

Biochemistry with Elements of Chemistry

Educational subject description sheet

Basic information

Department Faculty of Medicine Field of study Medical Program Study level long-cycle master's degree program Study form full-time Education profile general academic Disciplines Medical science Subject related to scientific research Yes		Didactic cycle 2016/17 Realization year 2016/17, 2017/18 Lecture languages English Block obligatory for passing in the course of studies Mandatory obligatory Examination examination Standard group B. Scientific basics of medicine
Subject coordinator	Barbara Piekarska	
Lecturer	Barbara Piekarska, Maria Wróbel, Piotr Laidler, Halina Jurkowska, Dorota Ciołczyk-Wierzbicka, Joanna Dulińska-Litewka, Anna Bentke, Dorota Gil, Kinga Kocemba-Pilarczyk, Marta Kaczor-Kamińska, Kinga Kaszuba, Barbara Ostrowska, Barbara Stopa, Monika Piwowar, Mateusz Banach	

Period Semester 1	Examination - Activities and hours seminar: 12, laboratory: 23, lecture: 24	Number of ECTS points 0.0
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Period Semester 2	Examination credit Activities and hours seminar: 20, laboratory: 19, lecture: 18	Number of ECTS points 7.0
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Period Semester 3	Examination examination Activities and hours seminar: 28, laboratory: 12, lecture: 34	Number of ECTS points 6.0
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Goals

C1	To provide students with the knowlegde about basic biochemical processes and the molecular basis of life in order to understand physiological and pathological phenomena learned during the studies.
C2	To familiarize students with basic biochemical laboratory techniques, the analysis of quantitative data and using modern sources of information (databases).
C3	To provide students with the skills for searching and selecting useful information concerning the biochemical basis of physiological and pathological processes

Subject's learning outcomes

Code	Outcomes in terms of	Effects	Examination methods
Knowledge - Student knows and understands:			
W1	water and electrolyte management in biological systems	B.W1	oral answer, test, gap filling test, multiple choice test
W2	acid-base balance and buffer mechanism, and their importance in systemic homeostasis	B.W2	oral answer, assignment report, test, gap filling test, multiple choice test
W3	terms: solubility, osmotic pressure, isotonia, colloidal solutions and Gibbs-Donnan equilibrium	B.W3	oral answer, test, gap filling test, multiple choice test
W4	basic reactions of inorganic and organic compounds in aqueous solutions	B.W4	oral answer, assignment report, test, gap filling test, multiple choice test
W5	structure of simple organic compounds included in macromolecules present in cells, extracellular matrix and body fluids	B.W10	oral answer, test, gap filling test, multiple choice test
W6	structure of lipids and polysaccharides and their functions in cellular and extracellular structures	B.W11	oral answer, test, gap filling test, multiple choice test
W7	primary, secondary, tertiary and quaternary structure of proteins, as well as post-translational and functional modifications of proteins and their importance	B.W12	oral answer, assignment report, test, gap filling test, multiple choice test
W8	nucleotide functions in the cell, primary and secondary DNA and RNA structures and chromatin structure	B.W13	oral answer, test, gap filling test, multiple choice test
W9	functions of the genome, transcriptome and human proteome, and basic methods used in their examination, processes of DNA replication, repair and recombination, transcription and translation and degradation of DNA, RNA and proteins, as well as concepts for regulation of gene expression	B.W14	oral answer, assignment report, test, gap filling test, multiple choice test

