Appendix number 1.5 to The Rector UR Resolution No. *12/2019*

SYLLABUS

concerning the cycle of education 2018-2024
(date range)

Academic year 2018/2019

1. BASIC INFORMATION CONCERNING THIS SUBJECT

Subject	**Biochemistry**
Course code *	**BCh/B**
Faculty of (name of the leading direction)	**College of Medical Sciences, University of Rzeszów**
Department Name	**Department of Biochemistry and General Chemistry**
Field of study	**medical direction**
level of education	**Uniform master studies**
Profile	**Genaeral academic**
Form of study	**Stationary/ non- stationary**
Year and semester	**Year I, II semester: II, III**
Type of course	**Obligatory**
Language	**English**
Coordinator	**Dr hab. n.med. David Aebisher, Prof UR**
First and Last Name of the Teachers	**Dr hab. n.med. David Aebisher, Prof UR**

*** - According to the resolutions of Educational Unit**

1.1. Forms of classes, number of hours and ECTS

Semester No.	Lecture	Exercise	Conversation	Laboratory	Seminar	ZP	Praktical	Other	**Number of points ECTS**
II	30	30	-	-	20	-	-	-	6
III	30	30	-	-	20	-	-	-	6

1.2. The form of class activities

☒ classes are in the traditional form

☐ classes are implemented using methods and techniques of distance learning

1.3 Examination Forms (**exam**, credit with grade or credit without grade)

2.BASIC REQUIREMENTS

Completed I semester of the course in biochemistry with elements of chemistry.

3. OBJECTIVES, OUTCOMES, AND PROGRAM CONTENT USED IN TEACHING

METHODS 3.1 Objectives of this course

C1	Understanding chemical equilibria, kinetics and chemical thermodynamics in aqueous solutions
C2	Knowledge of the chemical formulas of amino acids, carbohydrates and lipids of physiological significance and the ability to use them, including records of metabolic changes
C3	Ability to use laboratory equipment, perform chemical and biochemical experiments according to the procedures described in the instructions for laboratory exercises
C4	Ability to use metabolic transformation patterns (pathways) in the field of protein synthesis and degradation, carbohydrate, fat and fatty acid metabolic pathways, along with regulation and its disorders
C5	Knowledge and understanding of the flow of genetic information, knowledge of genetic diseases
C6	Understanding the mechanisms of homeostasis at the cell, organ and body level
C7	Ability to conduct biomolecule analysis by electrophoretic methods and selected outpatient blood and urine analyzes

3.2 OUTCOMES FOR THE COURSE

EK (learning effect)	Content of the learning effect defined for the subject	Reference to directional effects [1]
EK_01	The student knows and understands the acid-base balance and mechanism of action of buffers and their importance in systemic homeostasis;	B.W2
EK_02	The student knows and understands the concepts of solubility, osmotic pressure, isotonic solutions, colloidal solutions and Gibbs-Donnan equilibrium;	B.W3
EK_03	The student knows and understands the mechanisms of cellular metabolism	B.W4
EK_04	The student knows and understands the structure of simple organic compounds that are part of macromolecules present in cells, extracellular matrix and	B.W10

[1] In the case of a path of education leading to obtaining teaching qualifications, also take into account the learning outcomes of the standards of education preparing for the teaching profession.

