University of Gdańsk

Subject card

Subject name and code	Biothermodynamics with Elements of Statistical Physics, PG_00182159						
Field of study	Medical Physics						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2027/2028			
Education level	Bachelor's studies		Subject group	Obligatory subject group in the field of study 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	4		ECTS credits	3.0			
Learning profile	academic		Assessment form	exam			
Conducting unit	Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Anita Dąbrowska				
	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	45.0	90	
Subject objectives	Familiarization with the apparatus of statistical physics as a representation of thermodynamic processes in biology						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[FIZMEDL3_U01] He can formulate, analyse, and solve complex problems in physics and medicine, using mathematical formalism, based on the physical phenomena, principles, and theories he has learned.	The student is able to: apply the formalism of phenomenological thermodynamics and statistical physics to solve problems related to thermodynamic systems; create mathematical models and solve differential equations describing changes in thermodynamic parameters over time; analyze diffusion and osmosis processes in the context of substance transport in organisms; critically evaluate the correctness of a model and the assumptions used, and identify the limitations of the applied methods.	[SU6] demonstration of practical skills
[FIZMEDL3_W01] Knows and understands at an advanced level the phenomena, principles, laws and theories specific to physics and biophysics.	The student knows and understands: the basic concepts of thermodynamics; the thermodynamic description of an ideal gas; the definitions and significance of entropy and thermodynamic potentials; the laws of thermodynamics; types of processes and thermodynamic systems; the fundamentals of nonequilibrium process thermodynamics; the basics of thermodynamics of biological systems; the concept and types of statistical ensembles; the thermodynamic foundations of life.	[SW4] test/exam - oral or written
[FIZMEDL3_W02] Knows and understands to an advanced level selected biological phenomena and processes, as well as the laws of physics and chemistry underlying them.	The student knows and understands: the thermodynamic foundations of mass transport phenomena, including diffusion and osmosis in the context of processes occurring in living organisms; the transport of electric charge, including the concept of membrane potential and the Donnan equilibrium condition.	[SW4] test/exam - oral or written

Subject contents

1. Probabilistic introduction to statistical physics. The concept of entropy and its interpretation.
2. Basic concepts of thermodynamics: Thermodynamic system and its thermodynamic parameters. Ideal gas.Free energy, free enthalpy, chemical potential, electrochemical potential.
3. Laws of thermodynamics. Reversible and irreversible processes, spontaneous and forced processes.
4. Mass transport phenomena. Diffusion and osmosis. Electric charge transport phenomena.
5. Thermodynamic equilibrium.
6. Elements of nonequilibrium process thermodynamics.
7. Thermodynamics in biological systems, equilibrium and nonequilibrium states in biological systems.
8. Fundamentals of classical statistical mechanics of equilibrium states: statistical ensembles, microcanonical, canonical, and grand canonical distributions.
9. Thermodynamic foundations of life the organism as an open system.

Prerequisites and co-requisites

Formal requirements:

The student should have knowledge of basic physics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Exam	51.0%	60.0%
Tests	51.0%	40.0%

Recommended reading	Basic literature	L. Kubisz (red. naukowa), Biofizyka, Wydawnictwo Lekarskie PZWL, Warszawa 2024. F. Jaroszyk (red.), Biofizyka, Wydawnictwo Lekarskie PZWL, Warszawa 2008. K. Huang, Podstawy fizyki statystycznej, PWN, 2006. R. P. Feynman, Wykłady z mechaniki statystycznej, PWN, 1980.
	Supplementary literature	C. Blomberg, Physics of Life, Elsevier, 2007. R. K. Hobbie, B. J. Roth, Intermediate Physics for Medcine and Biology, Springer, 2007. D. T. Haynie, Biological Thermodynamics, Cambridge University Press, 2008. P. Atkins, J. de Paula, Physical chemistry for the life sciences, W. H. Freeman and Company, 2011.
	eResources addresses	
Example issues/ example questions/ tasks being completed	not required	
Work placement	Not applicable	

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