W10	basic catabolic and anabolic pathways, ways of regulating them, and the influence of genetic and environmental factors on them	B.W15	oral answer, assignment report, test, gap filling test, multiple choice test
W11	metabolic profiles of basic organs and systems	B.W16	oral answer, test, gap filling test, multiple choice test
W12	methods of intercellular communication, as well as between the cell and the extracellular matrix, and signal pathways in the cell, and examples of disorders in these processes leading to the development of cancer and other diseases	B.W17	oral answer, test, gap filling test, multiple choice test
W13	processes: cell cycle, cell proliferation, differentiation and aging, apoptosis and necrosis and their importance for the functioning of the body	B.W18	oral answer, test, gap filling test, multiple choice test
W14	principles of conducting scientific, observational and experimental studies and in vitro studies for the development of medicine	B.W29	oral answer, test, gap filling test, multiple choice test
W15	biochemical fundamentals of xenobiotic metabolic processes	B.W32	oral answer, test, gap filling test, multiple choice test
Skills - Student can:			
U1	calculate the molar and percentage concentrations of compounds and the concentrations of substances in isoosmotic, mono- and multicomponent solutions	B.U3	oral answer, assignment report, test
U2	calculate the solubility of inorganic compounds, determine the chemical background to the solubility or absence of organic compounds and its practical importance for dietetics and therapy	B.U4	oral answer, assignment report, test
U3	determine the pH of the solution and the effect of changes in pH on inorganic and organic compounds	B.U5	oral answer, assignment report, multiple choice test
U4	predict the direction of biochemical processes depending on the energetic state of cells	B.U6	oral answer, assignment report, multiple choice test
U5	use basic laboratory techniques such as qualitative analysis, titration, colorimetry, pH-metry, chromatography, electrophoresis of proteins and nucleic acids	B.U8	assignment report
U6	use databases, including online databases, and search for the necessary information using the available tools	B.U10	oral answer, assignment report
U7	use on-line databases of the human genome	B.U23	oral answer, assignment report
U8	operate simple measuring instruments and evaluate the accuracy of measurements made	B.U9	assignment report
U9	plan and perform simple scientific research and interpret its results and draw conclusions	B.U13	assignment report
Social competences - Student is ready to:			
K1	perceive and recognize own limitations and self-assessing educational deficits and needs	O.K5	oral answer
K2	use objective sources of information	O.K7	oral answer

K3	formulate conclusions from own measurements or observations	O.K8	oral answer, assignment report
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Calculation of ECTS points

Semester 1

Activity form	Activity hours*
seminar	12
laboratory	23
lecture	24
preparation for classes	25
preparation for test	25
Student workload	Hours 109
Workload involving teacher	Hours 59
Practical workload	Hours 23

* hour means 45 minutes

Semester 2

Activity form	Activity hours*
seminar	20
laboratory	19
lecture	18
preparation for test	30
preparation for classes	30
Student workload	Hours 117
Workload involving teacher	Hours 57
Practical workload	Hours 19

* hour means 45 minutes

Semester 3

Activity form	Activity hours*
seminar	28
laboratory	12
lecture	34
preparation for examination	85
preparation for classes	40
preparation for test	45
preparation of multimedia presentation	5
information collection	5
Student workload	Hours 254
Workload involving teacher	Hours 74
Practical workload	Hours 12

* hour means 45 minutes

Study content

No.	Course content	Subject's learning outcomes	Activities
1.	Types of chemical bonds. Organization of macromolecules. The importance of weak interactions. Chemical reactions in solutions. Steady state. Electrolytic dissociation, the ionic product of water, solubility equilibrium, pH of acids and bases solutions. Buffer mixtures. The role of physiological buffers. Equilibria in ligand- protein binding - ligand saturation, dissociation constants of complexes. Colligative properties of solutions. Osmosis. Osmotic and oncotic pressure. Colloidal solutions. Elements of thermodynamics and chemical kinetics. Concepts: internal energy of the system, entropy, free enthalpy. Rate constant of the reaction. Activation energy. Catalysis. Redox reactions, Standard and biological reduction potentials:	W1, W2, W3, W4, W5, U1, U2, U3, U4, U5, U8, K2, K3	seminar, laboratory

