

APPROVED
MESU order
dated June 05, 2013 No. 683

Form No. H-3.04

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

State Higher Educational Institution

«Pryazovskyi State Technical University »

Faculty of Information Technology
Department of Biomedical Engineering

APPROVED

Dean of the Faculty of
Information Technology

Vereshkun M.V.

« » 2019

**TEACHING PROGRAM OF THE EDUCATIONAL
DISCIPLINE**

Bioceramics

(code and name of the course)

Teaching direction – 163 "Biomedical Engineering"



Co-funded by the
Erasmus+ Programme
of the European Union



Developed in the frame of project «Erasmus+ (CBHE) Bio-Art: Innovative Multidisciplinary Curriculum in Artificial Implants for Bio-Engineering BSc/MSc Degrees» (586114-EPP- 1-2017- 1-ES-EPPKA2-CBHE- JP)

2019 – 2020 academic year

The discipline program Bioceramics for students of
(title of the course)
teaching direction – 163 "Biomedical Engineering"

Developers: Associated Professor I.M. Olienik

Professor

(indicate authors, their posts, academic degrees and academic titles)

Teaching program was approved at the meeting of the Department of
Biomedical Engineering.

Minutes of June 24, 2019, No. 21

Head of the Department _____ (Azarkhov O.Yu.)
(signature) (surname and initials)

Approved by the Faculty Methodological Commission

Minutes of June 24, 2019 No. 10

Chairman _____ (Cherevko O.O.)
(signature) (surname and initials)

This project has been funded with support from the European Commission. This publication / communication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained there in.

© SHEI «PSTU», 2019

© Olienik I.M.,

Iefremenko V.G., 2019

1. Description of the discipline

Semester	ECTS credits	Hours	Classroom hours				Individual work	Distribution by semesters		
			Total	Lectures	Practical	Laboratory		exams	Credit	Coursework
9	5	150	48	32	16	-	102	9	-	-

2 The purpose and objectives of the discipline

"**Bioceramics**" is a discipline of advanced study, taught by bioengineering students in the last stage of study, that is, during the masters course. It is professionally focused, since the selection and use of bio-ceramic materials is an integral part of such an important field of bioengineering as the developing of modern implants.

The **purpose** of the discipline is to train bioengineering students to be capable of solving engineer tasks related to the development and use of artificial implants.

The main **objective** of the course is to provide students with basic knowledge of the types, properties and possible directions for the use of ceramic materials in biomedical engineering.

As a result of studying the discipline students **should know**:

- the main types of bioceramic materials, their classification according to different principles;
- main directions of application of bioceramic materials for use in bioengineering;
- features of the structure of bioceramics, its chemical composition, types of intermolecular and atomic bonds;
- physicochemical and functional properties of bioceramic materials;
- the main technologies of production and processing of bioceramic materials

Students must acquire **competencies** with:

- innovative ideas in the application of bioceramic materials for biomedicine;

- selection of bioceramic material for specific biomedical applications;
- the choice of method of obtaining, processing and application of bioceramic materials;
- development novel types of bioceramics with improved functional capabilities.

As a result of studying the discipline students should acquire **practical skills in:**

- analysis of physical and mechanical properties of different types of bioceramics materials;
- comparative analysis of the advantages and disadvantages of ceramic materials in biomedicine;
- development and presentation of the project;
- ability to work with educational and scientific literature, taking advantage of the opportunities of computer networks;
- ability to navigate the flow of scientific and technical information.

3 The program of the discipline

Introduction (2 hours)

Purpose and objectives of the subject "Bioceramics". Historical retrospective and current state of use of ceramic materials in medicine.

Content Module 1. VARIETIES OF BIOMaterials: STRUCTURE AND PROPERTIES

1. Ceramics as a material for bio-use. (35 hours)

Fields of implants - dental, orthopedic. Classification of implant materials (biopolymers, bimetals), ceramic implants (porous ceramics, surface-active ceramics, absorbent ceramics). Biological indicators of materials, reaction of the body to materials for implants - corrosion, biodegradation and biocompatibility, wear in the joints. Test methods for *in vitro* and *in vivo* ceramic implant materials.

2. Biominerals and mineralized tissues. (25 hours)

Biological ceramics. Structure and properties of mineralized tissues. Bone, dentin and tooth enamel, their chemical composition and structure. Bone connection mechanism: the mechanism of bonding of living tissue is interphase communication. Mechanisms of degradation of mineralized tissues, measures of prevention of degradation.

3. Biostable ceramics. (18 hours)

Different types of modern ceramics: functionally classified, "smart", biomimetic, nanoceramics. Oxides included in ceramics: alumina and zirconium oxide. Atomic-crystalline structure, physicochemical properties, directions of use in the biomedical field.

4. Bioactive ceramics. (20 hours)

Calcium phosphate-based ceramics. Hydroxyapatite. Bioactive glass and glass ceramics. Bioactive glass ceramics: processing, structure, mechanical and biological properties. Surface-active glasses: mechanism of formation of surface apatite, dependence of properties on chemical composition.

Content Module 2. BIOACTIVE COMPOSITES AND COATINGS

5. Composites: characteristics and basic parameters. (30 hours)

Ceramic matrix composites: different types, their preparation and properties. Different types of ceramic fibers, composites, their properties and applications. Hydroxyapatite composites with zirconium, alumina and titanium - preparations and properties. Hydroxyapatite, reinforced with SiC fibers, ceramics based on biologically active glass acid, ceramics made of tempered zirconium and bioactive glass ceramics, composites of bio-glass-hydroxyapatite, carbon composites. Technological features of obtaining bioceramic composites.

