University of Gdańsk

Subject card

Subject name and code	From biomolecules through biosensors towards lab on a chip, PG_00185162		
Field of study	Physics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2025/2026
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	1	Language of instruction	Polish
Semester of study	1	ECTS credits	5.0
Learning profile	academic	Assessment form	credit
Conducting unit	Division of Biomaterials and Medical Physics -> Institute of Experimental Physics -> Faculty of Mathematics, Physics and Informatics -> Rector		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Anna Synak	
	Teachers	dr hab. Anna Synak	

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	0.0	0.0	60
	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	60	0.0	0.0	60

Subject objectives	The aim of the course is to acquaint students with the physical foundations of biomolecular spectroscopy and modern biodetection methods by developing an understanding of the optical and physicochemical properties of biomolecules at the nanoscale, gaining insight into the operation of advanced biosensors based on plasmonic phenomena and energy transfer, and introducing the concept of miniaturized analytical systems (lab-on-a-chip) used in contemporary diagnostics and biomedicine.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[FIZMU2_W01] has advanced knowledge of general physics and in-depth knowledge of various areas of physics; knows the history of the development of physics and its importance for the progress of exact and natural sciences, cognition of the world and social development	The student possesses advanced knowledge in broadly understood contemporary physics, particularly in optical and quantum physics, which is essential for understanding the processes underlying spectroscopic and plasmonic phenomena. They know the historical and contemporary stages in the development of spectroscopic methods and their significance for the advancement of natural sciences, biomedicine, and modern technologies. They understand the role of the development of physics and nanotechnology in creating innovative diagnostic and analytical tools used in contemporary scientific research and medical diagnostics.	[SW4] test/exam - oral or written
[FIZMU2_W06] has knowledge of the current directions of development of physics and fundamental dilemmas of modern civilization	The student possesses advanced knowledge of contemporary directions in the development of physics at the interface with biological, chemical, and material sciences, with particular emphasis on the applications of spectroscopic and plasmonic phenomena in biodetection, the analysis of molecular systems, and medical diagnostics. They know the design and applications of modern research instrumentation used in spectroscopy and in the imaging of objects at the nanoscale. They understand the importance of an interdisciplinary approach and the miniaturization of measurement systems (lab-on-chip) for the development of modern biomedical technologies and for addressing the challenges of contemporary science and civilization.	[SW4] test/exam - oral or written
[FIZMU2_U05] has the ability to synthesize methods and ideas from various areas of physics and other exact and natural sciences; is able to notice that even distant phenomena are described by similar models	The student is able to integrate knowledge from physics, chemistry, and molecular biology in the analysis of photophysical processes. They recognize analogies and common theoretical models describing the mechanisms underlying fluorescence and plasmonic phenomena.	[SU2] presentation/project/paper/ report

Subject contents

Fundamentals of fluorescence spectroscopy; selected natural biological absorbers and fluorophores.Selected biocompatible molecules and materials.Physicochemical properties of biomolecules and biomaterials at the nanoscale.Classical and advanced measurement instrumentation: from UVVis spectroscopy to high spatial and temporal resolution microscopy; spectroscopy and imaging of single bio-objects.Examples of indicators and biosensors.Plasmonic phenomena: surface plasmon resonance (SPR), metal-enhanced fluorescence (MEF), surface plasmoncoupled emission (SPCE).Energy transfer as a tool in biosensing; enhanced energy transfer mechanisms.Sensitive biomolecule detection and plasmonic platforms.Coreshell nanoparticles; applications in biomaterials and biomedical sciences.Introduction to drug delivery systems.Miniaturization and multifunctionality in measurement systems: advantages and limitations; lab-on-a-chip technologies.

Prerequisites and co-requisites

basic knowledge of physics

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
report - presentation	51.0%	60.0%
oral exam	51.0%	40.0%

Recommended reading	Basic literature	1) A.Kawski, Fotoluminescencja roztworów, PWN, 1992 2) J.R. Lakowicz, Principles of Fluorescence Spectroscopy, Plenum Press, 2006 3) Z.Gryczynski and I. Gryczynski, Practical Fluorescence Spectroscopy, CRC Press, 2020. 4)H.Hacken, H. Ch.Wolf, Fizyka molekularna z elementami chemii kwantowej, PWN, 1998. 5)A. Ho-Pui Ho, D.Kim, M.G. Somekh, Handbook of Photonics for Biomedical Engineering, Springer, 2017. 6)R.Walczak, Laboratoria chipowe z detekcja optyczną: konstrukcja, technologia i przykłady wykorzystania, Oficyna Wydawnicza Politechniki Wrocławskiej 2014.
	Supplementary literature	Own materials and data Websites of microscope manufacturers eg.:Nikon and Olympus: http://www.microscopyu.com/, http://www.olympusmicro.com/A, : https://www.ntmdt-si.com/page/resources
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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