

## GDAŃSK UNIVERSITY

## Subject card

Subject name and code	Principles of Physical and Biophysical Chemistry, PG_00047944							
Field of study	Biomedical Engineering							
Date of commencement of studies	October 2025		Academic year of realisation of subject			2027/2028		
Education level	first-cycle 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	3		Language of instruction			Polish		
Semester of study	6		ECTS credits			4.0		
Learning profile	general academic profile		Assessment form			assessment		
Conducting unit	Department Of Physic	Department Of Physical Chemistry -> Faculty Of Ch			/działy F	Politech	niki Gdańskiej	
Name and surname	Subject supervisor		prof. dr hab. inż. Jacek Czub					
of lecturer (lecturers)	Teachers							
Lesson types and methods	Lesson type	Lecture	Tutorial	Laboratory	Project		Seminar	SUM
of instruction	Number of study hours	30.0	15.0	0.0	0.0		0.0	45
	E-learning hours inclu	ided: 0.0						
Learning activity and number of study hours	Learning activity	Participation in classes includ plan	n didactic ed in study	Participation in consultation hours		Self-study		SUM
	Number of study hours	45		4.0		51.0		100
Subject objectives	Understanding the law	vs governing (t	pio)chemical pr	ocesses and re	eactions	5		
Learning outcomes	Course out	come	Subj	ect outcome			Method of ver	ification
	[K6_W02] knows and understands, to an a extent, selected laws and physical phenom as methods and theo explaining the compl relationships betwee constituting the basic knowledge in the field sciences related to the study	Student learns how to apply the laws of thermodynamics and kinetics to understand and quantitatively describe chemical and biochemical reactions, as well as other biomolecular processes, such protein folding, ligand binding, molecular recognition, DNA-protein binding. Student learns how to apply theoretical knowledge acquired throughout the course to solve basic and practical computational problems. Student learns to develop algorithms for solving problems of varying difficulty.			[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation			
Prerequisites and co-requisites	their consequences. Basic principles of the statistical theory. The most probable distribution, the probability of the fluctuation. The Boltzmanns principle, molecular interpretation of the entropy. The Maxwell-Boltzmann distribution. Employing of thermodynamics in chemistry, biochemistry and biophysics. The chemical equilibrium and its dependence on the pressure and temperature. Energy conversion in biological systems; bioenergetics. Phase equilibria, the Clausius-Clapeyron equation, phase diagrams in a single and multi- component systems. Ideal and real solutions, the activity coefficients, colligative properties, osmotic phenomena, mixing thermodynamics Principles of electrochemistry: the potential difference on the border of phases. Cells and electrode potentials. The polarization of electrodes. Diffusion and transport phenomena in biological systems. Principles of the chemical kinetics. The reaction rate, the velocity constant, the order of reaction and the activation energy, the influence of the temperature on reaction rate. Enzymatic catalysis. Theoretical bases of molecular spectroscopy, UV/Vis, IR and NMR spectroscopy. Mathematics, Physics, General Chemistry, Technical Thermodynamics							

Assessment methods	Subject passing criteria	Passing threshold	Percentage of the final grade				
and criteria	Presentation of the task solution	50.0%	25.0%				
	Written exam	50.0%	60.0%				
	Presentation of the assigned topic	ic 50.0% 15.0%					
Recommended reading	Basic literature 1. Atkins P. W. Podstawy Chemii Fizycznej, PWN						
	2. Libuś W. Chemia Fizyczna, Część I, Wydawnictwo PG						
		<ul> <li>3. D. Zuckerman. Statistical Physics of Biomolecules. Wykłady z Chemii Fizycznej, WNT</li> <li>4. Barrow G. M. Chemia Fizyczna, PWN</li> </ul>					
		5. Kęcki Z. Podstawy Spektroskopii Molekularnej, PWN 9.					
	Supplementary literature	1. K. Gumiński, Termodynamika, PWN 2. K. Huang Podstawy Fizyki Statystycznej, PWN					
	eResources addresses	Adresy na platformie eNauczanie:					
Example issues/ example questions/ tasks being completed	(a) sample presentation topics						
	1. Fluorescence (complementary color, light absorption, HOMO-LUMO gap and its dependence on the number of conjugated double bonds and donor/acceptor groups, UV-Vis spectroscopy, chlorophyll, luminescence, Jablonski diagram (why there's a difference in the frquency of the absorbed and emited radiation), fluorescence vs. phosphorescence, radiationless transitions, nonadiabatic dynamics, fluorescence yield)						
	<ul> <li>2. FRET (Forster resonance, efficiency of energy transfer vs chromophore distance and orientation, confocal microscopy, sample applications - conformational transitions in the ATP synthase or transcription initiation by DNAPol, smFRET)3</li> <li>3. Atomic force microscopy (working principle, anchoring biomacromolecules to the tip/surface, applications: protein unfolding, mechanical mapping)</li> <li>(b) sample projects</li> <li>1. Membrane proteins are crucial in the cell's response to the environment, e.g., through modulation of ion permissivity. Here, we will see how the amino acid sequence affects the protein's interaction with the bilayer.</li> <li>2.By analyzing the effect of single amino acid mutations, we can gain indirect insight into the mechanisms of protein folding. In this case, we will investigate the impact of a single key residue on the folding and unfolding kinetics of an extremely stable protein.</li> </ul>						
Selected exam questions:							
	1. Substrate A can be converted to t activation for product B are -50 and respectively. Which product will dom when at a high temperature allowing products be determined at low temp	In be converted to two products B and C. The standard Gibbs energy and Gibbs energy of duct B are -50 and 80 kJ/mol, respectively, and for product C, -15 and 20 kJ/mol, ch product will dominate when the reaction is carried out at a low temperature, and which imperature allowing for reaching equilibrium? Why? How can the concentration ratio of both rmined at low temperatures?					
	2. It is known that stretching a rubber band involves conformational ordering of polymer molecules in the rubber; the resulting entropy decrease accounts for the main force opposing the deformation. Is the force exerted by the rubber band greater or smaller after heating? Why?						
	3. The folding process of a certain protein was studied in a calorimeter with a heat capacity of 0.4 kJ K. It was found that at 330 K, unfolding of 0.01 mole of this protein is accompanied by a 1 K decrease in calorimeter temperature. Knowing that the entropy change upon folding of this protein is $-0.1 \text{ kJ/(mol K)}$ , determine which form of the protein, folded or unfolded, dominates in the cell in equilibrium (T = 300 K). Assume that for the folding process Cp = 0. How can the molar fractions of the folded and unfolded forms be determined from these data (do not calculate the final values, just indicate the formula and plug in the data)?						

Work placement	Not applicable

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