

**SYLLABUS of the MODULE (SUBJECT)****General Information**

Module code		Module title	BIOCHEMISTRY
Module type			<i>Obligatory</i>
Faculty			<i>Faculty of Medicine (WL)</i>
Field of study			<i>medicine ( KL )</i>
Major			<i>Not applicable</i>
Level of study			<i>II level/ long-cycle (2J)</i>
Mode of study			<i>full-time studies</i>
Year of study			<i>II</i>
Semester			<i>03/04</i>
ECTS points			
Types of training			<i>170 h: lecture – 20 h, practical classes/lab.- 150 h.</i>
Tutor responsible for the module			<i>Prof. dr hab. n. med. Dariusz Chlubek dclubek@pum.edu.pl</i>
Tutors conducting the subject			<i>Prof. dr hab. n. med. Dariusz Chlubek Dr n.med. Marta Goschorska Dr n.med. Piotr Wieczorek Dr n.med. Janina Zawierta</i>
WWW			<i>www.pum.edu.pl</i>
Language			<i>English</i>

**Detailed information**

<b>Module objectives</b>		<p>The aim of biochemistry is to understand life processes at the molecular level and explanation of the relationship between structure and function of biomolecules in a living organism. This knowledge is fundamental to understanding the role of the various tissues and organs and consequently, the functioning of the whole body in health and disease. It also allows to purposefully respond to the appearance of pathological processes through the implementation of effective treatment. It allows to take preventive measures in relation to civilization diseases, eg. Diabetes.</p> <p>The aim of biochemistry is also to prepare students to study clinical subjects.</p>
<b>Prerequisite /essential requirements</b>	<b>Knowledge</b>	<p>Student knows the basic models of chemical compounds. He explains the concept of: atom, molecule, chemical reagent, chemical reaction, the functional group. Identifies and defines the organic compounds: hydrocarbons, alcohols, aldehydes, ketones, acids, esters, ethers, amides, amines. Familiar with the term chemical bond, classifies types of chemical bonds. Defines the concepts of solubility, diffusion, osmosis, osmotic pressure, molarity. He knows the concepts of solution, molar concentration, percent concentration, equivalent concentration, electrolytic dissociation, ion, anion, cation.</p>
	<b>Skills</b>	<p>Student can properly use basic laboratory equipment (uses of the automatic pipette, measures the correct volume of solutions, prepares solutions in accordance with the prescribed concentration, can titrate). Performs chemical calculations based on the knowledge of chemistry and mathematics. Properly use the principles of functioning in the laboratory. Able to react properly in an emergency in a chemistry lab (action of the compounds corrosive, flammable, toxic, high temperature, etc.).</p>
	<b>Social Competences</b>	<p>Student can work in a team and actually perform tasks requiring precision, by following strictly established procedure. He can behave responsibly in emergency situations. It has a habit of self-education.</p>

<b>Description of the learning outcomes for the subject /module</b>			
<b>Number of learning outcome</b>	<b>Student, who has passed the (subject) Knows /is able to /can:</b>	<b>SYMBOL (referring the standards) EKK</b>	<b>Method of verification of learning outcomes</b>
KL2JPW01	describes water-electrolyte equilibrium in biological systems	K_B.W1	Single-choice tests Open questions Multiple-choice exam
KL2JPW02	describes acid-base equilibrium and buffer mechanisms and their role in systemic homeostasis	K_B.W2	Single-choice tests Open questions Multiple-choice exam
KL2JPW03	knows the structure of simple organic compounds included in macro particles of cells, extracellular matrix and somatic liquids	K_B.W10	Single-choice tests Open questions Multiple-choice exam
KL2JPW04	describes structure of lipids and polysaccharides and their function in cellular and extracellular structures	K_B.W11	Single-choice tests Open questions Multiple-choice exam
KL2JPW05	recognizes four protein structure levels (primary, secondary, tertiary and quaternary); knows the significance of protein post-translation and functional modifications	K_B.W12	Single-choice tests Open questions Multiple-choice exam

