Syllabus 2020/2021			
Description of the course			
Module/Course	Medical Chemistry	**Group of detailed education results**	
		Group code B	**Group name** The scientific basis of medicine
Faculty	Medicine		
Major	Medicine		
Specialties	Not applicable		
Level of studies	Uniform magister studies **X** * 1st degree studies ☐ 2nd degree studies ☐ 3rd degree studies ☐ postgraduate studies ☐		
Form of studies	**X** full-time ☐ part-time		
Year of studies	1st	**Semester**	X Winter X Summer
Type of course	X obligatory ☐ limited choice ☐ free choice / elective		
Course	☐ major ☐ basic		
Language of instruction	☐ Polish **X** English ☐ other		
* mark ☐ with an **X**			

Amount of hours

Form of education

Unit teaching the course	Lectures (L)	Seminars (SE)	Auditorium classes (AC)	Major Classes – not clinical (MC)	Clinical Classes (CC)	Laboratory Classes (LC)	Classes in Simulated Conditions (CSC)	Practical Classes with Patient (PCP)	Specialist Classes – magister studies (SCM)	Foreign language Course (FLC)	Physical Education obligatory (PE)	Vocational Practice (VP)	Self-Study (Student's own work)	E-learning (EL)
Winter Semester														
	6					**15**								
Summer Semester														
	4					12								
TOTAL per year:														
	10					27								

Educational objectives (max. 6 items)

C1. To transfer the knowledge in the field of structure, properties, and functions of the basic chemical components of human tissues and biological fluids.

C2. To provide the basic information on chemical homeostasis mechanisms and chemical composition of biological fluids, as a background for further biochemistry and physiopathology teaching.

C3. To make the student familiar with chemical calculations and prepare him/her for interpretation of the results of performed experiments.

C4. To develop the appropriate ethical and proper communication skills as well as practice efficient team work.

Education result matrix for module/course in relation to verification methods of the intended education result and the type of class

Number of course education result	Number of major education result	Student who completes the module/course knows/is able to	Methods of verification of intended education results (forming and summarising)	Form of didactic class ***enter the abbreviation*
K 01	**B.W1.** **B.W2.** **B.W3.**	Describes water and electrolyte equilibrium. Knows and understands the definition of: pH, solubility, isoionic and isohydric equilibrium. Describes types, composition, and properties of buffers as elements of homeostasis. Knows and understands the definition of: colloidal solutions, osmosis and Gibbs-Donnan equilibrium.	Presentation of the scope of knowledge with oral expression, written report, essay, multimedia presentation Written test no. 1 & 4: calculations, open ended questions, single and multiple choice test.	LC no. 1, 2-winter semester and 2-summer semester L no.1
K 02	**B.W4.** **B.W10.**	Knows the basic reactions of inorganic and organic compounds in aqueous solutions. Knows the basic structure of simple organic compounds, components of cells, extracellular matrix, and body fluid macromolecules. Knows the role of macro- and micro-minerals in the human body	Presentation of the scope of knowledge with oral expression, written report, essay, multimedia presentation Written test no. 2 & 3: calculations, open ended questions, single and multiple choice test, chemical structures and reactions.	LC no. 1,3,4,5;- winter semester and 1,2,3 summer semester
K 03	**B.W11.**	Describes the chemical structure of mono-, disaccharides, polysaccharides, glycosaminoglycans and glycosides, and their functions in cellular structures and extracellular space.	Presentation of the scope of knowledge with oral expression, written report, essay, multimedia presentation Written test No. 2: calculations, open ended questions, single and multiple choice test, chemical structures and reactions.	L no. 1-winter and 5-summer semester LC no: 3 winter semester
K 04	**B.W11.**	Describes the chemical structure of lipids and basic steroids, their functions in cellular structures and extracellular space, knows the chemical composition of bile - illustrates the components of the bile with chemical formulas.	Presentation of the scope of knowledge with oral expression, written report, essay, multimedia presentation Written test No. 2: calculations, open ended questions, single and multiple choice test, chemical structures	L no. 2, LC no: 4-winter semester
05	**B.W12.**	Knows the acid-base properties of amino acids. Describes the structure and biological role of protein and non-protein, amino acids, peptides and biogenic amines.	Written test No. 3: calculations, open ended questions, single and multiple choice test, chemical structures and	L no. 3 LC no: 5-winter semester

