THE DOCTORAL SCHOOL OF IPPT PAN

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

Name of the course	Polish	**Polimery i ich zastosowania w inżynierii tkankowej**				
	English	**Polymers and their applications in Tissue Engineering**				
Type of the course	**Specialized course**					
Course coordinator	**Prof. Paweł Sajkiewicz, Ph.D., D.Sc.**		Course teacher	**Prof. Paweł Sajkiewicz, Ph.D., D.Sc. Dr. Dorota Kołbuk-Konieczny, PhD., D.Sc.**		
Implementing unit	**SPPiB**	Scientific discipline / disciplines	**Materials Engineering Biomedical Engineering**			
Level of education	**Doctoral studies**	Semester	**Summer or winter**			
Language of the course	**Polish or English**					
Type of assessment	**Examination**	Number of hours in a semester	**30**	ECTS credits	**4**	

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	**2**	**0**	**0**	**0**	**0**
	in a semester	**30**	**0**	**0**	**0**	**0**

1. Prerequisites

Fundamentals of materials engineering, creating prospects for deepening knowledge of polymer materials in terms of their structure and properties. Knowledge of methods for testing the structure and properties of materials. Knowledge of material forming techniques.

2. Course objectives

The aim of the course is to familiarize students with issues related to the use of polymers in tissue engineering. The knowledge provided covers a wide range of topics. Students will gain basic knowledge about the structure and properties of polymers and more detailed knowledge about the use of polymers as cell scaffolds in tissue engineering. They will be introduced to techniques for forming cell scaffolds and methods for testing the structure and properties of such scaffolds. Students will become familiar with the structure of the extracellular matrix and methods for its mimicking during the formation of cell substrates for the regeneration of bone, cartilage and ligaments. They will understand the differences between cell substrate testing methods from the point of view of legal requirements for medical devices: biocompatibility, cytotoxicity, cell viability and proliferation testing.

3. Course content (separate for each type of classes)

Lecture

1. Materials for medical applications - general division, application areas

2. Polymers - general concepts, configuration and conformation of macromolecules, supramolecular structure, division of polymers

3. Extracellular matrix (ECM) in animal organisms as a template for cell scaffolds 4. Electrospinning as a method of forming polymer nanofibers for tissue engineering 5. Polymer hydrogels 6. Selected methods of testing the structure and properties of polymers with emphasis on testing polymer cellular scaffolds 7. Processes occurring on the surface of the cellular substrate after implantation 8. Requirements for implants for the regeneration of cartilage, bone and ligament tissue and commercially available medical products for these applications 9. Development of cellular substrates in the context of biocompatibility studies
Laboratory

4. Learning outcomes

Number of the learning outcome	Learning outcomes description	Reference to the learning outcomes according to the 8th level of PRK	Learning outcomes verification methods*
Knowledge			
1	The graduate acquires basic knowledge of the structure and properties of polymers	P8S_WG	examination
2	The graduate acquires knowledge of the possibilities of using polymers in tissue engineering	P8S_WG	examination
3	The graduate ackuires knowledge of designing cell substrates for specific applications - regeneration of bones, cartilage, ligaments	P8S_WG	examination
Skills			
1	The graduate is able to analyze the structure of polymers and deduce possible properties of these materials based on it	P8S_UW	examination
2	The graduate has knowledge of polymer scaffold forming techniques and is able to design polymer scaffold forming processes taking into account the specificity of a specific polymer material	P8S_UW	examination
3	The graduate is ready to apply the acquired knowledge of polymers and their use in tissue engineering in the area of their scientific research	P8S_UW	assessment of activity during classes
4	The graduate is able to use the acquired knowledge to design and manufacture cell scaffolds in specific applications and disseminate the results of their research.	P8S_UW	assessment of activity during classes and examination

5.	The graduate is able to use the acquired knowledge to assess the biocompatibility, including cytotoxicity of cell substrates	P8S_UW	assessment of activity during classes and examination
Communication			
1			
2			
3			
Social competences			
1	The graduate is ready to think and act in an engineering and creative way	P8S_KO	assessment of activity during classes
2	The graduate is ready to critically evaluate the achievements of tissue engineering, including their own contribution to the development of this discipline.	P8S_KK	assessment of activity during classes
3	The graduate is ready to plan work in the laboratory in accordance with the principles of sustainable development and the 3R principle (replacement, reduction and improvement)	P8S_KO	assessment of activity during classes

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
assessment of activity during classes, results of the examination

6. Literature
Primary references:
[1] Błażewicz, S., & Stoch, L. (2003). Biomateriały. Akademicka Oficyna Wydawnicza EXIT, Warszawa.
[2] Seeram Ramakrishna, Teik-Cheng Lim, Kazutoshi Fujihara, Wee Eong Teo, An Introduction to Electrospinning and Nanofibers. World Scientific (2005)
[3] Hydrogels. Recent Advances. Vijay Kumar Thakur, Manju Kumari Thakur (Eds.), Springer (2018)
[4] Gruin, I., Ryszkowska, J., & Markiewicz, B. (1996). Materiały polimerowe. Oficyna Wydawnicza Politechniki Warszawskiej.Secondary references:
[1] [1] Lewandowska-Ronnegren, A. (2018). Techniki laboratoryjne w biologii molekularnej. MedPharm Polska.
[2] Przygocki, W., Włochowicz, A. (2006). Uporządkowanie makrocząsteczek w polimerach i włóknach. Wydawnictwa Naukowo-Techniczne.

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours

1	Hours of scheduled instruction given by the lecturer in the classroom	**30**
2	Hours of consultations with the lecturer, exams, tests, etc.	**15**
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	**20**
4	Amount of time devoted to the preparation for exams, test, assessments	**35**
	Total number of hours	**100**
	ECTS credits	**4**

** 1 ECTS = 25–30 hours of the PhD students work (2 ECTS ≈ 60 hours; 4 ECTS ≈ 110 hours, etc.)