University of Gdańsk

Subject card

Subject name and code	Molecular biophysics, PG_00153669		
Field of study	Biotechnology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2024/2025
Education level	undergraduate studies	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	2	ECTS credits	2.0
Learning profile	academic	Assessment form	
Conducting unit	Intercollegiate Faculty of Biotechnology UG-MUG		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Bogdan Banecki	
	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	10.0	20.0	60

Subject objectives

Conveying knowledge in the field of biophysics, encompassing the application of fundamental physical laws to describe and understand processes occurring in biological systems.

The student will learn and understand basic concepts and biophysical terminology used to describe phenomena and physical processes in biological systems.

They will acquire knowledge in biophysics that allows them to understand fundamental physical processes occurring in biological systems, with particular emphasis on intracellular processes.

They will learn both the fundamentals and applications of techniques and research tools based on the use of physical phenomena to analyze processes and phenomena in biological systems.

They will gain skills in the proper selection of research techniques and understand the limitations of their applicability in biophysical research

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[BIOTECHL3_W06] The graduate knows and understands basic knowledge in science and natural sciences necessary for understanding the phenomena and biological processes, particular cellular processes at the molecular level	The student possesses a solid foundational knowledge in the exact and natural sciences, particularly in the field of biophysics, which is essential for understanding complex biological phenomena and processes. They understand how fundamental physical laws apply to biological systems and can explain the mechanisms underlying cellular processes at the molecular level. They know and understand concepts such as biological thermodynamics, kinetics of enzymatic reactions, mass and energy transport in cells, and the structure and function of biomolecules. The student is aware of research methods and techniques used in biophysics, such as spectroscopy, microscopy, electrophoresis, and calorimetry. They understand the principles of their operation, capabilities, and limitations, which allows them to critically assess and interpret experimental research results. Thanks to the acquired knowledge, the student is prepared to integrate information from various scientific fields to solve problems related to biological processes at the molecular level. They are able to apply the acquired knowledge in laboratory practice and further education in the field of biotechnology and related sciences.	[SW4] test/exam - oral or written [SW5] implementation of a problem task
	[BIOTECHL3_W07] The graduate knows and understands basic techniques and research tools used in biotechnology.	Revised Learning Outcomes: Knowledge: The student has knowledge about the application of measurement apparatus and equipment used in experimental research in the field of biophysics. Skills: Is able to list and describe the basic structural elements of measurement apparatus used in biotechnology and related sciences, and understands the principles of their operation. Competencies: Is capable of correctly selecting and applying appropriate measurement apparatus in various fields of biotechnology, taking into account its limitations and possibilities.	[SW4] test/exam - oral or written [SW5] implementation of a problem task

Subject contents	The biophysics lecture aims to acquaint students with both basic and advanced research techniques used in this interdisciplinary field of science. It covers both the theoretical foundations of biophysical methods and the practical aspects of their application in scientific research, industry, medical diagnostics, and environmental protection. Particular emphasis is placed on understanding the limitations of individual methods, resulting from the need for appropriate sample preparation for analysis and requirements regarding the quantity and quality of research material.
	
	The lecture topics include:
	
	Spectroscopic Techniques:
	
	• **Visible and Ultraviolet Spectroscopy (UV-VIS):** Analysis of radiation absorption by biological samples; applications in quantification and identification of chemical compounds.
	
	• **Fluorescence Spectroscopy:** Study of the fluorescent properties of molecules; applications in detecting trace amounts of substances and in imaging cells and tissues.
	
	• **Fourier Transform Infrared Spectroscopy (FT-IR):** Identification of functional groups, analysis of molecular structure, and study of intermolecular interactions.
	
	• **Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD) Spectroscopy:** Examination of the secondary and tertiary structures of proteins and nucleic acids; analysis of conformational changes.
	
	• **Nuclear Magnetic Resonance (NMR) Spectroscopy:** Detailed analysis of molecular structure at the atomic level; study of molecular dynamics and intracellular interactions.
	
	Thermal and Kinetic Techniques:
	
	• **Microcalorimetry:** Measurement of energy changes in biological systems; study of the thermodynamics of biochemical reactions and biomolecular interactions.
	