KL2JPW06	knows functions of nucleotides, structures of DNA and RNA (primary and secondary) and chromatin structure	K_B.W13	Single-choice tests Open questions Multiple-choice exam
KL2JPW07	knows functions of genome, transcriptome and proteome as well as basic methods applied to investigate these; describes processes of DNA replication, repair and recombination, processes of transcription and translation also the processes of DNA, RNA and protein degradation; knows the concepts of gene expression regulation	K_B.W14	Single-choice tests Open questions Multiple-choice exam
KL2JPW08	describes basic anabolic and catabolic pathways, their regulation mechanisms and influence of genetic and environmental factors on these	K_B.W15	Single-choice tests Open questions Multiple-choice exam
KL2JPW09	knows metabolic profiles of major organs and systems	K_B.W16	Single-choice tests Open questions Multiple-choice exam
KL2JPW10	knows the concepts of oxidative potential and oxidative stress	K_B.W17	Single-choice tests Open questions Multiple-choice exam
KL2JPW11	knows digestive enzymes, mechanism of hydrochloric acid production in stomach, role of bile, process of digestion product absorption and connected disorders/associated abnormalities/	K_B.W18	Single-choice tests Open questions Multiple-choice exam
KL2JPW12	knows consequences of malnutrition, incl. permanent starving, excessive alimentation and non-balanced diet	K_B.W19	Single-choice tests Open questions Multiple-choice exam
KL2JPW13	knows consequences of hypovitaminosis and minerals deficiency as well as vitamin and mineral excess in human organism	K_B.W20	Single-choice tests Open questions Multiple-choice exam
KL2JPW14	knows modes of action and regulatory mechanisms of all human organs and systems, incl. circulatory system, respiratory system, alimentary system, urinary system and dermal integument and understands relationships between these	K_B.W25	Single-choice tests Open questions Multiple-choice exam
KL2JPW15	knows mechanism of hormonal activities and consequences of their deregulation	K_B.W26	Single-choice tests Open questions Multiple-choice exam
KL2JPU01	predicts course of biochemical processes with regard to energetic status of cells	K_B.U6	Constant assessing on classes Multiple-choice exam
KL2JPU02	uses basic laboratory techniques, such as qualitative analysis, titration, colorimetry, pH-metry, chromatography, electrophoresis of proteins and nucleic acids	K_B.U9	Constant assessing on classes Multiple-choice exam
KL2JPU03	uses simple measuring instruments and evaluates the accuracy of measurements taken	K_B.U10	Constant assessing on classes Multiple-choice exam
KL2JPU04	uses databases, incl. on-line bases and searches for information required by means of available tools	K_B.U11	Constant assessing on classes Multiple-choice exam
KL2JPU05	designs and conducts simple research projects and interprets their outputs and draws conclusions	K_B.U14	Constant assessing on classes Multiple-choice exam

Matrix presenting the learning outcomes of the subject/module in relation to the form of classes									
Number of learning outcome	Student, who has passed the (subject) Knows /is able to /can:	Types of training							
		Lecture	Seminar	Laboratory classes	Project work	Clinical classes	Classes	Practical classes	Other
KL2JPW01	describes water-electrolyte equilibrium in biological systems	X		X			X		
KL2JPW02	describes acid-base equilibrium and buffer mechanisms and their role in systemic homeostasis	X		X			X		
KL2JPW03	knows the structure of simple organic compounds included in macro particles of cells, extracellular matrix and somatic liquids			X			X		
KL2JPW04	describes structure of lipids and polysaccharides and their function in cellular and extracellular structures			X			X		
KL2JPW05	recognizes four protein structure levels (primary, secondary, tertiary and quaternary); knows the significance of protein post-translation and functional modifications	X		X			X		
KL2JPW06	knows functions of nucleotides, structures of DNA and RNA (primary and secondary) and chromatin structure	X		X			X		
KL2JPW07	knows functions of genome, transcriptome and proteome as well as basic methods applied to investigate these; describes processes of DNA replication, repair and recombination, processes of transcription and translation also the processes of DNA, RNA and protein degradation; knows the concepts of gene expression regulation	X		X			X		
KL2JPW08	describes basic anabolic and catabolic pathways, their regulation mechanisms and influence of genetic and environmental factors on these	X		X			X		
KL2JPW09	knows metabolic profiles of major organs and systems	X		X			X		
KL2JPW10	knows the concepts of oxidative potential and oxidative stress	X		X			X		
KL2JPW11	knows digestive enzymes, mechanism of hydrochloric acid production in stomach, role of bile, process of digestion product absorption and connected disorders/associated abnormalities/	X		X			X		
KL2JPW12	knows consequences of malnutrition, incl. permanent starving, excessive alimentation and non-balanced diet	X		X			X		
KL2JPW13	knows consequences of hypovitaminosis and minerals deficiency as well as vitamin and			X			X		

