INFORMATION ABOUT THE COURSE

Biochemistry

1. Basic information

Field of studies field of medical and health sciences, discipline: medical sciences **Unit responsible for the field of studies** Faculty of Medicine Bydgoszcz University of Science and Technology **Level of studies** Uniform master's studies **Profile of studies** General academic **Form of studies** Full-time	**Studies cycle** …….. **Course code** 17-EMS-BCH-SP1 **Language** English **Obligatory** Yes

Prerequisites	None
Introductory courses	None
Coordinator	Grażyna Gozdecka, PhD, Assoc. Prof.

Study period	**Form of assessment** **Form and hours of classes**	**ECTS credits**
Winter semester	Exam Lecture 60h Exercise 60h	9.0

2. Learning outcomes

Code	**Description of learning outcomes**	**Learning outcomes reference**
Knowledge (student knows and understands):		
K1	The graduate describes the water and electrolyte balance in biological systems	B.W1.
K2	The graduate describes acid-base balance and the mechanism of buffer action and the importance of buffers in systemic homeostasis	B.W2.
K3	The graduate knows and understands the concepts of: solubility, osmotic pressure, isotonia, colloidal solutions and Gibbs-Donnan equilibrium	B.W3.
K4	The graduate knows and understands the structure of lipids and polysaccharides and their functions in cellular and extracellular structures	B.W9.
K5	The graduate knows and understands the primary, secondary, third and fourth order structures of proteins and post-translational and functional protein modifications and their importance	B.W10.

K6	The graduate knows and understands the functions of nucleotides in the cell, the primary and secondary structures of DNA and RNA and the structure of chromatin	B.W11.
K7	The graduate knows and understands the functions of the genome, human transcriptome and proteome and methods used in their study, processes of DNA replication, repair and recombination, transcription and translation, and degradation of DNA, RNA and proteins, as well as concepts of gene expression regulation	B.W12.
K8	The graduate knows and understands the basic catabolic and anabolic pathways, methods of their regulation and the influence of genetic and environmental factors on them	B.W13.
K9	The graduate knows and understands the metabolic changes occurring in organs and the metabolic, biochemical and molecular basis of diseases and therapies	B.W15.
Abilities (student can do/perform):		
A1	The graduate is able to calculate molar and percentage concentrations of compounds and concentrations of substances in isosmotic, single- and multi-component solutions	B.U3.
A2	The graduate is able to calculate the solubility of inorganic compounds, determine the chemical basis of the solubility of organic compounds or its lack and its practical significance for dietetics and therapy	B.U4.
A3	The graduate is able to determine the pH of a solution and the effect of pH changes on inorganic and organic compounds	B.U5.
A4	The graduate is able to predict the direction of biochemical processes depending on the energy state of cells	B.U6.
A5	The graduate is able to use basic laboratory and molecular techniques	B.U12.
Social skills (the student is ready to):		
S1	The graduate is ready to notice and recognize their own limitations, make self-assessment of deficits and educational needs	O.K5.
S2	The graduate is ready to use objective sources of information	O.K7.
S3	The graduate is ready to formulate conclusions from their own measurements or observations	O.K8.
S4	The graduate is ready to accept responsibility related to decisions made as part of professional activity, including in terms of their own safety and the safety of others.	O.K11.

3. Programme contents

No.	Programme contents	Form of studies	Learning outcomes covered by the programme content
1	**Introduction to Biochemistry and Basic Chemical Principles** 1. Introduction to Biochemistry: • Biochemistry as an Interdisciplinary Science – Relationship to Medicine. • Basic Cell Components: Water, Biological Macromolecules. • Properties of Water and Their Importance to Biochemical Processes. 2. Basic Chemical Principles in Biochemistry: • Chemical Interactions in Biological Systems (Ionic, Covalent, Coordination, Hydrogen, Van Der Waals Bonds). • Buffer Solutions – Role in the Body. • Ion Concentrations, Transmembrane Potential, Oxidation-Reduction Reactions. 3. Biochemical Thermodynamics and Kinetics: • First and Second Laws of Thermodynamics. • Chemical Equilibrium and Equilibrium Constant. • The Concept of Free Energy and Its Relationship to Metabolic Processes. • Enzymatic Catalysis – Fundamentals of Enzyme Action.	Lecture	K1, K2
2	**Structure and function of biomolecules** 1. Proteins – structure and function: • Amino acids and their classification. • Protein structure (primary, secondary, tertiary, quaternary). • Protein folding and its biological significance. 2. Hemoglobin and oxygen transport: • The structure of hemoglobin and myoglobin. • The Bohr effect and regulation of oxygen binding. • Porphyrias, hemolytic anemias and other disorders. 3. Enzymes and their mechanisms of action: • Classification of enzymes. • Cofactors and coenzymes. • Michaelis-Menten kinetics and enzymatic inhibition. • The importance of enzymes in clinical diagnostics. 4. Carbohydrates – structure and function: • Classification of sugars. • Polysaccharides – glycogen, starch, cellulose. • The role of carbohydrates in cell signaling. 5. Lipids and biological membranes: • Classification of lipids. Structure of biological membranes, membrane transport. • Plasma cholesterol and lipoproteins – clinical significance. 6. Nucleic acids and the flow of genetic information: • Structure of DNA and RNA. • Replication, transcription, translation. • Regulation of gene expression.	Lecture	K3, K4, K5, K6

