GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Nanotechnology in biological protection and battlefield medicine, PG_00071219		
Field of study	Nanotechnology		
Date of commencement of studies	February 2027	Academic year of realisation of subject	2027/2028
Education level	second-cycle studies	Subject group	Specialty subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Division of Electrochemistry and Surface Physical Chemistry -> Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Jacek Ryl	
	Teachers	prof. dr hab. inż. Jacek Ryl dr hab. inż. Justyna Kucińska-Lipka	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	0.0	0.0	30

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	30	2.0	43.0	75

Subject objectives

The aim of this course is to familiarize students with the application of nanotechnology in the production of materials useful for biological defense and battlefield medicine. The course develops the ability to select materials and technologies for specific scenarios, taking into account clinical and engineering conditions.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W02] has in-depth, theoretically grounded and detailed knowledge of phenomena, methods, and theories related to nanotechnology, as well as of related and allied fields of science or engineering	The student has knowledge of physical and biochemical phenomena related to nanotechnology, biological protection and battlefield medicine.	[SW1] Assessment of factual knowledge
[K7_W07] has extended knowledge of the effects of using nanostructures in biological, environmental, social, economic, and legal dimensions, as well as in a broad non-technical context. Also has extended knowledge of the basics of entrepreneurship, quality management, or safety related to the application of nanomaterials	The student has non-technical knowledge that allows him to select nanotechnology solutions for various applications.	[SW1] Assessment of factual knowledge
[K7_U04] is able to formulate hypotheses, plan and conduct experimental research, critically analyze results, verify hypotheses, draw conclusions, and formulate well-founded opinions within nanotechnology and related physical and natural sciences. Recognizes economic and non-technical aspects of the activities performed	The student is able to plan experimental studies aimed at producing or characterizing nanomaterials, as well as assessing their suitability for a specific application.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task

<table>
<tr><td>Subject contents</td><td>Course content – lecture
Segment A (8h): Hydrogels and Bioactive Nanocomposites

Hydrogels: physical/chemical cross-linking, swelling, transport, tissue adhesion, "moist wound healing"
Nanocomposites in Hydrogels: metal/oxide nanoparticles, nanocarbons, nanofibers; trade-off: activity vs. cytotoxicity
Antibacterial Dressings: AgNPs in a Hydrogel Matrix as a classic example; mechanisms and limitations (silver as a potent antimicrobial agent)
Controlled-Release Systems: kinetics, carriersBiodegradable Materials and "Smart Dressings": response to pH, ROS, temperature, and humidity

Segment B (6h) Surgical Field Scenarios: Wounds and Infections
Types of Injuries: gunshot/fragment wounds, burns, crush injuries; hemorrhage and hemostasis (in a practical context).
Infections: field risk, biofilm, contamination, limitations of antiseptics/antibiotics.
Operational requirements for materials: application time, simplicity, mass/volume, stability, sterility, compatibility with emergency procedures.

Test (1 hour)

Course content – laboratory
Laboratory 1 (3h) Production of hydrogels: Natural and synthetic hydrogels (alginate, gelatin, PVA), preparation of 23 hydrogel variants with different degrees of cross-linking, observation of gelation (time, homogeneity), preliminary assessment of adhesion to the surface

Laboratory 2 (3h) - Nanocomposite hydrogels: Incorporation of nanoadditives into hydrogels, preparation of reference and nanocomposite hydrogel, testing: swelling, color/transparency change, structural stability, cytotoxicity model test

Laboratory 3 (3h): Controlled release systems: Understanding mass transport and release kinetics of active substances. incubation of hydrogel samples in a medium, measurements of concentration as a function of time (UV-Vis / conductometry), fitting of simple kinetic models.

Laboratory 4 (3h): Additive manufacturing of bioprotective structures:. Preparation of a CAD model of a bioprotective structure (dressing grid / absorbent insert / flexible shield), printing of a structure from a biodegradable polymer, assessment of: porosity, elasticity, fit.

Laboratory 5 (3h): Integration: hydrogel + 3D printed structure. Impregnation of the 3D structure with hydrogel, functional tests: absorbency, stability, "application time" (simulation),</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Chemistry, surface physicochemistry</td></tr>
<tr><td>Assessment methods and criteria</td><td><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>test</td><td>60.0%</td><td>60.0%</td></tr>
<tr><td>lab reports</td><td>60.0%</td><td>40.0%</td></tr>
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<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>Nanochemistry: a Chemical Approach to Nanomaterials (RSC Publishing)</td></tr>
<tr><td>Supplementary literature</td><td>articles in JCR-ranked journals</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>Explain the differences between physical and chemical cross-linking of hydrogels.

Describe the mechanisms of action of silver nanoparticles (AgNPs) in a hydrogel matrix as an antibacterial dressing.

Based on the hydrogel incubation experiment, describe: the processes responsible for the release of the active substance (diffusion, degradation, swelling), and how to interpret the concentration-time graph.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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