	mineral excess in human organism								
KL2JPW14	knows modes of action and regulatory mechanisms of all human organs and systems, incl. circulatory system, respiratory system, alimentary system, urinary system and dermal integument and understands relationships between these	X		X			X		
KL2JPW15	knows mechanism of hormonal activities and consequences of their deregulation			X			X		
KL2JPU01	predicts course of biochemical processes with regard to energetic status of cells			X			X		
KL2JPU02	uses basic laboratory techniques, such as qualitative analysis, titration, colorimetry, pH-metry, chromatography, electrophoresis of proteins and nucleic acids			X			X		
KL2JPU03	uses simple measuring instruments and evaluates the accuracy of measurements taken			X			X		
KL2JPU04	uses databases, incl. on-line bases and searches for information required by means of available tools			X			X		
KL2JPU05	designs and conducts simple research projects and interprets their outputs and draws conclusions			X			X		

Module (subject) contents		
Symbol of teaching programme	Content of teaching programme	References to learning outcomes
TK.....01	<i>Protein: molecular structure, properties</i> Biomedical importance of amino acids, peptides, proteins. Classification and nomenclature of peptides and proteins. Protein structure: a primary, secondary, tertiary and quaternary. Bonds stabilizing the structure of proteins: strong and weak bonds. Properties of proteins. Functions of proteins in the body. The characteristic features of the structure of collagen. The isoelectric point of the protein. Methods of protein separation.	KL2JP W03, W05 KL2JP U02, U03, U04, U05
TK.....02	<i>Nucleosides and nucleotides. The structure and function of nucleic acids.</i> Nucleosides and nucleotides - structure and function. Structure and function of DNA and RNA. Different types of RNA. Control of transcription. Construction of bacterial promoters. Exons and introns. Splicing. Posttranscriptional modification of various RNA. RNA catalytic properties.	KL2JP W03, W06, W07 KL2JP U02, U03, U04, U05
TK.....03	<i>Protein biosynthesis</i> Properties of the genetic code. Types of mutations and their effects. Types of tRNA. Functions of tRNA arms. Stages of protein biosynthesis: initiation, elongation and termination. Posttranslational modifications of proteins. Effect of antibiotics on protein synthesis.	KL2JP W05, W07 KL2JP U02, U03, U04, U05
TK.....04	<i>Enzymes: general properties and kinetics of enzymatic reactions</i> Biomedical importance of enzymes. Classification and nomenclature of enzymes. Coenzymes. Biochemical catalysis. Transition state theory. Specificity of	KL2JP W05, KL2JP U02, U03, U04, U05

