Syllabus of the training module at the university level

Name of the Faculty	School of Medicine in English UJ CM
Name of the unit responsible for training	Chair of Medical Biochemistry UJ CM
Name of module	Biochemistry with Chemistry
Module code	
Language of training	English
Training effects for the module	After completing the student: -has a knowledge of biochemical basis necessary for learning clinical subjects and to understand the key issues of modern medicine. He knows basic laboratory techniques used in biochemistry and molecular biology. **In term of knowledge, the student is able to:** - explain the concepts of solubility, osmotic pressure, izotonia, colloidal solutions and Gibbs-Donnan equilibrium - describe the acid-base equilibrium and mechanism of action of buffers, and the importance of buffers in systemic homeostasis, describes the water and electrolyte balance in biological systems - describe the basic reactions of inorganic and organic compounds in aqueous solutions - describe the structure of the basic groups of organic compounds included in the macromolecules - describe the structure of lipids and polysaccharides and their functions in cellular and extracellular structures **-** characterize primary, secondary, tertiary and quaternary structure of proteins; presents posttranslational modifications of proteins and their role; **-** describe role of the nucleotides in the cell, the structure of DNA and RNA - explain the concept of the genome, transcriptome and the proteome of human and describes the basic methods used in their studying; describes the processes of replication, DNA repair and recombination, transcription and translation, and degradation of DNA, RNA and proteins, explains the concept of gene expressions' regulation - enzymes involved in the digestion of nutrients, digestion products and the transport in blood - describe the basic catabolic and anabolic pathways, explains the mechanisms of the regulation and the impact of genetic and environmental factors on metabolism - compare the metabolic profiles of the basic organs and systems - explain the concepts of the oxidative stress and role of antioxidants - the consequences of inadequate nutrition, including prolonged fasting and over nutrition, - explain the consequences of the lack of vitamins or minerals or their excess ody - explains signal transduction pathways in the cell, and gives examples of

	disorders resulting from defects in signal transduction pathway e.g.: cancer - explain the principles of scientific research leading to the development of medicine **In terms of skills the student is able to:** **-** calculate the molar and percentage concentration of compounds; calculate the concentration of a substance in isotonic solutions: single-and multicomponent - calculate the solubility of inorganic compounds, determine the basis of a chemical solubility of organic compounds, or lack thereof, and practical significance for nutrition and therapy **-** determine the pH of the solution and the effect of changes in pH on inorganic and organic solutions - predict the direction of biochemical processes depending on the energy conditions - predict the consequences of metabolic disorders - use basic laboratory techniques such as titration, spectrophotometry, pH measurement, chromatography, electrophoresis of proteins and nucleic acids, and can handle simple instrumentation and assess the accuracy of measurements **In terms of professionalism the student is able to:** -work in a group -demonstrates the ability to self-education
Type of module (mandatory/facultative)	mandatory
Year of studies	1-6
Semester	1 and 2
Name of the person leading the module	Prof. Maria Wróbel
Name of the person examining or person granting the credit	as above
Realisation	Activities requiring direct participation of academic and student teacher
Prerequisites and additional needs	
Type and number of hours of classes that require direct participation of the academic teacher and students when such activities are provided for such module	Lectures - **78** Seminaries**- 58** Lab exercises **-54**
Number of ECTS	**13**
Balance of ECTS	**Participation in classes 190 hours** incl.: Lectures: **76** Seminaries: **60** Lab exercises: **54** Preparation to the seminaries: **60** Preparation to the lab exercises: **30**

