University of Gdańsk

Subject card

Subject name and code	Monographic lecture - Computational nanomedicine and nanotechnology, PG_00117799		
Field of study	Chemistry		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2027/2028
Education level	Master's studies	Subject group	Obligatory subject group in the field of study Optional subject group
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	English
Semester of study	4	ECTS credits	3.0
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	30.0	0.0	0.0	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	5.0	40.0	75

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
[CHEMMU2_U03] Finds necessary information in specialist literature, databases and other sources, lists basic scientific journals in chemistry.	Searches for necessary information in specialist literature, databases, and other sources.	[SU4] test/exam - oral or written
[CHEMMU2_K01] Knows the limitations of her/his own knowledge; understands the need for further education and can inspire other people to do so.	Is aware of the limitations of his knowledge, understands the need for continuous education, and recognizes the rapid progress in the field of nanomaterials.	[SK1] oral statement/conversation/ discussion
[CHEMMU2_W06] Applies mathematics to the extent necessary to understand, describe and model chemical processes of medium complexity.	Understands and applies mathematical formulas and algorithms necessary for the description of nanostructures and the construction of nano-QSAR models	[SW4] test/exam - oral or written
[CHEMMU2_U02] Critically assesses the results of conducted, performed observations and theoretical calculations and discusses errors.	Critically evaluates the results of conducted experiments and is also able to subject the obtained model to statistical evaluation.	[SU4] test/exam - oral or written
[CHEMMU2_K04] Correctly identifies and resolves dilemmas related to the profession of a chemist.	He correctly identifies and resolves dilemmas related to the practice of the chemist profession.	[SK4] test/exam - oral or written
[CHEMMU2_K06] Undertakes research tasks consciously and responsibly, understanding the social aspects of the practical application of the acquired knowledge and skills and the responsibility related to it.	He undertakes the implementation of research tasks in a conscious and responsible manner, understanding the social aspects of the practical application of the knowledge and skills acquired, and the responsibility associated with it.	[SK4] test/exam - oral or written
[CHEMMU2_U01] Plans and implements chemical experiments of medium complexity.	Plans and carries out computational experiments related to the description of the structure of nanomaterials	[SU1] oral statement/conversation/ discussion [SU4] test/exam - oral or written

Subject contents

Nanoparticles and nanomaterials. Experimental and computational characterization of nanoparticles. Modeling adsorption, distribution, metabolism /transformation, and excretion of nanoparticles in a living organism. Computational methods for supporting the design of nanoparticles used in medicine. In silico toxicity testing of nanoparticles.

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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