3	**Metabolism – energy pathways and their regulation** 1. Introduction to metabolism and bioenergetics: • ATP as the main energy currency of the cell. • High-energy compounds and the role of kinases/phosphatases. 2. Glycolysis and fermentation: • Detailed course of glycolysis. • Enzymatic regulation. • Lactic and alcohol fermentation. 3. Krebs cycle and respiratory chain: • Citric acid cycle as the central pathway of metabolism. • Oxidative phosphorylation and ATP formation. 4. Carbohydrate metabolism: • Gluconeogenesis. • Pentose phosphate pathway. • Disorders of sugar metabolism (e.g. galactosemia, diabetes). 5. Lipid metabolism: • Beta-oxidation of fatty acids. • Synthesis of fatty acids. • Ketone bodies – ketogenesis and ketosis. • Transport and Role of Lipoproteins • Plasma lipoproteins – LDL, HDL, VLDL. • Atherosclerosis and lipid disorders. 6. Amino acid metabolism: • Amino acid catabolism and the urea cycle. • Gluco- and ketogenic amino acids. • Tyrosine and phenylalanine metabolism (phenylketonuria). 7. Nucleotide metabolism: • Biosynthesis and degradation of purines and pyrimidines. • Gout. 8. Metabolic regulation: • Hormonal control of metabolism. • Insulin and glucagon signaling.	Lecture	K7, K8
4	**Medical Biochemistry and Clinical Aspects of Biochemistry** 1. Free Radicals and Oxidative Stress: • Mechanisms of Oxidative Damage. • Antioxidant Defense. 2. Hormones and Cell Signaling: • Steroid and Peptide Hormones. • Signal Transduction Mechanisms. 3. Metabolic Disorders and Diseases of Civilization: • Diabetes - Biochemical Aspects and Consequences. • Obesity and Metabolic Syndrome. 4. Carcinogenesis and Cellular Metabolism: • Metabolic Changes in Cancer Cells. • The Importance of Biochemistry in Clinical Oncology. • Vitamins and Microelements: • Water- and Fat-Soluble Vitamins. • Deficiencies and Their Clinical Consequences.	Lecture	K6, K7, K8

5	1. Organizational classes – principles of work in a biochemical laboratory, exercise regulations, health and safety regulations. 2. Water and aqueous solutions – the effect of polarity on solubility, pH measurement of various solutions. 3. Buffer solutions and pH indicators – preparation of buffer solutions, determination of their buffer capacity, operation of pH indicators. 4. Oxidation and reduction reactions in biological systems – redox potential, the effect of pH on the course of the reaction, application of redox indicators. 5. Organic compounds in biochemistry – identification and basic characteristic reactions of alcohols, phenols, aldehydes and ketones (Tollens test, Fehling test, iodoform reaction). 6. Amino acids, peptides and proteins – characteristic reactions of amino acids (ninhydrin, biuret), the effect of physicochemical factors on protein denaturation. 7. Enzymes and their properties – the effect of pH, temperature and inhibitors on enzymatic activity, determination of enzyme activity by spectrophotometric method (e.g. amylase, catalase). 8. Carbohydrate metabolism – characteristic reactions of simple and complex sugars (Benedict's test, Lugol's test). 9. Lipids in biochemistry – saponification reactions, determination of lipids in various samples, assessment of their solubility. 10. Isolation and analysis of nucleic acids – simple methods of DNA isolation from biological material, agarose gel electrophoresis. 11. Vitamins – identification of selected vitamins using chemical and spectrophotometric methods, assessment of the role of coenzymes. 12. Biochemistry of body fluids – analysis of the biochemical composition of urine or serum, assessment of diagnostic parameters. **13.** Basics of biochemical diagnostics – interpretation of biochemical test results in clinical practice (e.g. glucose, cholesterol, serum protein testing).	Exercise	K2, K3, K4, K5, A1, A2, A3, A4, A5, K1, K2, K3, K4

4. Methods of verifying and assessing the learning outcomes achieved by the student

Winter semester

Form of studies		
Lecture	**Methods of studies form:**	
	Lecture, Discussion	
	Methods of verification:	**Involvement:**
	Written exam	100%
	Conditions for passing the course:	
	The condition for taking the exam is passing the tutorials. The condition for passing the lecture is obtaining at least 60% of the number of points that are to be obtained in the exam.	

Exercise	**Methods of studies form:**	
	Laboratory exercise, Discussion, Showcase, Math exercise, Group work	
	Methods of verification:	**Involvement:**
	Test	50%
	Report	20%
	Observation	10%
	Entrance test	20%
	Conditions for passing the course:	
	Passing the entrance exams. Submitting and passing the reports on the exercises performed. Obtaining at least 60% of the total number of points for the tests (three tests).	

Learning outcomes	**Methods of verification**				
	Written exam	Report	Entrance test	Test	Observation
K1	X	X	X	X	
K2	X	X	X	X	
K3	X	X	X	X	
K4	X	X	X	X	
K5	X	X	X	X	
K6	X	X	X	X	
K7	X	X	X	X	
K8	X	X	X	X	
K9	x	X	x	X	
A1		X			X
A2		X			X
A3		X			X
A4		X			X
A5					X
S1					X
S2					X
S3					X
S4					X

5. Student workload – balance of hours and ECTS credits

Students activity		**Student workload Number of hours**
Classes conducted with the direct participation of an academic teacher or other persons conducting classes	Lecture	60
	Exercise	60
Student's own work	Preparing for classes	20
	Studying literature	25
	Preparing a report	15
	Preparing for an exam	25
	Preparing for a test	20
Total student workload		225
ECTS		9

One (teaching) hour is 45 minutes.

6. Literature

The list of required and recommended literature will be provided by the lecturer at the first meeting.