			reactions.	
K 06	B.W12.	Describes the I, II ,III and IV- levels of protein structure. Knows posttranslational modifications of proteins and their importance.	Written test No. 3: calculations, open ended questions, single and multiple choice test.	L no. 3-winter and 4-summer semester LC no: 5-winter and 1,2-summer semester
K 07	B.W25.	Understands the concepts of: reactive oxygen species, oxidative potential of the body and oxidative stress. Understands the importance of non-enzymatic oxidation of lipids, proteins and DNA. Understands the importance of selected mechanisms of oxidative-antioxidative balance and the role of antioxidant compounds.	Presentation of the scope of knowledge with oral expression, written report, essay, multimedia presentation	LC no: 1,2,3-winer and 1,3-summer semester
S 01	B.U3.	Calculates percent and molar concentrations in solutions and concentration of the compounds in regarding osmotic pressure, knows simple and serial dilutions.	Test 1: written calculations, open ended questions, single and multiple choice test Report in the protocol	LC no: 1-winter and 1,3-summer semester
S 02	B.U4.	Is able to calculate the solubility of inorganic compounds. Student explains the chemical background of the solubility or lack of solubility of the organic compounds and biological importance of these features	Test 1: written calculations and open-ended questions Report in the protocol	LC no: 1,3 and 4-winter and 2-summer semester
S 03	B.U5.	Describes the consequences of hemostasis disruption for human organism. Describes the changes in the functioning of the organism in a situation disruption of homeostasis. Is able to determine and calculate buffer pH and capacity.	Test 1: written calculations and open-ended questions Report in the protocol	LC no: 1-5
S 04	B. U9. B.U8.	Uses basic laboratory methods such as qualitative analysis, titration, pH-meter, chromatography, electrophoresis. Executes basic laboratory analyses. Understands analytical techniques exploiting UV-VIS spectroscopy, application of a calibration curve, is able to interpret the assay results.	Evaluation of accuracy of the analysis and interpretation of results allows to measure the ability to use theoretical skills in practice Test 1,2,4: calculations and open-ended questions	All LC
S 05	B.U9.	Is able to use simple laboratory devices obtaining an appropriate accuracy of measurements.	Evaluation of laboratory work	All LC
S 06	B.U13.	Is able to plan and executed simple experiments, interpret the results and draw conclusion.	Assessment of analysis and interpretation of the results allows them to measure the ability to use theoretical knowledge in practice Evaluation of laboratory class protocols	All LC

** L - lecture; SE - seminar; AC – auditorium classes; MC – major classes (non-clinical); CC – clinical classes; LC – laboratory classes; SCM – specialist classes (magister studies); CSC – classes in simulated conditions; FLC – foreign language course; PCP practical classes with patient; PE – physical education (obligatory); VP – vocational practice; SS – self-study, EL – E-learning .

Please mark on scale 1-5 how the above effects place your classes in the following categories: communication of knowledge, skills or forming attitudes:

Knowledge: 5

Skills: 5

Student's amount of work (balance of ECTS points)	
Student's workload	**Student Workload (h)**

(class participation, activity, preparation, etc.)	
1. Contact hours:	37
2. Student's own work (self-study):	32,7
Total student's workload	69,7
ECTS points for module/course	4
Comments	

Content of classes (please enter topic words of specific classes divided into their didactic form and remember how it is translated to intended educational effects)

Lectures

Attending lectures is mandatory

Winter semester

1. Buffers. Henderson-Hasselbalch equation, pH and buffer capacity. The buffers of human organism and the role of homeostasis. Acidosis and alkalosis. **Carbohydrates**. Important monosaccharides and their derivatives, chemical structures and reactivity. Important disaccharides, oligo- and polysaccharides. Homopolysaccharides: structure and function (starch, cellulose, glycogen, chitin, inulin). Heteropolysaccharides: heparin and hyaluronic acid. Introduction to glycoconjugates. **BW4, BW10, BW11**

2. **Lipids**. Essential and non-essential fatty acids. Classification of lipids. Acylglycerols and waxes: structure and function. Complex lipids: glycerophospholipids and sphingosides: structures, properties, function. Lipid-like compounds: eicosanoids and steroids. Cholesterol, cholic acid and its derivatives, steroids hormones, vitamine D. The structure of biological membranes. Lipoproteins as transport complexes. **BW10, BW11,**

3. **Amino acids and peptides**. Amphoteric properties of amino acids. Classification and properties of protein amino acids. Non-protein amino acids: examples, function. **Biogenic amines**. Amino acids chemical reactivity – the peptide bond: properties and stereochemistry. Examples of short peptides and their biological function. **Proteins** – general structure. Organization levels: primary, secondary, tertiary and quaternary structure. Chemical bonds and forces involved in maintaining protein spatial arrangement. **BW10, BW12**