2.	Basic concepts in organic chemistry. Types of isomerism. Aromatic rule. Derivatives of hydrocarbons: alcohols, thiols, phenols, aldehydes, ketones (reactions of their oxidation and reduction). Keto-enol tautomerism. Biologically important carboxylic acids and their derivatives. Hydroxy and keto acids. Active derivatives of carboxylic acids. Transfer Potential. Biological phosphorylation reactions - the role of ATP. Lipids - classification, properties.	W4, W5, W6, U4, K2	seminar
3.	Carbohydrates - classification, nomenclature, stereo-isomerism, reducing properties. Formation of O- and N-glycosides, esterification, formation of amino sugars. Di-, oligo- and polysaccharides. Heteroglycans. Amines and amides. Heterocyclic compounds. Bases found in DNA and RNA. Nucleosides and nucleotides. Reactions of amines with nitric acid (III). Carbonic acid amides - carbamates, urea.	W4, W5, W6, W8, K2	seminar
4.	Amino acids - classification. Peptides - peptide unit structure. Calculation of pI values of amino acids and peptides. Proteins - structure, physicochemical properties. Globular proteins. Myoglobin and hemoglobin - structure and function. Fibrous proteins (collagen, keratin). Plasma proteins.	W5, W7, U3, U5, U8, K2, K3	seminar, laboratory, lecture
5.	Enzymes. Specificity and catalytic efficiency. Kinetics of the enzymatic reaction. Enzyme classes. Coenzymes (the role of vitamins). Regulation of activity (allosteric enzymes). Examples of the mechanism of enzyme action. The role of enzymes in diagnostics. Enzyme inhibitors.	W10, W7, U5, U8, U9, K2, K3	seminar, laboratory, lecture
6.	Fundamentals of bioenergetics. The role of ATP. Anabolism and catabolism. Respiratory chain, oxidative phosphorylation. Krebs cycle. Reactive oxygen species - formation in the body, effects, methods of disposal.	W10, W4, U4, U5, U8, U9, K2, K3	seminar, laboratory, lecture
7.	Carbohydrate digestion and absorption. Glycolysis. Substrate-level phosphorylation. Pentose phosphate pathway. Glycogen metabolism. Gluconeogenesis. Fructose and galactose metabolism. Coordination of carbohydrate metabolism at the body level. Glucose homeostasis and its disorders.	W10, W5, W6, U4, U5, K2, K3	seminar, laboratory, lecture
8.	Digestion, absorption and transport of lipids. Lipases. Plasma lipoproteins (types, metabolism, role). Oxidation of fatty acids. Synthesis and role of ketone bodies. Synthesis of saturated and unsaturated fatty acids. Lipid synthesis. Intracellular degradation of complex lipids. Synthesis of cholesterol and its derivatives (bile acids, hormones). Eicosanoid metabolism.	W10, W5, W6, K1, K2	seminar, lecture

9.	Protein digestion. Absorption and fate of amino acids. Protein nitrogen removal. Urea synthesis. Ammonia toxicity. Gluco and ketogenic amino acids. Degradation of selected amino acids and synthesis of endogenous amino acids. The role of one-carbon fragments and transmethylation in the metabolism of amino acids and their derivatives. Conversion of phenylalanine and tyrosine. Metabolism of nitrogen compounds derived from the amino acids: heme, creatine, adrenalin, serotonin. Biosynthesis and degradation of purine and pyrimidine nucleotides.	W10, W11, K2	seminar, lecture
10.	Nucleic acids: the structure and physico-chemical properties of DNA and RNA. Replication. Mutations and DNA repair mechanisms. Transcription and post-transcriptional modifications. Translation. Post-translational modifications and protein sorting. Cellular protein degradation. Basic methods of molecular biology (PCR, gene expression analysis - RT-PCR, DNA electrophoresis, hybridization).	W8, W9, U5, U6, U7, U8, U9, K1, K2, K3	seminar, laboratory, lecture
11.	Biochemistry of detoxification processes. The role of cytochromes P450, coupling reactions. Metabolism of ethanol.	W11, W15, K2	seminar, lecture
12.	Basic concepts of signal transduction. Membrane and nuclear receptors. Signaling cascades of cell cycle regulation. Cellular transformation in tumor development: morphological features and metabolism of the tumor cell. Oncogenes, suppressor genes. Signal transduction disorders. Invasion and metastasis of cancer. Apoptosis.	W10, W12, W13, W14, W9, K2	seminar, lecture
13.	Integration and coordination of metabolic changes. Energy metabolism of various tissues - after meals, during fasting and starvation. Hormonal regulation of metabolism at the cell and body levels. Metabolic syndrome.	W10, W11, W12, U4, K1, K2	seminar, lecture