	• **Methods for Studying Reaction Kinetics (optional):**
	
	  • **Stopped-flow Technique:** Rapid mixing of reagents and measurement of optical changes in real-time.
	  • **Surface Plasmon Resonance (SPR):** Direct monitoring of biomolecular interactions without the need for labeling.
	  • **Isothermal Titration Calorimetry:** Measurement of heat released or absorbed during chemical reactions at a constant temperature.
	
	Quality Aspects and Laboratory Standards:
	
	• **Equipment Qualification:**
	
	  • **IQ (Installation Qualification):** Confirmation of proper installation of equipment according to the manufacturer's requirements.
	  • **OQ (Operational Qualification):** Verification that the equipment operates according to specifications under operational conditions.
	  • **PQ (Performance Qualification):** Confirmation that the equipment meets specified performance criteria during routine use.
	• **Method and Equipment Validation:** Procedures ensuring that analytical methods are suitable for their intended purpose, in accordance with Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP) requirements.
	
	Additional Elements of the Lecture:
	
	• **Practical Application Examples:** Discussion of real case studies illustrating the use of biophysical methods in solving research and industrial problems.
	
	• **Integration of Methods:** Discussion on the complementarity of various biophysical techniques and their combination to achieve more comprehensive results.

Educational Objectives of the Lecture:

- **Equipping students with the knowledge necessary to select appropriate biophysical techniques depending on the nature of the problem being studied.**
- **Understanding the principles of operation, capabilities, and limitations of individual methods, enabling critical evaluation of experimental data.**
- **Preparation for work in research and industrial laboratories, in accordance with the highest standards of quality and safety.**

This lecture provides a solid foundation for further education and specialization in the fields of biophysics, biotechnology, and related natural and technical sciences.

Prerequisites and co-requisites

Basic knowledge of general physics: including mechanics, thermodynamics, electricity and magnetism, and optics. The student should understand fundamental physical laws and be able to apply them to simple problems.

Knowledge of basic chemistry: including general and organic chemistry. It is important to understand the structure of atoms and molecules, chemical bonds, chemical reactions, and basic chemical processes occurring in living organisms.

Fundamentals of biology: particularly cell biology and molecular biology. The student should know the structure and functions of cells, cellular organelles, and basic life processes at the cellular and molecular level.

Mathematical skills: knowledge of basic algebra, calculus, and statistics.

Basic knowledge in biochemistry: understanding the structure and function of biomolecules such as proteins, nucleic acids, lipids, and carbohydrates.

Laboratory experience: knowledge of basic laboratory techniques, safety principles, and the ability to operate basic measurement equipment.

Ability to use scientific literature: the capability to search for, read, and interpret scientific texts in Polish and English.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
aktywność podczas zajęć	20.0%	20.0%
test	80.0%	80.0%

Recommended reading

Basic literature

1. Podstawy biofizyki. Podręcznik dla studentów medycyny, pod redakcją Andrzeja Pilawskiego, PZWL,2. Biofizyka dla biologów. Red. M. Bryszewska, W. Leyko, PWN,3. European Directorate for the Quality of Medicines & Healthcare, QUALITY MANAGEMENT (QM) GUIDELINES http://www.edqm.eu4. The International Conference on Harmonisation of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH), http://www.ich.org/.

	Supplementary literature	J. Bulock, B. Kristiansen. "Basic biotechnology"wybrane rozdziały Farmakopei Europejskiej jak na przykład:2.2.21. Fluorimetry2.2.24. Absorption spectrophotometry, infrared2.2.25. Absorption spectrophotometry, ultraviolet andvisible 2.2.40. Near-infrared spectroscopy 2.2.41. Circular dichroism Protein purification handbook- wersje dostępne na stronach www producentów kolumn.
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	**Infrared Spectroscopy:** • **Theoretical Foundations of Infrared Spectroscopy** • Normal vibrations • Description of stretching vibrations (harmonic oscillator) • Probability of absorption of electromagnetic radiation • **Equipment and Measurement Techniques** • Construction of an infrared spectrophotometer • Spectral measurement and sample preparation • Infrared spectral parameters **Isothermal Titration Microcalorimetry** • **Theoretical Foundations of Isothermal Titration Microcalorimetry** • Principles of thermodynamics • State functions • Thermodynamics of chemical reactions • **Construction of an Isothermal Titration Microcalorimeter** • Equipment • Measurement range and sensitivity • Sample preparation	
Work placement	Not applicable	

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