Summer semester

4. **Proteins**. Structural classes of proteins: contribution of □ and □ structures. Globular proteins: properties and solubility. Fibrous proteins: collagen, keratin, elastin, silk fibroin – association of structure and function. Membrane proteins: ways of association with the membrane. Integral membrane proteins (□-barrel, bench of □-helices, single □-helix). Peripheral proteins: anchoring via lipid fragments (acylation, prenylation, GPI) and weak surface associations. **Protein** folding and quality control system (ERAD). **BW12, BW21, BW28**

5. **Protein cont.** The importance of post-translational modifications. Protein aging. Conformational diseases (amyloidoses). **Glycoconjugates.** Glycoproteins: structure and function (N- and O-bonds, ABO blood groups, immunomodulatory glycoepitopes, mucins). Glycosaminoglycans and proteoglycans: connective tissue strength and signal transduction. Glycolipids (cerebroside and ganglioside). Bacterial glycoconjugates: lipopolysaccharide (LPS) and peptidoglycan. **BW11, BW12, BW21,BW28**

Seminars

Without seminars

Practical classes

Winter semester

1.Water solution as environment of life. Electrolyte equilibrium in biological fluids. pH and chemical composition of biological fluids (blood plasma and serum, saliva, gastric juice, urine, pancreatic juice, cerebrospinal fluid). Micro- and macro minerals, toxicity elements. Isoionic and isohydric equilibrium.

Laboratory class: Preparation of a solution of demanded concentration, simple and serial dilution, detection of glucose and pH in urine (strip test). Chemical calculation: measurement units, concentration: molar, per mile, percent. B.W1., B.W4.,B.W10., B.U34.

2. Buffer solution. **The buffers of physiological fluids as elements of homeostasis**. **Buffers: types, composition, and properties.** The Henderson-Hasselbach equation for acidic and basic buffers. The definition of buffer capacity, and the effect of strong acids and bases on buffer capacity. Protein, haemoglobin, phosphate, and bicarbonate buffers. The role of blood, lungs, and kidneys in maintaining physiological pH in the human organism. Acidosis and alkalosis. Calculations of pH, pOH and buffer capacities.

Laboratory class: Preparation of buffer solutions, determination of buffer capacity by titration of the buffer

solution using a strong base and a strong acid. Calculations of buffer capacities. **B.W2., B.U5., B.U8., B.U9.**

3. Saccharides of tissues and body fluids. Isomerization and epimerization of monosaccharides. Structure and reactivity of derivatives of sugars: acyl derivatives, amino sugars, oxidation and reduction products, esters, deoxy sugars. Glucuronides and L-ascorbic acid. The reaction of aldol condensation and cleaving a sugar chain. The destruction of monosaccharide ring in DNA by reactive oxygen species. Monosaccharides of body fluids (blood plasma, saliva, cerebrospinal fluid). Diagnosis of hypo and hyperglycemia.

Laboratory class: Glucose acylation, oxidation of reducing mono- and disaccharides, condensation with amines, enolization. **B.W11., B.U9.**

Test 1: Chemical calculations. Knowledge regarding practical classes 1,2 and lecture 1

4. Lipids: structure and function. Essential fatty acids. Arachidonic acid and its derivatives. Lipids of human, plant and animal (oil, hen egg yolk, milk, blood plasma and serum, cerebrospinal fluid) . Glycerophospholipids: structure, components and bonds. Sterols-cholesterol, bile salt, acids and vitamin D. Vitamins soluble in fat (ADEK). Hydrophobic and amphipathic properties of lipids and sterols. Lipid peroxidation, and antioxidants. Aspirin.

Laboratory class: Esterification of salicylic acid. Extraction of lipids from hen egg yolk. Oxidation of unsaturated fatty acids. Detection of cholesterol in natural products (Salkowski reaction). Hay's test with sulphur. Detection of hydroxyl group in bile acids.. **B.W11., B.U9.**

5. Amino acids and peptides with biological activity. Amino acids and proteins - biological fluids and secretions (blood plasma, saliva, gastric juice, milk). The primary structure of proteins, types of bonds and interactions stabilizing the structure, the isoelectric point, the structure of the peptide bond. N- and C- terminal amino acid residues. Determination of the N- and C- terminal residue. The role of disulphide bonds in proteins. Non-protein amino acids, biogenic amines - formation and functions, biologically active peptides. Damage of protein structure caused by reactive oxygen species.