	enzymatic reactions. Isoenzymes: properties and importance in the enzymology diagnosis. Functional and non-functional plasma enzymes. The rate of the enzyme reaction. Factors affecting the rate of the enzyme reaction. The kinetics of enzymatic catalysis. Active place and allosteric site: structure and meaning. Inhibition of the enzymatic reactions: competitive and non-competitive inhibition. Enzymes poisons.	
TK.....05	<i>Enzymes: mechanisms of action and regulation of enzymes activity</i> Significance of metal ions in substrate binding and catalysis. Metalloenzymes and enzymes activated by metals. The mechanisms regulating the activity of enzymes: change the amount of enzyme, change the pool of reacting compounds, change of catalytic efficiency of enzyme. Constitutive and inducible enzymes. Compartmentation of enzymes. Multienzyme complexes. Allosteric effectors. Feedback inhibition, covalent modifications and limited proteolysis in the regulation of enzyme activity.	KL2JP W05, W08 KL2JP U02, U03, U04, U05
TK.....06	<i>Dietary proteins. Protein digestion. Absorption of amino acids</i> The biological value of protein: proteins of standard value, partially defective and defective proteins. Nitrogen balance. Digestion of proteins. Synthesis and secretion of hydrochloric acid. Significance of hydrochloric acid and proteolytic enzymes in the digestion of proteins. Mechanisms of amino acid absorption.	KL2JP W09, W11, W12, W14, W15 KL2JP U02, U03, U04, U05
TK.....07	<i>Plasma proteins. Immunoglobulins biochemistry</i> Biomedical importance of plasma proteins. The division and functions of plasma proteins. Properties of plasma proteins. Significance of plasma proteins in the transport of hydrophobic substances. Oncotic pressure in physiologic and pathologic conditions. Acute phase proteins. Immunoglobulins nomenclature and function of the body's defense mechanisms. The structure and properties of immunoglobulins.	KL2JP W05, W09, W14 KL2JP U02, U03, U04, U05
TK.....08	<i>The biosynthesis of amino acids. Conversion of amino acids to specialized products</i> Dietary essential and nonessential amino acids. Biomedical importance of amino acids. Biosynthetic pathways of dietary nonessential amino acids. The physiologically important products derived from amino acids.	KL2JP W03, W08, W09 KL2JP U02, U03, U04, U05
TK.....09	<i>Catabolism of amino nitrogen</i> Interorgan exchange of amino acids. Deamination, deamidation and transamination reactions: the course and tissue location. Reactions releasing ammonia. Cellular mechanisms of binding and detoxification of ammonia. Urea cycle. The share of the liver and muscles in nitrogen system: purine and alanine cycle. Metabolic disorders associated with reactions of urea cycle.	KL2JP W08, W09, W14 KL2JP U02, U03, U04, U05
TK.....10	<i>Citric acid cycle.</i> Biomedical significance of processes obtaining and storing energy in the cell. Characteristics of citric acid cycle reactions and their regulation. The energy balance of citric acid cycle. Amphibolic character of citric acid cycle. The enzymes involved in the oxidative and reductive reactions.	KL2JP W08 KL2JP U01, U02, U03, U04, U05
TK.....11	<i>Biological oxidation. Respiratory chain</i> Characteristics of particular groups of oxidoreductases. Free-radical reactions and reactive oxygen species. Oxygen toxicity. Elements of blood antioxidant system.	KL2JP W08, W10 KL2JP U01, U02, U03, U04, U05

	The components of mitochondrial respiratory chain. Redox potential. The poisons and uncouplers of respiratory chain.	
TK.....12	<i>Acid - base balance in physiologic conditions: lung regulation</i> The physiologically important buffer systems of blood and tissues. Henderson-Hasselbalch equation. The share of respiratory system in maintaining acid-base homeostasis. The partial pressure of carbon dioxide.	KL2JP W02, W09, W14 KL2JP U02, U03, U04, U05
TK.....13	<i>Acid - base balance in physiologic conditions: renal regulation</i> The share of renal function in homeostasis of acid-base balance. Mechanisms of bicarbonate reabsorption and regeneration in the renal tubules. Amoniogenesis. Production of titratable acidity, pH of the urine.	KL2JP W02, W09, W14 KL2JP U02, U03, U04, U05
TK.....14	<i>Sugars of physiological importance. Digestion and absorption of sugars. Glycogen metabolism</i> Sugars of physiological importance. Glycogen synthesis: glycogenogenesis. The degradation of glycogen: glycogenolysis. Metabolic and hormonal regulation of glycogenogenesis and glycogenolysis. The differences in the regulation of glycogen metabolism in muscle and liver. Glycogen related metabolic disorders.	KL2JP W03, W04, W08, W09, W11, W12, W14, W15 KL2JP U01, U02, U03, U04, U05
TK.....15	<i>Glucose metabolism</i> Synthesis of glucose: gluconeogenesis. Substrates of gluconeogenesis. Lactic acid cycle. Alanine – glucose cycle. Metabolic and hormonal regulation of gluconeogenesis. The role of gluconeogenesis in the control of blood glucose. The oxidation of glucose: glycolysis. Metabolic and hormonal regulation of glycolysis. Significance of glycolysis under aerobic and anaerobic conditions. The energy balance of glycolysis and oxidative combustion of glucose.	KL2JP W08, W09, W12, W14, W15 KL2JP U01, U02, U03, U04, U05
TK.....16	<i>Pentose phosphate pathway. Uronic acid pathway. Metabolism of fructose and galactose</i> Physiological role and tissue location of pentose phosphate pathway. Characteristics of particular reactions of pentose phosphate pathway. Hormonal regulation of pentose phosphate pathway. Uronic acid pathway and the role of active glucuronide. The metabolism of fructose. The metabolism of galactose. Defects in the metabolism of fructose and galactose.	KL2JP W08, W09, W12, W14, W15 KL2JP U02, U03, U04, U05
TK.....17	<i>Tissue glucose metabolism</i> Carbohydrate metabolism in resorptive and postresorptive state. Glucose transport to the tissues: insulin-dependent and insulin-independent tissues. The share of the liver, adipose tissue, brain, red blood cells, muscle and kidney function in glucose metabolism. Normoglycemia, hyperglycemia, hypoglycemia, glycosuria. Glucose metabolism in diabetes.	KL2JP W08, W09, W11, W12, W14, W15 KL2JP U01, U02, U03, U04, U05
TK.....18	<i>Lipids of physiological importance. The digestion and absorption of lipids</i> The presence of lipids in the diet. Digestion of lipids in the gastrointestinal tract: the importance of individual enzymes. Absorption of products of digested lipids. The emulsification and micellization processes. Monoacylglycerol pathway. Participation of glucose in lipids absorption. Lipids of physiological importance.	KL2JP W03, W04, W08, W09, W11, W12 KL2JP U02, U03, U04, U05
TK.....19	<i>Transport and storage of lipids. Lipoproteins</i> The role of lipoprotein transport and metabolism of lipids. Classification of apolipoproteins. Fractions of lipoproteins and their metabolism. The role of receptors in lipoprotein metabolism. The share of the liver and adipose tissue in metabolism of lipoproteins. Hepatic	KL2JP W08, W09, W12, W14 KL2JP U02, U03, U04, U05