	body fluids;	
EK_05	The student knows and understands the structure of lipids and polysaccharides and their functions in cellular and extracellular structures;	B.W11
EK_06	The student knows and understands the I-, II-, III- and IV-order structures of proteins as well as post-translational and functional modifications of proteins and their meaning;	B.W12
EK_07	The student knows and understands the functions of nucleotides in the cell, the structure of primary and secondary DNA and RNA, and the structure of chromatin;	B.W13
EK_08	The student knows and understands the basic catabolic and anabolic pathways, ways of their regulation and the influence of genetic and environmental factors on them;	B.W15
EK_09	The student knows and understands metabolic profiles of basic organs and systems;	B.W16
EK_10	The student knows and understands the consequences of vitamin or mineral deficiency and excess in the body;	C.W48
EK_11	The student knows and understands the mechanism of hormones;	C.W51
EK_12	Student is able to calculate molar and percentage compounds and substance concentrations in iso-osmotic, single and multi-component solutions;	B.U3
EK_13	Student is able to calculate the solubility of inorganic compounds, determine the chemical basis of the solubility of organic compounds or its absence and its practical importance for dietetics and therapy;	B.U4
EK_14	Student is able to determine the pH of the solution and the impact of pH changes on inorganic and organic compounds;	B.U5
EK_15	Student is able to predict the direction of biochemical processes depending on the energy state of cells;	B.U6
EK_16	The student is able to use the basic laboratory techniques, such as qualitative analysis, titration, colorimetry, pH measurement, chromatography, electrophoresis of proteins and nucleic acids;	B.U8
EK_17	The student is able to operate simple measuring instruments and assess the accuracy of measurements;	B.U9

EK_18	The student is ready to see and recognize their own limitations and to make self-assessments of educational deficits and needs;	K.05
EK_19	Student jest gotów do korzystania z obiektywnych źródeł informacji;	K.07
EK_20	The student is ready to use objective sources of information;	K.08
EK_21	The student is ready to accept the responsibility associated with decisions taken as part of his professional activity, including in terms of his own safety and the safety of others.	K.11

3.3 CONTENT CURRICULUM

A. Problems of the lecture

Semester 1

Course contents	Hours
1. Water and pH, overview of organic chemistry, covalent vs ionic bonds, VSEPR model	
2. Amino acids and the peptide bond, primary and higher protein structures	
3. Myoglobin and hemoglobin	
4. Enzymes: mechanism of action	
5. Enzyme kinetics	
6. Enzyme regulation of Activities / Transition metals	
7. Bioenergetics: role of ATP	
8. Bioenergetics: role of ATP	
9. Biological oxidation/Respiratory chain and oxidative phosphorylation	
10. Overview of metabolism/carbohydrates	
11. The citric acid cycle	
12. Glycolysis and Oxidation of pyruvate	
13. Metabolism of glycogen/gluconeogenesis	
14. Pentose phosphate pathway	
15. Lipids of physiological significance	

Semester 2

Course contents	Hours
1. Lipid metabolism part 1 (ketogenesis, biosynthesis, metabolism)	
2. Lipid metabolism part 2 (storage, cholesterol synthesis, transport and excretion)	
3. Metabolism of proteins and amino acids part 1 (biosynthesis, catabolism, conversion, porphyrins and bile pigments)	
4. Nucleotides/metabolism of purine/pyrimidine	
5. Nucleic acids/DNA replication	

6. RNA synthesis and modification	
7. Protein synthesis	
8. Regulation of gene expression	
9. Special topics: membranes	
10. Endocrine system	
11. Hormonal action and signal transduction	
12. Nutrition/micronutrients	
13. Glycoproteins	
14. Clinical Biochemistry part 1	
15. Clinical Biochemistry part 2	

