycle studies
Course offered in
Polish
Form of study
full-time
Requirements
compulsory

Number of hours

Lecture
30
Laboratory classes
Other (e.g. online)
Tutorials
Projects/seminars
30

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
dr hab.inż. lek.med. Ryszard Uklejewski, prof. nzw. UKW w Bydgoszczy; e-mail: uklejew@ukw.edu.pl

Responsible for the course/lecturer:
dr inż. Mariusz Winiecki; email: winiecki@ukw.edu.pl

Prerequisites

There is required the knowledge of main problems in field of fundamentals of medical bioengineering, in particular the engineering of biomaterials of skeletal system and vascular system. There is also required the knowledge of biostructure of tissues, in particular the musculoskeletal system and vascular system, as well as, the knowledge of the main groups of engineering (biosusbstitute) biomaterials and fundamentals properties of the biomaterials.

Course objective

The student should acquire the knowledge on bioprocesses in human tissue/substitute biomaterial interface and organ/implant systems, as well as the knowledge on the bioengineering methods of influencing the course of the bioprocesses.

Course-related learning outcomes

Knowledge

Student is able to characterize the biological environment and the occurring in it physiological and pathophysiological bioprocesses - [K_W12].

Student is able to discuss the requirements for artificial biomaterials and selected issues regarding biocompatibility tests of medical biomaterials according to PN-EN ISO 10993 - [K_W02, K_W03, K_W08].

Student knows the processes of manufacturing and modification of biomaterials and their surfaces to improve the course of peri-implant osteoprocesses - [K_W06, K_W07, K_W08].

Skills

Student is able to design and examine the surface properties of biomaterials and bone graft substitutes as well as bone-implant interfacial properties impacting the bioprocesses in bone-implant interphase (osteoinduction, osteoconduction, osseointegration)- [K_U01, K_U03, K_U06, K_U09].

Student is able to design elementary drugs releasing biomaterial and choose the process of biomaterial surface modification in terms of the desired course of peri-implant osteoprocesses- [K_U01, K_U03, K_U06, K_U09].

Social competences

The student is able to interact and work in a group, assuming different roles in it, set priorities for the implementation of the task specified by himself or others, think and act in a creative way - [K_K01, K_K02, K_K03].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Current control of preparation to design exercises, valuation of the tests concerning designing of properties of engineering medical biomaterials and bioprocesses courses in biomaterial/human tissue interface and organ/implant system, valuation of the final examination.

Programme content

There are lectured the characteristics of biologic environment, physiologic and pathophysiologic processes in 1) tissues (on the example of tissues of the skeletal system and the vascular system) and 2) human tissue/substitute biomaterials interface and organ/implant systems (on the example of orthopaedic endoosseous implants and vascular implants). In particular there are presented: the wound healing process, the foreign body biologic response, the processes in bone-implant interface (osteoinduction, osteoconduction, osteointegration, adaptive bone tissue remodelling – the bioprocess adapting the internal structure and cross section geometry in response to the mechanical load history and electrochemical, hormonal, genetic and other stimuli). There are lectured the requirements for substitute biomaterials (biotolerance, corrosion resistance, atrombogenity, tmagnetic properties of implants, surface properties, an influence of chemical composition to toxicity and cancerogenicity. There are reviewed the examples of (chemical, termochemical, mechanical, electrochemical and others) surface modification of biomaterials (passivation, polishing, coatings improving the biocompatibility and biointegration of implants with tissues, techniques of physical and chemical vacuum deposition, ion implantation, plasma spraying, Al2O3 coatings, ZrO2 coatings, hydroxyapatite coatings, electrophoretic deposition, sol-gel methods), bioengineering methods of design of the biomaterials properties and influencing the course of the bioprocesses in human tissue/substitute biomaterial interface and organ/implant systems. There are presented the problems concerning the processes of electrochemical

and triboelectrochemical corrosion of metallic biomaterials and metallic implants: the corrosive environment of tissues and body fluids, passivity, methods of testing the corrosion resistance.