Course advanced

Semester 1

Teaching methods:

computer classes, laboratories (labs), lecture

Activities	Examination methods	Credit conditions
seminar	written examination, oral answer, gap filling test, multiple choice test	At the end of seminars students will be subjected to a closing test. Midterm exams, multiple choice test as final exam. Attendance at seminars is obligatory. Maximum one excused (doctors leave) absence is allowed.
laboratory	oral answer, assignment report, gap filling test, multiple choice test	Attendance at labs is obligatory. Maximum one excused (doctors leave) absence is allowed. Theoretical basis of the labs is included into midterm and final exams. 60% of possible points from quizzes (at the beginning of each lab) and for lab reports are required to get credit for the laboratories.
lecture	multiple choice test	Attendance is obligatory and will be monitored. Midterm exams, multiple choice test as final exam

Semester 2

Teaching methods:

computer classes, laboratories (labs), lecture

Activities	Examination methods	Credit conditions
seminar	oral answer, gap filling test, multiple choice test	At the end of seminars students will be subjected to a closing test. Midterm exams, multiple choice test as final exam. Attendance at seminars is obligatory. Maximum one excused (doctors leave) absence is allowed.
laboratory	oral answer, assignment report, gap filling test, multiple choice test	Attendance at labs is obligatory. Maximum one excused (doctors leave) absence is allowed. Theoretical basis of the labs is included into midterm and final exams. 60% of possible points from quizzes (at the beginning of each lab) and for lab reports are required to get credit for the laboratories.
lecture	multiple choice test	Attendance is obligatory and will be monitored. Midterm exams, multiple choice test as final exam.

Semester 3

Teaching methods:

case study, laboratories (labs), discussion, presentation, seminar, lecture, lecture with multimedia presentation

Activities	Examination methods	Credit conditions
seminar	oral answer, gap filling test, multiple choice test	At the end of seminars students will be subjected to a closing test. Midterm exams, multiple choice test as final exam. Attendance at seminars is obligatory. Maximum one excused (doctors leave) absence is allowed.
laboratory	oral answer, assignment report, test, gap filling test	Attendance at labs is obligatory. Maximum one excused (doctors leave) absence is allowed. Theoretical basis of the labs is included into midterm and final exams. 60% of possible points from quizzes (at the beginning of each lab) and for lab reports are required to get credit for the laboratories.
lecture	test	Attendance is obligatory and will be monitored. Midterm exams, multiple choice test as final exam

Additional info

The Students knowledge acquisition in Part I of the Course (semester I and II) will be checked by 3 midterm exams. These midterm exams will be consisting of 40-50 questions each (first midterm will also include open questions -calculations). To get credit for the First part fo the Course students must collect minimum 60% of possible points for the seminars and midterm tests, and also get credit for the labs. Additional test will be organized for students who do not fulfill this requirement - students who receive minimum 60% will receive credit. Only students who get credit for Part I will be allowed to take Part II of the Biochemistry with elements of Chemistry course. Two midterm exams will be organized in part II of the course - 40 -50 questions each. To get credit for the second part fo the Course students must collect minimum 60% of possible points for the seminars and midterm tests, and also get credit for the labs. The Final Biochemistry with Elements of Chemistry exam consists of 80-100 multiple choice questions from the entire course with passing threshold at 60%. Final exam grading: > 85% - very good; 81-84% - good plus; 76-80% - good; 71-75% - satisfactory plus; 60-70% - satisfactory. The detailed course rules will be sent to the students before the beginning of the course.