	conversion of hydrocarbon material into lipids. Intravascular and intracellular lipolysis.	
TK.....20	<i>Fatty acid metabolism</i> Fatty acid synthesis: lipogenesis. Location and regulation of lipogenesis. Catabolism of fatty acids – $\beta$ -oxidation. Location and regulation of $\beta$ -oxidation. Energy balance of fatty acid oxidation. The plasma transport of free fatty acids. Transport of fatty acids through cell membranes and mitochondria. The biosynthesis of acylglycerols and phospholipids.	KL2JP W08 KL2JP U02, U03, U04, U05
TK.....21	<i>Tissue metabolism of fatty acids</i> Absorptive and postabsorptive state in lipids metabolism. The role of adipose tissue in fatty acid metabolism. Storage and degradation of triacylglycerols in adipose tissue: hormonal regulation. The metabolism of fatty acid during starvation and diabetes. Ketogenesis: tissue and subcellular localization. Regulation of ketogenesis. Ketone bodies. Ketolysis. Ketoacidosis.	KL2JP W08, W09, W12, W14, W15 KL2JP U01, U02, U03, U04, U05
TK.....22	<i>Hormonal regulation of carbohydrate and lipid metabolism. Biochemistry of pancreatic hormones. Gastrointestinal hormones</i> Insulin: molecular structure, synthesis, secretion, biodegradation. Metabolic and hormonal regulation of insulin secretion. Glucagon: structure, synthesis, secretion. Entero-pancreatic axis. The metabolic activity of insulin and glucagon. Gastrointestinal hormones.	KL2JP W08, W09, W12, W14, W15 KL2JP U01, U02, U03, U04, U05
TK.....23	<i>Biochemistry of thyroid hormones and hormones of the adrenal medulla</i> The biosynthesis of thyroid hormones. Storage and secretion of thyroid hormones. The metabolic effects of thyroid hormones. Catecholamines: dopamine, noradrenaline, adrenaline. Regulation of catecholamine synthesis. Metabolic action of adrenal medulla hormones.	KL2JP W08, W09, W14, W15 KL2JP U02, U03, U04, U05
TK.....24	<i>The metabolism of cholesterol and bile acids</i> Sources of dietary cholesterol. Regulation of cholesterol absorption. Biosynthesis of cholesterol and its regulation. The role of liver in the turnover of cholesterol. Cholesterol catabolism - synthesis of bile acids. Primary and secondary bile acids. Enterohepatic circulation of bile acids.	KL2JP W08, W09, W12, W14 KL2JP U02, U03, U04, U05
TK.....25	<i>Steroid hormones biochemistry. Adrenal and gonadal hormones</i> Cholesterol as a precursor of steroid hormones. Adrenal hormones: mineralocorticoids and glucocorticoids. Gonadal hormones: gestagens, estrogens and androgens. The synthesis of steroid hormones. Metabolic role of steroid hormones.	KL2JP W08, W09, W14, W15 KL2JP U02, U03, U04, U05
TK.....26	<i>Porphyryn metabolism. Bile pigments. Iron metabolism</i> Biosynthesis of porphyrins. Hemoproteins and ferroproteins. The synthesis of heme. The degradation of heme. Bilirubin: transport, metabolism in the liver, secretion into the bile, metabolism in the gut. Sterkobilinogen and urobilinogen. Differentiation of hyperbilirubinemia. Dietary sources of iron. The absorption of iron. The plasma iron transport and its distribution in the body. Role of transferrin and ferritin. The total iron binding capacity.	KL2JP W08, W09, W14 KL2JP U02, U03, U04, U05
TK.....27	<i>Biochemistry of liver</i> The central role of the liver in the metabolism of proteins, carbohydrates and lipids. Liver detoxification. The metabolism of xenobiotics in the liver. Functionality tests based on the metabolic function of the liver.	KL2JP W08, W09, W14 KL2JP U02, U03, U04, U05