Teaching methods

Lectures, fundamentals of designing (design of biomaterials properties and bioprocesses courses in biomaterial/human tissue interface and organ/implant system).

Bibliography

Basic

1. Uklejewski R. (red.), Winiecki M., Tokłowicz R.: Inżynieria bioprocesów i biomateriałów medycznych dla specjalności Inżynieria bioprocesów i biomateriałów. Materiały dydaktyczne. Wydawnictwo Politechniki Poznańskiej, Poznań, 2012

2. Traczyk W., Trzebski A.: Fizjologia człowieka z elementami fizjologii stosowanej i klinicznej, PZWL, Wyd. III, Warszawa 2007

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4. Marciniak J.: Biomateriały. Wyd. Politechniki Śląskiej, Gliwice 2000

5. Błażewicz S., Stoch L. (red.): Biomateriały, t.4; W: Biocybernetyka i Inżynieria Biomedyczna (red. M. Nałęcz). Wydawnictwo Exit, Warszawa 2004

6. Łaskawiec J., Michalin R.: Zagadnienia teoretyczne i aplikacyjne w implantach. Wyd. Politechniki Śląskiej. Gliwice 2002.

7. Marciniak J., Paszenda Z., Walke W., Tyrlik-Held J., Kajzer W.: Stenty w chirurgii małoinwazyjnej, Wyd. Politechniki Śląskiej, 2006

8. Wierzchoń T, Czarnowska E. Krupa D. Inżynieria powierzchni w wytwarzaniu biomateriałów tytanowych, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2004

9. Breme J., Kirkpatric C.J., Thull R.: Metallic Biomaterial Interfaces, Wiley, 2008

10. Bronzino J. (ed.): The Biomedical Engineering Handbook, SECTION V: J. Y. Wong: Biomaterials, CRC 2006

11. Jurczyk M., Jakubowicz J.: Bionanomateriały, Wyd. Politechniki Poznańskiej 2008.

Additional

1. Gierzyńska-Dolna M.: Biotribologia. Wyd. Politechniki Częstochowskiej, 2002.

2. Będziński R.: Biomechanika inżynierska, Wyd. Politechniki Wrocławskiej, 1997

3. Ostrowski K.: Histologia, Wyd. PZWL, Warszawa 2001

4. Sawicki W.: Histologia, PZWL, Wyd. IV, Warszawa 2006.

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7. Ellingsen J.E, Lyngstadaas S.P. (Eds.): Bio-Implant Interface. Improving Biomaterials and Tissue Reactions, CRC Press LLC, Boca Raton 2003.

8. Park J. Lakes R.S.: Biomaterials, An Introduction, Sprinter, New York 2008

9. Bartolo P. Bidanda B. (Eds.): Bio-Materials and Prototyping Applications in Medicine, Sprinter New York 2008.

10. Chu P.K, Liu X. (Eds.): Biomaterials Fabrication and Processing Handbook, CRC Press LLC, Boca Raton 2008.

11. Helfrich M.H., Ralston S.H. (Eds.): Bone Research Protocols, Humana Press, Totowa, New York 2003.

12. Hao L., Lawrence J.: Laser Surface Treatment of Bio-Implant Materials, Jon Wiley & Sons, London 2005.

13. Webster T.J. (Ed.): Nanotechnology for the Regeneration of Hard and Soft Tissues, World Scientific Publishing Co. Pte. Ltd. London 2007

14. Selected foreign journals covering issues in the field of medical bioengineering i.e.: Acta Biomaterialia, Biomaterials , Journal of Biomechanical Engineering (American Society of Mechanical Engineers), Journal of Biomedical Materials Research (John Wiley & Sons), Journal of Biomedical Materials Research (Applied Biomaterials), John Wiley & Sons), Journal of Engineering in Medicine Part H (Mechanical Engineering Publications Ltd.), Journal of Materials Science ? Materials in Medicine (Chapman & Hall, CRC Press), Surface & Coatings Technology

Breakdown of average student's workload

	Hours	ECTS
Total workload	120	4,0
Classes requiring direct contact with the teacher	60	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	60	2,0

[1] delete or add other activities as appropriate