University of Gdańsk

Subject card

Subject name and code	From Biomolecules Through Biosensors to Lab on a Chip-, PG_00209961						
Field of study	Medical Physics						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2026/2027		
Education level	Master's studies		Subject group		Optional 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	2		Language of instruction		Polish		
Semester of study	3		ECTS credits		3.0		
Learning profile	academic		Assessment form		credit		
Conducting unit							
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Anna Synak				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	15.0	0.0	0.0	0.0	45
	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	45		0.0		30.0	75
Subject objectives	The aim of the course is to familiarize students with the physical principles of biomolecular spectroscopy and modern biodetection methods by developing an understanding of the optical and physicochemical properties of biomolecules at the nanoscale, introducing the operating principles of advanced biosensors based on plasmonic phenomena and energy transfer mechanisms, and presenting the concept of miniaturized lab-on-chip analytical systems used in modern diagnostics and biomedicine.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZMEDMU2_W04] Knows and understands in depth the theoretical foundations and principles of operation of measurement systems and research, diagnostic and therapeutic equipment specific to the field of physics and medicine.	The student knows and understands the theoretical foundations, construction, operating principles, and applications of advanced measurement systems and research instrumentation used in biomolecular spectroscopy and biodetection. In particular, the student is familiar with the operating principles of UV–Vis and fluorescence spectroscopy systems, instrumentation for spectroscopy and imaging of single bio-objects, and high spatial- and temporal-resolution microscopy techniques. The student understands the principles of operation of biosensors and biological indicators based on surface plasmon resonance (SPR), metal-enhanced fluorescence (MEF), surface plasmon-coupled emission (SPCE), and energy transfer mechanisms. The student is also familiar with the construction and properties of plasmonic platforms, core–shell nanoparticles, miniaturized lab-on-chip analytical systems, and drug delivery systems, and understands their applications in modern diagnostics, biodetection, and biomedicine.	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion
	[FIZMEDMU2_W03] Knows and understands advanced experimental and numerical techniques that allow you to plan and perform a complex physical experiment.	The student is familiar with the operating principles, and applications of advanced experimental techniques used in biomolecular spectroscopy and biodetection, including spectroscopic, microscopic, and biosensing methods, as well as miniaturized lab-on-chip analytical systems. The student understands their role in the planning, execution, and interpretation of complex physical and biomedical experiments and is aware of their capabilities and limitations in modern diagnostics and biomedical research.	[SW4] test/exam - oral or written
	[FIZMEDMU2_U02] Can plan and conduct an experiment using new or adapt existing methods and tools, and critically analyse the results of measurements, observations or numerical calculations, assessing the accuracy of the results using known methods and tools.	The student is able to plan and perform experiments using spectroscopic and optical methods for the investigation of biomolecules and biomaterials, select appropriate measurement techniques and analytical tools, critically analyze and interpret the obtained results, and assess their accuracy and reliability using established methods and evaluation criteria.	[SU3] text preparation/written work [SU8] observation of student's independent or team work

Course outcome	Subject outcome	Method of verification
[FIZMEDMU2_W01] Knows and understands in depth selected issues in the field of physics and medicine, the complex relationships between them, and development trends in the exact and natural sciences, health sciences, and others.	The student knows and understands the principles of biomolecular spectroscopy and modern biodetection methods, including the optical and physicochemical phenomena occurring at the nanoscale. The student possesses advanced knowledge of the properties of biomolecules, advanced biosensors based on plasmonic phenomena and energy transfer mechanisms, and miniaturized lab-on-chip analytical systems. The student understands the relationships between physical phenomena and biological and medical processes, as well as the significance of these technologies for the development of modern diagnostics, biomedicine, and medical physics.	[SW4] test/exam - oral or written

Subject contents

Fundamentals of fluorescence spectroscopy. Selected naturally occurring biological absorbers and fluorophores.

Selected biocompatible molecules and materials.

Physicochemical properties of selected biomolecules and biomaterials at the nanoscale.

Conventional and advanced analytical instrumentation: from UV–Vis spectroscopy to high spatial- and temporal-resolution microscopy. Spectroscopy and imaging of single bio-objects.

Examples of biological indicators and biosensors.

Surface plasmon resonance (SPR), metal-enhanced fluorescence (MEF), and surface plasmon-coupled emission (SPCE).

Energy transfer as a tool in biosensing. Enhanced energy transfer mechanisms.

Sensitive biomolecule detection and plasmonic platforms.

Core–shell nanoparticles and their applications in biomaterials and biomedical sciences.

Drug delivery systems: concepts and applications.

Miniaturization and multifunctionality in analytical measurements: advantages and limitations. Lab-on-a-chip systems.

Prerequisites and co-requisites

Knowledge of the fundamental principles of physics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Report or presentation	51.0%	40.0%
Oral test	51.0%	60.0%

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 Strony producentów mikroskopów np.:Nikon and Olympus: http://www.microscopyu.com/, http://www.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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