A. Problems of tutorials, seminars, laboratories and practical classes

COURSE CONTENTS - SEMESTER 2
DEMONSTRATION AND EXERCISE CLASSES. WORK SAFETY IN A CHEMICAL AND BIOCHEMICAL LABORATORY (1 HOUR). DEMONSTRATION OF LABORATORY GLASS AND ITS USE, BURNER OPERATION, CENTRIFUGE, PH METER, PIPETTING TECHNIQUES. CHEMICAL COMPOUNDS AND SOLUTIONS
HARDLY SOLUBLE COMPOUNDS AND THEIR PROPERTIES AS WELL AS COMPLEX IONS
OXIDATION REACTIONS - REDUCTION.
SOLUTIONS: WEIGHING AND VOLUME MEASURING OPERATIONS. PREPARATION OF AQUEOUS SOLUTIONS OF SALTS, ACIDS AND BASES.
BUFFER SOLUTIONS AND ALKACIMETRIC INDICATORS
SOLUTIONS, MIXTURES AND THEIR PROPERTIES.
ORGANIC COMPOUNDS - SYNTHESIS AND IDENTIFICATION REACTIONS. ELECTROLYTE CONDUCTIVITY.
ALKACIMETRIC TITRATION
. CHEMICAL EQUILIBRIUM - ALKACIMETRIC INDEX EQUILIBRIUM CONSTANT - PKIND
CHEMICAL EQUILIBRIUM - ALKACIMETRIC INDEX EQUILIBRIUM CONSTANT - PKIND

COURSE CONTENTS - SEMESTER 3
DETERMINATION OF TOTAL AND HDL CHOLESTEROL AND TRIGLYCERIDES
LIPID ANALYSIS
ISOLATION, PURIFICATION AND QUANTIFICATION OF SERUM PROTEINS. AGAROSE GEL CHROMATOGRAPHY
SUGAR REACTIONS AND PROPERTIES
DETERMINATION OF BLOOD GLUCOSE.
DETERMINATION OF GLUTATHIONE CONCENTRATION IN ANIMAL MATERIAL.
DETERMINATION OF CREATININE AND BILURUBIN.
THIN-LAYER AND COLUMN AMINO ACID CHROMATOGRAPHY. CHARACTERISTIC REACTIONS OF AMINO ACIDS.
DETERMINATION OF ENZYME ACTIVITY.

A. SEMINARS

COURSE CONTENTS - SEMESTER 3
Elements building blocks of living matter (macroelements) and elements present in small and trace amounts (microelements). Calculation of molecular weights of compounds based on summary formulas. Content of sodium and potassium ions in body fluids. Units expressing concentration
EXERCISES IN CALCULATING THE MOLAR CONCENTRATION (AND DERIVATIVES) OF A COMPOUND IN AQUEOUS SOLUTION, DILUTION, AND EXERCISES IN CALCULATING THE MASS OF THE COMPOUND (OR / AND ION) CONTAINED IN A SOLUTION OF KNOWN CONCENTRATION.
EXERCISES IN DETERMINING THE FORMAL DEGREE OF CARBON OXIDATION IN COMPOUNDS CONSISTING OF C, H, O (ETHANE; ETHANOL; ACETALDEHYDE; ACETIC ACID; CARBON DIOXIDE). EXERCISES IN DETERMINING THE TYPE OF BOND BETWEEN ATOMS OF ELEMENTS WITH DIFFERENT ELECTRONEGATIVITY
ORGANIC COMPOUNDS: SATURATED, UNSATURATED AND AROMATIC HYDROCARBONS. ALCOHOLS, ALDEHYDES, CARBOXYLIC ACIDS. AMINES AND AMIDES. AMINO ACIDS - EQUILIBRIA IN AMINO ACID SOLUTIONS

CALCULATION OF THE BUFFER SOLUTION COMPOSITION AT THE SET PH VALUE. BUFFERS IN THE HUMAN BODY: CARBONATE BUFFER, PROTEIN BUFFERING CAPACITY
CRITERION OF REACTION SPONTANEITY. RELATIONSHIP BETWEEN REACTION EQUILIBRIUM CONSTANT AND FREE ENTHALPY.
ELECTROCHEMICAL POTENTIAL. SUPPLEMENTARY CONTENT OF THE LECTURE: PASSIVE AND ACTIVE TRANSPORT THROUGH MEMBRANES.
PARTIAL TEST 1
PROTEIN METABOLISM. PROTEIN FUNCTIONS. PKA VALUES OF AMINO ACIDS AND AMINO ACID FUNCTIONAL GROUPS IN THE PROTEIN STRUCTURE.
ACTIVE ENZYME CENTERS AND REGULATION OF ENZYMATIC ACTIVITY. INHIBITORS AND ENZYME ACTIVATORS
SUPPLEMENTARY CONTENT LECTURE: TRANSFORMATION OF AMINO ACIDS INTO SPECIALIZED PRODUCTS
PARTIAL TEST 2
BIOENERGETICS: GLYCOLYSIS, KREBS CYCLE, PENTOSE PHOSPHATE PATHWAY
FAT AND FATTY ACID METABOLISM
SUPPLEMENTARY CONTENT LECTURE: SYNTHESIS, TRANSPORT AND EXCRETION OF CHOLESTEROL
PARTIAL TEST 3