Entry requirements

Literature

Obligatory

1. Marks' Basic Medical Biochemistry: A Clinical Approach, Lieberman, Peet, 2012, 5th ed., Walters-Kluwer (1st and 2nd year)
2. BIOCHEMISTRY LABORATORY, Jagiellonian University Press, 2014 (Biochemistry with elements of chemistry course) (1st and 2nd year)

Optional

1. Harper's Illustrated Biochemistry, Rodwell, Bender, Botham, Kennely, Weil, 31th edition (2013), McGraw-Hill (1st and 2nd year)
2. General Chemistry. Principles & Structure, James E. Brady, 2009, John Wiley & Sons (1st year)
3. Lippincott's Illustrated Reviews: Biochemistry, Ferrier, 7th ed., 2012 Walters-Kluwer (1st and 2nd year)
4. Chemistry for the Biosciences, Crowe, Bradshaw, 2014, 3rd ed., Oxford University Press (1st year)

Standard effects

Code	Content
B.U3	calculate the molar and percentage concentrations of compounds and the concentrations of substances in isoosmotic, mono- and multicomponent solutions
B.U4	calculate the solubility of inorganic compounds, determine the chemical background to the solubility or absence of organic compounds and its practical importance for dietetics and therapy
B.U5	determine the pH of the solution and the effect of changes in pH on inorganic and organic compounds
B.U6	predict the direction of biochemical processes depending on the energetic state of cells
B.U8	use basic laboratory techniques such as qualitative analysis, titration, colorimetry, pH-metry, chromatography, electrophoresis of proteins and nucleic acids
B.U9	operate simple measuring instruments and evaluate the accuracy of measurements made
B.U10	use databases, including online databases, and search for the necessary information using the available tools
B.U13	plan and perform simple scientific research and interpret its results and draw conclusions
B.U23	use on-line databases of the human genome
B.W1	water and electrolyte management in biological systems
B.W2	acid-base balance and buffer mechanism, and their importance in systemic homeostasis
B.W3	terms: solubility, osmotic pressure, isotonia, colloidal solutions and Gibbs-Donnan equilibrium
B.W4	basic reactions of inorganic and organic compounds in aqueous solutions
B.W10	structure of simple organic compounds included in macromolecules present in cells, extracellular matrix and body fluids
B.W11	structure of lipids and polysaccharides and their functions in cellular and extracellular structures
B.W12	primary, secondary, tertiary and quaternary structure of proteins, as well as post-translational and functional modifications of proteins and their importance
B.W13	nucleotide functions in the cell, primary and secondary DNA and RNA structures and chromatin structure
B.W14	functions of the genome, transcriptome and human proteome, and basic methods used in their examination, processes of DNA replication, repair and recombination, transcription and translation and degradation of DNA, RNA and proteins, as well as concepts for regulation of gene expression
B.W15	basic catabolic and anabolic pathways, ways of regulating them, and the influence of genetic and environmental factors on them
B.W16	metabolic profiles of basic organs and systems
B.W17	methods of intercellular communication, as well as between the cell and the extracellular matrix, and signal pathways in the cell, and examples of disorders in these processes leading to the development of cancer and other diseases
B.W18	processes: cell cycle, cell proliferation, differentiation and aging, apoptosis and necrosis and their importance for the functioning of the body
B.W29	principles of conducting scientific, observational and experimental studies and in vitro studies for the development of medicine
B.W32	biochemical fundamentals of xenobiotic metabolic processes
O.K5	perceive and recognize own limitations and self-assessing educational deficits and needs
O.K7	use objective sources of information
O.K8	formulate conclusions from own measurements or observations