6. Bioactive coatings, basic characteristics. (20 hours)

The importance of bioactive coatings. Hydroxyapatite coated metal implants: coating methods, characteristics and properties. Hydroxyapatite coated composites with zirconium, alumina and titanium - structure and properties. Methods of treatment of bioactive coatings for enhancement of functional properties.

5 Individual work

Individual work of the student (full-time form) includes preparation for practical and laboratory classes; self-studying of additional literature and questions for self-control of mastering the content of educational material, as well as solving homework for each content module.

5.1 5.1 List of topics for individual work 3rd semester

№	The name of the topic	Number of hours
1	Bioceramic nanomaterials	4
2	Bioceramic materials in dentistry.	2
3	The structure of the teeth. Structure and properties of dental enamel	2
4	Ceramic basis of bones. Mechanisms of bone degradation and methods of its prevention.	4
5	Structure and properties of aluminum and zirconium oxides.	2
6	Bioceramic materials in implantology of support-but-mobile apparatus.	4
7	Methods of applying bioceramics on the surface of friction in joint implants.	2
	Total	20

5.2 Calculation of time for individual work of the student by types

№	Types of work	Number of hours
1	Development of the program material, which is taught at lectures and topics of self-study	50
2	Preparation for practical classes.	22
3	Performing individual tasks	30
	Total	102

Individual work is performed in accordance with the methodological guidelines for self-study students's work.

6 Individual tasks

Students complete individual assignments in the form of an abstract and defend it with a presentation of MS PowerPoint presentation.

7 Learning Methods

Explanatory illustrative method, receptive method, reproductive method and problem presentation method. On another classification: verbal (lectures, explanations at practical classes, instruction - at laboratory); practical methods (solving problems of specific situations); visual methods.

8 Methods of control

Control written surveys during practical classes. Modular material control for content modules.

EXAMINATION QUESTIONS

1. Classification of materials for orthopedic implants.
2. Classification of materials for dental implants.
3. Ceramic implants (porous ceramics, surface-active ceramics, absorbent ceramics).
4. Biological indicators of biomaterials for implants.
5. The body's response to implant materials.
6. Test methods for ceramic materials for implants.
7. Mechanism of fastening of living tissue in musculoskeletal apparatus.
8. Biological ceramics. Structure and properties of mineralized tissues.
9. Structure and chemical composition of bones, dentin and dental enamel.
10. Mechanisms of degradation of mineralized tissues, measures of prevention of degradation.
11. Ceramics, atomic-crystalline structure and physicochemical properties.
12. Classification of modern ceramics: functionally classified, "reasonable", biomimetic, nanoceramics.
13. Calcium phosphate based ceramics, structure and properties.
14. Bioactive glass ceramics: processing, structure, mechanical and biological properties.
15. Surface-active glasses: mechanism of formation of surface apatite, dependence of properties on chemical composition.
16. Hydroxyapatite. Structure, chemical composition, properties. Application in medicine.
17. Types of ceramic fibers, composites, their properties and applications.
18. Varieties of bioceramic composites.

19. Technological features of obtaining bioceramic composites.
20. Ceramic matrix composites: different types, their preparation and properties.
21. Hydroxyapatite composites with zirconium, alumina and titanium - structure and properties.
22. Hydroxyapatite coated metal implants: coating methods, characteristics and properties.
23. Coatings of bio glass and bioactive glass ceramics.
24. Methods of treatment of bioactive coatings for enhancing functional properties.
25. Methods of applying bioceramic coatings on tribo-joints of joint implants.

9 Distribution of points that students receive

From a class or a control event	Points for one class or control measure	For the semester		Before the 1st certification	
		number of classes or control activities	the sum of points	number of classes or control activities	the sum of points
Control work	3	8	24	4	12
Modular work.	13	2	26	1	12
Submission of individual tasks	10	1	10	-	-
The amount of current control			60		24
Passing the exam			40		
Total			100		

Rating scale

Sum of points for all kinds of educational activity	Score on a national scale	
	Exam, course project (work), practice	Credit
90 – 100	perfect	counted
82-89	good	
74-81		
64-73	satisfactorily	
60-63		
35-59	unsatisfactory with the possibil-	not reckoned with the

	ity of reassembly	possibility of re-drafting
0-34	unsatisfactory with the compulsory re-study of the discipline	not counted with the compulsory re-study of the discipline

10 Recommended information sources

Basic

1. Roger Narayan. Biomedical Materials. Springer-Verlag New York Inc., 2009. – 566 p.
2. Верещагин В.И. Керамические и стеклокристаллические материалы для медицины. Учебное пособие. - Томск: НИПУ, 2011. – 148 с.
3. Joon B. Park, Joseph D. Bronzino. Biomaterials Principles and Applications. CRC Press. 2002. – 250 p.

Secondary

4. Баринов С.М. Биокерамика на основе фосфатов кальция Москва: Наука, 2005. – 245 с.
5. Фадеева И.В. Медицинская керамика из замещенных фосфатов кальция. Москва: МГУ, 2016. – 167 с.
6. Поюровская И.Я. Стоматологическое материаловедение. ГЭОТАР-Медиа, 2008. – 192 с.
7. Ramakrishna S., Ramalingam M., Kumar T.S.S., Soboyejo W.O. Biomaterials. Taylor & Francis Group, LLC, 2010. — 350 p.

Information resources

8. Reference materials on the site:
<https://www.sciencedirect.com/topics/chemistry/bioceramic>
9. Reference materials on the site:
<https://www.britannica.com/technology/bioceramics>
10. Reference materials on the site:
<https://www.sciencelearn.org.nz/resources/1776-bioceramics>