COURSE CONTENTS - SEMESTER 3
PROTEIN SYNTHESIS AND GENETIC CODE.
Supplement: Recombinant DNA techniques
REGULATION OF GENE EXPRESSION.

PARTIAL TEST 1
MEMBRANES: STRUCTURE AND FUNCTIONS.
Hormonal effects and signal transduction
ENDOCRINE SYSTEM. HORMONAL EFFECTS AND SIGNAL TRANSDUCTION.
Partial test 2
NUTRITION, DIGESTION AND ABSORPTION.
ROLES OF GLYCOPROTEINS, PLASMA PROTEINS, CELL MEMBRANES AND BLOOD GROUP SUBSTANCES
EXTRACELLULAR SUBSTANCES. BIOCHEMISTRY OF SMOOTH AND STRIATED MUSCLE CONTRACTION. THE ROLE OF ACTIN AND MYOSIN, THE CONTRIBUTION OF CA2 + AND ATP IONS IN MUSCLE CONTRACTION.
Partial test 3

3.4 Didactic methods

Lecture: problem lecture, lecture with multimedia presentation, distance learning methods

Seminar: text analysis with discussion, project method (research, implementation, practical project), group work (task solving, discussion), didactic games, distance learning methods **Exercise**: performing experiments, designing experiments.

4. METHODS AND EVALUATION CRITERIA

4.1 Methods of verification of learning outcomes

Symbol of effect	Methods of assessment of learning outcomes (Eg.: tests, oral exams, written exams, project reports, observations during classes)	Form of classes
EK_ 01-EK_11	WRITTEN TEST, EXAM	L., SEM.
EK_ 12-EK_20	PRELIMINARY AND FINAL COLLOQUIUM, REPORT AND OBSERVATION DURING CLASSES	EXERCISE,
EK_17-EK20	OBSERVATION DURING CLASSES	SEM.

4.2 Conditions for completing the course (evaluation criteria)

Semester 2

Lecture: Credit based on attendance. The course ends with an exam after a one-year course.

Seminar: Assessment based on written colloquia (3). The subject is passed, when all three tests are positive. The student has the right to one correction date for each of the tests. In the event of failing one of the colloquiums twice, the student may proceed to the semester colloquium from the entire scope of material covered in this semester. Correction dates from the semester test are not foreseen. In the event of failing more than one partial test, the student will not pass the semester. In order to verify the student's preparation for a given seminar, the lecturer will conduct introductory colloquia on current topics. Failure to complete the initial test results in the obligation to do the homework and pass the initial test with another group.

Exercises: Block A exercises are performed by all students in the same classes.

Exercises of block B are performed in groups of two to three people in a rotational system (4 exercises in block B). Exercises in block C are performed in groups of two to three people in a rotational system (4 exercises in block C).

Each student must complete all exercises. The condition of starting the exercise is a short preliminary test, checking the theoretical knowledge related to the experiment.

The exercise is confirmed by passing on the basis of the results table and the report passed by the teacher.

Classes end with a final test covering all the content discussed during the classes (1 hour).