	Preparation to the exam and to the test: **110** hours **Total 390 hours of students' work**
Didactic methods applied	- Lectures - Work in groups - seminars - Lab exercises
Methods for testing and evaluation criteria of learning outcomes achieved by students	Formative tests (assessed in relation to the standard) 1. In terms of knowledge, four written (multiple-choice test, each with 50 questions). 2. During the seminars students are subjected to a closing test (multiple-choice questions or open questions) and prepare a Power Point presentation on a selected topic (evaluated). 3. During the lab exercises each student can get points for a theoretical knowledge, and points for the execution of the experiments and for the report. 4. Final exam in the form of multiple choice questions (100 questions, 5 possible answers).
The form and the conditions for completion of the module, including the rules of admission to the exam, and the form and conditions for completion of the various activities within the scope of the module	Requirements for completing the module is: (1) Attendance to the mandatory classes which shall be a maximum of 2 absences in a semester, including no more than one of the laboratory exercises. (2) Obtain at least 60% of the total number of points that can be gathered from partial tests, seminars, labs and the final exam. The final grade will be determined on the basis of the distribution of results of all students.
Training module content	1. The types of chemical bonds. The organization of macromolecules. The importance of weak interactions. 2. The chemical reactions in solutions. State of equilibrium. Electrolytic dissociation, ionic product of water. Solubility. pH of solutions of acids and bases. Buffer mixtures. The role of physiological buffers. 3. Equilibrium in reactions of binding ligands to proteins - saturation of the ligand, the dissociation constants of the complexes. 4. Properties of colligative solutions. Osmosis. Oncotic and osmotic pressure. Colloidal solutions. 5. Elements of thermodynamics and chemical kinetics. The terms: internal energy, entropy, enthalpy free. The reaction rate constant. Activation energy. Catalysis. 6. Redox reactions. Galvanic cells. Reduction potentials, standard and biological. 7. Basic concepts in organic chemistry. Types of isomerism. The rule of aromaticity. Hydrocarbons: alcohols, thiols, phenols, aldehydes, ketones (for reactions of oxidation and reduction). Keto-enol tautomerism. 8. Carboxylic acids of biological importance, and their derivatives. Hydroxy- and keto acids. The active derivatives of carboxylic acids. The potential transfer. Biological reactions of phosphorylation - the role of ATP. Lipids - classification, properties. 9. Carbohydrates - classification, nomenclature, stereo-isomerism, reducing property. Creating O-and N-glycosides, esterification, the formation of amino sugars. Di-, oligo-and polysaccharides. Heteroglycans. 10. Amines and amides. Heterocyclic compounds. Bases occurring in DNA and RNA. Nucleosides and nucleotides. Reactions of amines with nitrous acid

	(III). Amides of carbonic acid - carbamates, urea. 11. Amino acids - classification. Peptides - the structure of the peptide bond. Calculation of the pI of amino acids and peptides 12. Proteins - structure, physico-chemical properties. Globular proteins. Myoglobin and hemoglobin - the structure and function. Fibril protein (collagen, keratin). Plasma proteins. 13. Enzymes. The specificity and catalytic efficiency. The kinetics of enzymatic reaction. Class of enzymes. Coenzymes (vitamins role). Control of enzyme activity. Examples of the catalytic mechanisms. The importance of enzymes in diagnosis. Enzyme inhibitors. 14. Fundamentals of bioenergetics. Role of ATP. Anabolism and catabolism. Respiratory chain, oxidative phosphorylation. Krebs cycle. Reactive oxygen species - formation in the body, effects, means of disposal. 15. Digestion and absorption of carbohydrates. Glycolysis. Phosphorylation of substrates. Pentose-phosphate pathway. Glycogen metabolism. Gluconeogenesis. Metabolism of fructose and galactose. The regulation of carbohydrate metabolic pathways. Glucose homeostasis. 16. Digestion, absorption and transport of lipids. Lipases. Plasma lipoproteins (types, metabolism, role). Oxidation of fatty acids. Synthesis and the role of ketone bodies. The synthesis of saturated and unsaturated fatty acids. Synthesis of lipids. Intracellular degradation of complex lipids. The synthesis of cholesterol and its derivatives (bile acids, hormones). Eicosanoids metabolism. 17. Digestion of proteins. Absorption and fates of amino acids in a cell. Removal of protein nitrogen. Synthesis of urea. Ammonia toxicity. Glucogenic and ketogenic amino acids. Degradation of selected amino acids and the synthesis of amino acids. The role of one-carbon fragment transport reactions (role of methionine, folate and B12 vitamin). Metabolism of phenylalanine and tyrosine. The metabolism of nitrogenous compounds derived from amino acids: heme, creatinine, adrenaline, serotonin. 18. Biosynthesis and degradation of purine and pyrimidine nucleotides. 19. Nucleic acid structure and physico-chemical properties. Replication. Mutations and DNA repair mechanisms. Transcription and post-transcriptical modifications. Reverse transcription (HIV, structure, cycle and therapy). Translation. Post-translational modifications and protein sorting. The degradation of proteins in the cell. 20. Basic methods of molecular biology (PCR, RT-PCR, DNA electrophoresis, hybridization). 21. Biochemistry of detoxification processes. The role of cytochrome P450 and coupling reactions. Ethanol metabolism and its effects. 22. Basic concepts of signal transduction. Membrane and nuclear receptors. Signaling cascades. 23. Fundamentals of cell cycle regulation. Oncogenic transformation of cells. Oncogenes, tumor suppressor genes. Invasion and metastasis of cancer. 24. Integration and coordination of metabolism. Energy metabolism of different tissues - after meals, between meals, during starvation. Hormonal regulation of metabolism. Metabolic syndrome – biochemical aspects of diabetes, obesity, atherosclerosis.
Basic and supplementary bibliography to complete the module	**see the booklist**
Amount of hours, principles and form of apprenticeship, when the training program provides practice	