



WL-7/1521/2020

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Syllabus for academic year: 2020/2021														
Training cycle: 2020-2025														
Description of the course														
Module/Course	Basic of medical chemistry										Group of detailed education results			
											Group code B	Group name Scientific foundations of medicine		
Faculty	Faculty of Dentistry													
Major	Dentistry													
Unit realizing the subject	Department of Chemistry and Immunochemistry													
Specialties														
Level of studies	Uniform magister studies X* 1 st degree studies <input type="checkbox"/> 2 nd degree studies <input type="checkbox"/> 3 rd degree studies <input type="checkbox"/> postgraduate studies <input type="checkbox"/>													
Form of studies	X full-time <input type="checkbox"/> part-time													
Year of studies	1st	Semester		X Winter <input type="checkbox"/> Summer										
Type of course	X obligatory <input type="checkbox"/> limited choice <input type="checkbox"/> free choice / elective													
Course	<input type="checkbox"/> major X basic													
Language of instruction	<input type="checkbox"/> Polish X English <input type="checkbox"/> other													
* mark <input type="checkbox"/> with an X														
Number 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													



Direct (contact) education							13									13
Online learning (synchronous)	10	8					2									20
Distance learning (asynchronous)		2														2

Summer Semester

Direct (contact) education																
Online learning (synchronous)																
Online learning (asynchronous)																

TOTAL per year:

Direct (contact) education							13									13
Online learning (synchronous)	10	8					2									20
Online learning (asynchronous)		2														2

Educational objectives (max. 6 items)

- C1.** The transfer of knowledge in the field of structure, properties, and functions of the basic chemical components of tissues and biological fluids of humans.
- C2.** Explanation of the basic mechanisms of chemical homeostasis and chemical composition of biological fluids, as a background for further biochemistry and physiopathology teaching.
- C3.** Teaching chemical calculations and interpretation of the results obtained from experiments performed.
- C4.** Development of appropriate ethical and proper communication skills.

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 <i>**enter the abbreviation</i>
W 01	B.W.1. B.W.23	Knows the role of major and trace elements in the processes occurring in the body, including intake, absorption, transport and toxicity Describes water and electrolyte equilibrium within the body Understands the role of selected macro and microelements in the human body. He/she knows the consequences of a deficiency of minerals and their excess in the body.	Presentation of the scope of knowledge with oral expression, written report, essay, multimedia presentation Written test No. 1: calculations, open questions.	SE 1, LC 1
	B.W.2 B.W.6	Knows and understands the definition of: pH, solubility, osmotic	Presentation of the scope of knowledge	SE 1,2,5-7 LC 2,5-7



	B.W.21 B.W.23	pressure, as well as isoionic, isohydric and, isotonic balance. Describes the acid-base balance, the mechanism of action of buffers and their importance in systemic homeostasis. Is able to define the factors affecting the acid-base balance and to characterize the transport of oxygen and carbon dioxide in the body, understands the importance of homeostasis of the body system.	with oral expression, written report, essay, multimedia presentation Written test No. 1: calculations, open questions.	
	B.W4.	Knows the basic reactions of inorganic and organic compounds in aqueous solutions. Recognizes and explains the types of chemical reactions that take place in biological systems, in / on the cells. Knows the structure of simple organic compounds that are components of macromolecules present in cells, extracellular matrix and body fluids	Presentation of the scope of knowledge with oral expression, written report, essay, multimedia presentation Written tests No. 2,3: calculations, open questions, writing chemical formulas and reactions.	B.W4.
	B.W4.	Describes the chemical structure of saccharides, polysaccharides, glycosaminoglycans and glycosides, and their functions in cellular structures and extracellular space. Describes the chemical structure of lipids and basic steroids, their functions in cellular structures and extracellular space. He/she 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 questions, writing chemical formulas and reactions.	SE 3, LC 3,4, L 1,2,5
	B.W4.	Describes the chemical structures of amino acids and peptides and their functions in cellular structures and extracellular matrix. Characterizes the structure of biogenic amines and their formation. Knows the post-translational modifications of amino acids / proteins and their importance. Is able to characterize the I-, II-, III and IV level of protein structure Describes the chemical structure of proteins, including mucins. Knows and understands the concepts: colloidal solutions and Gibbs-Donnan balance.	Presentation of the scope of knowledge with oral expression, written report, essay, multimedia presentation Written test No. 3: calculations, open questions.	SE 5, LC5,6 L 3, 4,5