Laboratory class: Chemical reactions of amino acids. Acylation of the α-amino group. Reactions of the α-amino group (Schiff's base). Deamination of amino groups (Van Slyke's reaction). Reaction of amino acids with ninhydrin, xanthoproteic reaction, detection of cysteine, the biuret assay. Reaction of a free amino group (Sanger reaction). **B.W12., B.U9**.

Test no. 2: Knowledge regarding practical classes 3,4 and material from the lectures

6. The completion of the missed laboratory classes. **The first repetition of the tests 1 and 2**

7. The second repetition of the tests 1 and 2

Summer semester

1. Amino acids: Chromatography and absorption spectroscopy in medical analysis.

Principles of absorption spectroscopy. Absorption spectra of organic compounds, amino acids, proteins and nucleic acids, Beer's law. Analytical chromatography.

Laboratory class: Reaction of Amino acids with ninhydrin. Amino acids concentration assay – the biuret method, calibration curve, calculations. Amino acid separation in TLC. The elution profile and Rf calculation. **B.U8., B.U9., B.U13**

2. The physicochemical properties of proteins. Proteins as colloidal solutions. Posttranslational modification of amino acids and their influence on proteins properties. Solubility of proteins depending on: pH, concentration of salt, temperature. Salting in and salting out of proteins. Osmosis and Gibbs-Donnan equilibrium. Diffusion. Calculations of Donnan equilibrium.

Laboratory class: Denaturation and coagulation of proteins. Isolation of serum protein fractions with ammonium sulphate. Dialysis. **B.W3., B.W12., B.U8.**

Test No. 3: Lab No. 5 of the winter semester and Lab 1 of the summer semester

3. Electrophoresis and chromatography in separation of biomolecules.

General principle of electrophoresis. Media used for electrophoresis. The electrophoresis of human serum proteins and lipoproteins in agarose gel. Densitometry analysis. Comparison of the patterns in physiological and pathological samples.

Chromatography: General principle of chromatographic methods: adsorption chromatography, ion-exchange chromatography, affinity chromatography and partition chromatography.

Laboratory class: The electrophoresis of serum proteins an lipoproteins in 1 % agarose, pH = 8.6. Interpretation of the results. Separation of a dye mixture by adsorption chromatography. Desalting of hemoglobin preparation by

gel filtration. **B.U9. B.U10 B.U13.**

4. The completion of the laboratory classes 1-3. Test No. 4: Labs 2-3 summer semester

5. The first repetition of the tests 3 and 4

6.The second repetition of the tests 3 and 4

Other

Not applicable

Basic literature (list according to importance, no more than 3 items)

1. Chemistry. An Introduction to General, Organic and Biological Chemistry. Timberlake KC, Benjamin Cummings, Pearson Education, Inc., 2016
2. Handbook of chemistry: for students Faculty of Medicine and Faculty of Dentistry; ed. Iwona Kątnik-Prastowska; Wroclaw: Wroclaw Medical University, 2012

Additional literature and other materials (no more than 3 items)

1. Murray RK, Granner DK, Rodwell VW. Illustrated Harper's Biochemistry (chapters 1,2,3-6,14,15,25,40,46,49)
2. Harvey R, Ferrier D. Lipincot's Illustrated Reviews: Biochemistry (chapters 1-4,14, 17, 18, 31)

Didactic resources requirements (e.g. laboratory, multimedia projector, other...)

1. Chemical laboratory equipment
2. Overhead projector

Preliminary conditions (minimum requirements to be met by the student before starting the module/course)

To start the Medical Chemistry course the student must be familiar with:

Chemical measurements: units of measurements, prefixes and equalities

Atoms and elements: the periodic table, atomic and mass numbers, atom valence and electronegativity

Chemical bonds: ions – transfer of electrons, molecular compounds – sharing electrons, valency of the elements – bonds of carbon, nitrogen, oxygen, hydrogen; bond polarity; inter-molecular forces (hydrogen bonds and van der Waals forces)

Solutions: electrolytes and non-electrolytes; solubility; concentration of solutions – percentage and molar, molar mass concept and calculation

Acids and bases: ionization of water, the pH scale, definition of an acid and base, inorganic and organic acids and bases

Organic compounds: alkanes, alkenes, alkynes, cis-trans isomers; alcohols and phenols, aldehydes and ketones; carboxylic acids; amines and amides; functional groups of organic compounds, oxidation/ reduction and polarity of organic compounds

Conditions to receive credit for the course (specify the form, criteria and conditions of receiving credit for classes included in the module/course, admission terms to final theoretical or practical examination, its form and requirements to be med by the student to pass it and criteria for specific grades).