TK.....28	<i>Vitamins</i> Classification of vitamins: fat-soluble vitamins and water-soluble vitamins. The metabolism of vitamins. Metabolic disorders associated with hypo- or hypervitaminosis.	KL2JP W08, W12, W13 KL2JP U02, U03, U04, U05
TK.....29	<i>Water and electrolyte administration in the physiologic states</i> Basic laws deciding of water and electrolyte administration. Water spaces of body. The ionic composition of the extracellular and intracellular fluid. Sodium metabolism. Metabolism of potassium. Metabolism of chloride.	KL2JP W01, W08, W13 KL2JP U02, U03, U04, U05
TK.....30	<i>Water and electrolyte administration in the pathologic states</i> Hypernatremia and hyponatremia. Hyperkalemia and hypokalemia. Hyperchloremia and hypochloreaemia. Hypotonic, isotonic and hypertonic overhydration and dehydration.	KL2JP W01, W13 KL2JP U02, U03, U04, U05
TK.....31	<i>Economy of calcium -phosphate –magnesium metabolism</i> Calcium metabolism. Phosphorus metabolism. Magnesium metabolism. Parathyroid hormone and vitamin D in the regulation of calcium-phosphate-magnesium metabolism. The role of the kidneys, bone and gastrointestinal tract in the regulation of calcium-magnesium-phosphate metabolism.	KL2JP W08, W09, W13, W15 KL2JP U02, U03, U04, U05
TK.....32	<i>Biochemistry of kidneys</i> Renal tubular function. The processes of filtration, reabsorption, and secretion. The role of kidneys in the concentration and dilution of urine. Renal regulation of sodium levels. Biochemical mechanisms of hormonal effects on renal function. The composition and properties of the urine as an exponent of the biochemical processes in the body.	KL2JP W01, W09, W13, W14, W15 KL2JP U02, U03, U04, U05

#### References and educational resources

**1. V.W. Rodwell, D.A. Bender, K.M. Botham, P.J. kennelly, P.A. Weil: Harper's Illustrated Biochemistry. 30 Th Eddition. 2015 by The McGraw-Hill Education**

#### Student's workload (balance sheet of ECTS points)

Form of student's activity (in-class participation; activeness, produce a report, etc.)	Workload [h]		
	Tutor	Student	Average
activities that require direct participation of tutors	170	170	
Preparation to the classes			
Reading of the indicated/specified literature			
Report writing/project making			
Time spent to prepare for the exam			
Other			

Student's workload in total			
ECTS points for the subject	18		
Remarks at the end			

Methods of assessment, for example:

E – exam- problem resolving

S – verifying of practical skills

R – report

D – discussion

P – presentation

Others-