	B.W4.	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	SE 3-6, LC 3-6
U 01	B. U1.	Calculates the percentage and molar concentrations of compounds in the solution, in mono- and multi-component solutions. Is able to prepare a solution of a substance at a given concentration and dilute a solution in a simple and geometrical way	Evaluation of protocols completed by students to assess the knowledge of experimental laboratory procedures.	SE 3-6, LC 3-6
	B. U1. B.U3.	Calculates the solubility of inorganic compounds using appropriate tables and formulas, understands the chemical basis of the solubility or its lack in organic compounds as well as its practical meaning for nutrition and therapy.	Evaluation of performed analyses and interpretation of results, allowing to measure the ability to apply theoretical information in practice.	LC 1, SE 1
	B. U1.	Estimates and determines the pH of the solution and the effect of environmental pH changes on the behaviour of inorganic and organic compounds. Calculates the buffer capacity.	Evaluation of teamwork.	SE 2, LC 2,
	B. U1.	Understands the importance of homeostasis and the consequence of its impairment. Explains the mechanism of body buffers action and their importance in systemic homeostasis. Describes the parameters of acidosis and alkalosis. He/she can define factors affecting the acid-base balance and characterize the transport of oxygen and carbon dioxide in the body.	Assessment of the use of practical skills with stoichiometry and pH measurements of solutions. Written tests 1,2,3,4: open questions, writing chemical formulas and reactions, calculation tasks.	SE 1,2,5,6 LC 1,2,5,6
	B.U1. B. U5.	Is able to execute simple analytical chemical reactions and write the appropriate formulas and reactions. Performs the basic laboratory techniques, such as qualitative analysis, titration, pH measurements,		LC 1-7 SE 1-7



		protein electrophoresis, amino acid chromatography. He/she is able to use the simple laboratory equipment and evaluate the accuracy of measurements that have been taken.	
	B. U5.	Is able to plan, execute and evaluate experiment, as well as draw critical conclusions.	LC 1-7

** 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: 4

Social competences: 5

Student's amount of work (balance of ECTS points)

Student's workload (class participation, activity, preparation, etc.)	Student Workload (h)
1. Contact hours:	35
2. Online learning hours (e-learning):	
3. Student's own work (self-study):	44
Total student's workload	79
ECTS points for module/course	2
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 - Online

Lectures (10h: 5x2h)

Attending lectures is obligatory

1. 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, BW6**

2. Lipids. Essential and non-essential fatty acids. Classification of lipids. Acylglycerols and waxes: structure and function. Complex lipids: glycerophospholipids and sphingolipids: structures, properties, function. Lipid-like compounds: eicosanoids and steroids. Cholesterol. Bile acid and its derivatives, hormones, vit. D. The structure of biological membranes. Lipoproteins as transport complexes. **BW4, BW6**

3. Heterocyclic compounds (purines and pyrimidines and their derivatives, porphyrines, examples of coenzymes and vitamins). **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. **BW4**

4. Proteins. General structure. Organization levels: primary, secondary, tertiary and quaternary structure. Chemical bonds and forces involved in maintaining protein spatial arrangement. **Structural classes of proteins:** contribution of α and β structures. **Globular proteins:** properties and solubility. **Fibrous proteins:** collagen, keratin, elastin, silk fibroin – association of structure and function. **BW4, BW2**



5. Membrane proteins: ways of association with the membrane. Integral membrane proteins (β -barrel, bench of α -helices, single α -helix). Peropheric proteins: anchoring via lipid fragments (acylation, prenylation, GPI) and weak surface associations. Protein aging. **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. Bacterial glycoconjugates: lipopolysaccharide (LPS) and peptidoglycan.