Each absence must be made up, including rector's days or dean's hours.

The student is obliged to accomplish all the laboratory classes. The classes missed because of the sick leave must be made up in the last week of the semester course (week 6 in winter semester and week 4 in the summer semester). The form of accomplishment of the classes shipped because of rector's days (assay or presentation) will be arranged with the teachers.

Positive evaluation of laboratory skills and protocol notes, obtaining a minimum of 60% of points from each test. For a final grade, also extra presentations or essays prepared during the course will be considered.

The exam includes simple chemical calculations and theoretical knowledge about the structures and properties of buffers, carbohydrates, lipids, amino acids and proteins provided during the laboratory classes and lectures. The exam is written and takes the form: multiple choice test, open-ended questions, and important structures of sugars, lipids, and amino acids.

The exam is considered to be passed on satisfactory grade after obtaining a minimum of 60% of the total pool of exam points (100%) . The evaluation points will be given at each exam task. **After a written request of the students the pre-term exam can be organised in May. Only the students who obtain final grade at least 4 (67%) will be allowed to attend the pre-term exam.**

Grade:	Criteria for course
Very Good (5.0)	As for (3), but the average score of the tests (including failed attempts) ≥85%
Good Plus (4.5)	As for (3), but the average score of the tests (including failed attempts) ≥76%
Good (4.0)	As for (3), but the average score of the tests (including failed attempts) ≥67%
Satisfactory Plus (3.5)	As for (3), but the average score of the tests (including failed attempts) ≥60%
Satisfactory (3.0)	All laboratory classes completed and all the protocols positively evaluated. Each of the tests passed at minimum 60% of total score

Grade:	Criteria for exam (if applicable)
Very Good (5.0)	≥90%
Good Plus (4.5)	≥82%
Good (4.0)	≥75%
Satisfactory Plus (3.5)	≥67%
Satisfactory (3.0)	≥60%

Name of unit teaching course:	**Department of Chemistry and Immunochemistry**
Address	**Skłodowskiej-Curie Street, 50**
Phone	**607604848**
E-mail	**immunochemia@umed.wroc.pl**

Person responsible for course:	**Dr hab. Mirosława Ferens-Sieczkowska prof. nadzw.**
Phone	**607604848**
E-mail	**miroslawa.ferens-sieczkowska@umed.wroc.pl**

List of persons conducting specific classes:	*degree/scientific or professional title*	*Discipline*	*Performer profession*	*Form of classes*
Mirosława Ferens-Sieczkowska	*dr hab., prof. nadzw.*	*Medical Chemistry*	*scientist/ academic teacher*	***Lectures, lab classes, and exam***
Magdalena Orczyk-Pawiłowicz	*dr hab.*	*Medical Chemistry*	*scientist/ academic teacher*	*Lab classes*
Małgorzata Pupek	*dr*	*Medical Chemistry*	*scientist/ academic teacher*	*Lab classes*
Anna Lemańska-Perek	*dr*	*Medical Chemistry*	*scientist/ academic teacher*	*Lab classes*
Dorota Krzyżanowska-Gołąb	*dr*	*Medical Chemistry*	*scientist/ academic*	*Lab classes*

			teacher	
Beata Olejnik	*dr*	*Medical Chemistry*	*scientist/ academic teacher*	*Lab classes*
Jolanta Lis-Kuberka	*dr*	*Medical Chemistry*	*scientist/ academic teacher*	*Lab classes*
Agata Kozioł	*dr*	*Medical Chemistry*	*scientist/ academic teacher*	*Lab classes*
Anna Kałuża	*mgr*	*Medical Chemistry*	*scientist/ academic teacher*	*Lab classes*
Justyna Szczykutowicz	*mgr*	*Medical Chemistry*	*scientist/ academic teacher*	*Lab classes*

Date of Syllabus development

31.05.2020

Syllabus developed by

Anna Lemańska-Perek

Signature of Head of teaching unit

Uniwersytet Medyczny we Wrocławiu
KATEDRA I ZAKŁAD CHEMII I IMMUNOCHEMII
kierownik

.....

dr hab. Mirosława Ferens-Sieczkowska, prof. nadzw.

Signature of Faculty Dean

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Wrocław Medical University
Faculty of Medicine
Vice-Dean for Education Studies
prof. Beata Sobieszczańska, PhD