The condition of getting credit for laboratory exercises is to perform all the experiments contained in the program, describe the results with conclusions in a positively evaluated report and pass the final test. Exercise grade is the average of partial grades from: preliminary test (kw), final test (kk), performance and report (sp) of the exercise calculated according to the formula:

$$OK = 0{,}2 \times kw + 0{,}1 \times sp + 0{,}7 \times kk$$

Semester 3

Lecture: Credit based on attendance. The course ends with an exam after a one-year course.

Seminar: Assessment based on written colloquia (3). The subject is passed, when all three tests are positive. The student has the right to one correction date for each of the tests. In the event of failing one of the colloquiums twice, the student may proceed to the semester colloquium from the entire scope of material covered in this semester. Correction dates from the semester test are not foreseen. If more than one partial test is not passed, the student fails the semester. In order to verify the student's preparation for a given seminar, the lecturer will

conduct introductory colloquia on current topics. Failure to complete the initial test results in the obligation to do the homework and pass the initial test with another group.

Exercises: The condition of obtaining a credit for laboratory exercises is to perform all the experiments contained in the program, to describe the results and conclusions in a positively evaluated report. Exercise may be preceded by an initial test checking preparation for classes.

Classes end with a final test covering all the content discussed during the classes (1 hour).

The final grade from the exercises is the average of partial grades from: final test, performance and report of the exercise.

EXAM:

The condition of admission to the exam is a positive grade from the seminar (from both semesters) and laboratory exercises (from both semesters) and credit from lectures.

The exam is in writing

Single choice test (80-100 questions, scored 1 point for correct answer). Test duration - 90 minutes.

Students are entitled to two exam dates: date I and resit date.

FINAL ASSESSMENT (OK) of the subject is a weighted average of the average of six grades of colloquium (S) seminar, exam (E) and final grade from laboratory (C) in the proportion:
OK = 0.3 x S + 0.5 x E + 0.2 x COK = 0.4 x S + 0.4 x E + 0.2 x C

Knowledge assessment:

5.0 - shows knowledge of education content at the level of 93% -100%

4.5 - shows knowledge of education content at the level of 85% -92%

4.0 - shows knowledge of education content at the level of 77% -84%

3.5 - shows knowledge of education content at the level of 69% -76%

3.0 - shows knowledge of education content at 60% -68%
2.0 - shows knowledge of education content below 60%

Skill assessment:

3.0- Mastering program content at the basic level, chaotic answers, necessary guidance questions, performing laboratory activities with the help of a teacher.

3.5- Mastering program content at the basic level, systematic answers, requires the help of a teacher. Laboratory activities performed with the help of a teacher, with inadequate performance.

4.0- Mastering program content at the basic level, systematized, independent answers. Solving problems in typical situations, laboratory activities performed independently, quite efficiently, with a small amount of error.

4,5- The scope of presented knowledge exceeds the basic level based on the supplementary literature provided. Solving problems in new and complex situations. Laboratory activities carried out independently, quite efficiently and correctly.

5.0- The scope of presented knowledge goes beyond the basic level based on independently acquired scientific sources of information, laboratory activities carried out independently, efficiently and correctly

5. Total student workload required to achieve the desired result in hours and ECTS credits

Activity	**The average number of hours to complete the activity**
Contact hours (with the teacher) resulting from the study schedule of classes	120
Contact hours (with the teacher) participation in the consultations, exams	8
Non-contact hours - student's own work (preparation for classes, exam, writing a paper, etc.)	172
SUM OF HOURS	180
TOTAL NUMBER OF ECTS	6

** It should be taken into account that 1 ECTS point corresponds to 25-30 hours of total student workload.*

6. TRAINING PRACTICES IN THE SUBJECT

NUMBER OF HOURS	-
RULES AND FORMS OF APPRENTICESHIP	-

7. LITERATURE

Harper's Illustrated Biochemistry

Thirty-First Edition 31st Edition by Victor Rodwell, David Bender, Kathleen Botham, Peter Kennelly, P. Anthony Weil
Class handouts

Acceptance Unit Manager or authorized person