University of Gdańsk

Subject card

Subject name and code	Introduction to nanomedicine and nanotoxicology, PG_00080821						
Field of study	Chemical Business						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2029/2030			
Education level	Bachelor's studies		Subject group	Optional subject group			
Mode of study	full-time studies		Mode of delivery	at the university			
Year of study	4		Language of instruction	English			
Semester of study	7		ECTS credits	1.0			
Learning profile	academic		Assessment form	credit			
Conducting unit	Laboratory of Environmental Chemoinformatics -> Department of Environmental Chemistry and Radiochemistry -> Faculty of Chemistry -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Tomasz Puzyn					
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	0.0	0.0	15
	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	15		2.0	8.0	25	
Subject objectives	During the course, students will discover the applications of nanotechnology in medicine. They will delve into the latest achievements in the field of nanomedicine, including the use of nanoparticles, nanotubes, and nanosystems in diagnostics and therapy. The course will also address issues related to nanotoxicology. Participants will learn how to link the structure of nanomaterials with their biological activity and will familiarize themselves with drug delivery systems in nano form.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[BCHINŻ_W02] Enumerates basic laws and theories in chemistry, physics and mathematics necessary to formulate and solve simple engineering tasks.	Understands which physical laws describe the behavior of nanomaterials.	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion
[BCHINŻ_K01] Identifies the level of her/his own knowledge and skills as well as the need to update engineering knowledge, continuous professional training and personal development.	Understands how rapidly nanotechnology and nanomedicine are developing, and recognizes the need for continuous education in this field.	[SK1] oral statement/conversation/ discussion [SK4] test/exam - oral or written
[BCHINŻ_U09] Using the acquired knowledge, skills and various sources of scientific information independently prepares written papers and oral presentations.	Using the knowledge and skills he has acquired, as well as various sources of scientific information, he independently prepares a presentation of his research task, showing both an understanding of the problem and the logic of the solutions he has applied.	[SU2] presentation/project/paper/ report
[BCHINŻ_W01] Describes the relationship between the economy and the functioning of the chemical industry.	Understand the pharmacoeconomic benefits of nanomedicine	[SW2] presentation/project/paper/ report
[BCHINŻ_U08] Uses the chemical nomenclature and engineering terminology properly.	Properly uses the nomenclature used to describe nanomaterials, including drug nanocarriers, and describe basic ADME properties	[SU1] oral statement/conversation/ discussion [SU4] test/exam - oral or written
[BCHINŻ_K02] Works individually demonstrating initiative and independence in actions, and effectively cooperates in a team, performing various roles in it.	He works individually on the development of the script, independently identifies errors and seeks solutions.	[SK6] demonstration of practical skills

Subject contents

Nanocząstki i nanomateriały. Charakterystyka eksperymentalna i obliczeniowa nanocząstek. Modelowanie adsorpcji, dystrybucji, metabolizmu/transformacji i wydalania nanocząstek w żywym organizmie. Metody obliczeniowe wspomagające projektowanie nanocząstek stosowanych w medycynie. Badania toksyczności in silico nanocząstek.

Prerequisites and co-requisites

Familiarity with machine learning methods, understanding of basic concepts related to nanomaterials, knowledge of biology at the high school level.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
written test	60.0%	100.0%

Recommended reading

Basic literature	T. Puzyn, J. Leszczynski (Eds): Towards Efficient Designing of Safe Nanomaterials, RSC Publishing, Cambridge 2012 A. Gajewicz, T. Puzyn (Eds): Computational Nanotoxicology: Challenges and Perspectives, Jenny Stanford Publishin, 2020.
Supplementary literature	Research articles published in the following journals: ACS NanoNature NanotechnologyNanoscaleSmallNanotoxicologyNanomedicine: Nanotechnology, Biology and Medicine Journal of Nanotoxicology and Nanomedicine
eResources addresses	

Example issues/ example questions/ tasks being completed	1. Fullerene (C60) was discovered by: a) Richard Feynman b) Richard Buckminster Fuller c) Harold Kroto d) Sumio Iijima 2. Quantum dot ZnS is a typical example of a nanoparticle type a) 0D b) 1D c) 2D d) 3D 3. Which of the listed nanoparticles is a composite (multi-component nanoparticle)? a) liposome b) dendrimer c) quantum dot ZnSe d) nanoparticle Ag@TiO2 4. The process in which nanoparticles combine into larger structures as a result of mutual interaction using van der Waals forces is a) agglomeration b) aggregation c) sedimentation d) creaming 5. Zeta potential is measured a) directly on the surface of the nanoparticle b) at the boundary of the Stern layer c) at the slip plane boundary d) at the isoelectric point 6. Which of the listed measurement techniques uses van der Waals forces? a) SEM b) TEM c) AFM d) DLS 7. The process in which a nanoparticle present outside the cell is surrounded by membrane protrusions and then absorbed into the cell is a) passive transport b) exocytosis c) phagocytosis d) pinocytosis 8. For four substances, distribution volumes (Vdist) were determined. Which of them will be best absorbed from the bloodstream into tissues? a) Substance A, Vdist (A) = 3 dm3 b) Substance B, Vdist (B) = 2 dm3 c) Substance C, Vdist © = 1 dm3 d) Substance D, Vdist (D) = 0.5 dm3 9. Which of the listed nanoparticles is not suitable for use in imaging with magnetic resonance imaging (MRI)? a) NaGdF4 b) Fe3O4 c) Ag d) Gd@SiO2 10. Which of the following groups of nanoparticles are used in research as potential drug carriers a) liposomes b) chitosan nanoparticles c) metal oxide nanoparticles d) all of the above groups 11. Which of the listed mechanisms are used in targeted cancer therapies using nanoparticles as chemotherapeutic carriers a) the possibility of changing the structure of the nanoparticle under the influence of pH changes within the tumor b) changes in the charge of the nanoparticle under the influence of the environment c) attachment of ligands specific to receptors located on the surface of tumor cells to the surface of the nanoparticle d) all of the above 12. What actions are taken to more accurately predict in vivo effects caused by nanoparticles based on in vitro studies? a) use of advanced cellular models (including several types of cells, three-dimensional structure of the model, dynamic flows of tested substances through the model) b) use of advanced animal models (spontaneous and metastatic tumors) c) patient selection preceded by a more detailed interview and division into two groups: patients who are given the tested substance and patients who are given a placebo d) all of the above 13. The following mechanisms of nanoparticle transport through the blood-brain barrier should be included: a) transport through connections between endothelial cells b) transcytosis, the first stage of which is the interaction of the ligand attached to the nanoparticle with the receptor located on the surface of the endothelial cell c) endocytosis d) all of the above 14. In what units should the cytotoxic concentration EC50 of TiO2 nanoparticles (in vitro test on a single cell line) be expressed in the most correct way, taking into account the possibility of agglomeration-aggregation processes? a) mg/dm3 b) mol/dm3 c) number of nanoparticles / dm3 d) cm2 / dm3 15. It is believed that the toxicity of multi-walled carbon nanotubes (MWCNTs) mainly results from: a) release of ions from the surface b) large aspect ratio c) high red-ox reactivity of the surface d) the ability to transport toxic xenobiotics into the cell
Work placement	Not applicable

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