BW4, BW2

Seminars

Seminar I Online

- Water balance of the body and body water.
- Water and electrolyte management: electrolyte composition, pH of various selected body fluids (blood plasma, saliva, gastric juice, urine, bile, cerebrospinal fluid).
- Micro, macro-components and trace elements of the body. Intake and demands. Toxic elements.
- Elements of the systemic balance with respect to isovolemia, isoionia i isohydria.
- Simple and geometric dilutions.
- Calculations: percent and molar concentration, molar mass.

Seminar II Online

Buffers: types, composition and properties:

- Henderson-Hasselbalch equation for acidic and alkaline buffers.
- Definition of buffer capacity and the effect of strong acids and bases on buffer pH and capacity.

Buffers of body fluids as elements of maintaining homeostasis:

- Bicarbonate, protein, hemoglobin, and phosphate buffers.
- The involvement of blood, lungs and kidneys in maintaining physiological pH in the human body.
- Transport of oxygen and carbon dioxide in the body.
- Values of physiological acid-base balance parameters. The concept of acidosis and alkalosis.

Chemical calculations:

- Calculation of pH and pOH of monocomponent solutions and buffers.
- Calculation of buffer capacity of buffer solutions.
- Calculation of changes in the pH / pOH of the buffer after addition of a strong acid or strong base.

Seminar III Online

Sugars of tissues and body fluids of the human organism:

- Selected isomerization and epimerization reactions of monosaccharides in biological systems.
- Oxidation and reduction of carbohydrates.
- D-glucose derivatives - glucuronides and L-ascorbic acid.
- O-glycosidic bonding in oligosaccharide structures, N- and O-glycosides including glycoproteins.
- Damage of sugar rings by reactive oxygen species.
- Monosaccharides of body fluids: blood plasma, urine, human milk, cerebrospinal fluid, seminal plasma.
- Sugar reactions in the diagnosis of hypo- and hyperglycaemia.

Seminar IV Online

Lipids in the body

- Essential and non-essential fatty acids.
- Triacylglycerols and energy storage, physic-chemical and hydrophobic properties.
- Membrane lipids: phosphatides and sphingosides, physic-chemical and amphipatic properties.
- Steroids: structure, properties, biological functions.

Test no 1: calculations, solutions, buffers, carbohydrates (SE, LC 1-3, L 1)

Seminar V Online



Amino acids and proteins of body fluids: blood plasma, human milk, saliva, gastric juice.

- The isoelectric point of amino acids.
- N- and C-terminal amino acids of the polypeptide. Methods for determining the N- and C-terminal amino acid.
- Non-protein amino acids, biogenic amines - formation and functions.
- Primary structure of proteins, peptide bond.
- Disulfide bridges in proteins.
- Peptides with biological activity.
- Glycosylation and glycation of proteins. Damage of the protein structure caused by reactive oxygen species.

Seminar VI Online

Proteins, salting out, dialysis.

- II-, III- and quaternary structure of proteins, types of bonds and structure-stabilizing interactions. Isoionic point of proteins.
- Basic post-translational amino acid modifications in proteins: acetylation, hydroxylation, phosphorylation, carboxylation, methylation.
- Solubility of globular proteins depending on the structure, pH of the solution and salt concentration.
- Salting out and salting in of proteins.
- Equilibrium in aqueous solutions of proteins separated by semipermeable membrane:
 - a) osmosis, tonicity
 - b) dialysis - mechanism and application.
- Denaturation and coagulation of proteins with chemical agents.

Seminar VII Online

Electrophoresis of proteins and serum lipoproteins.

- The principle of electrophoresis.
- Gels used for electrophoretic separation: agar, agarose, polyacrylamide gel.
- Electrophoresis of serum proteins in agarose. Densitometric analysis.
- Separation of serum lipoproteins in agarose.
- The principle of electrophoretic separation of nucleic acids.
- Principle of separation in capillary electrophoresis and isoelectric focusing.

Test no 2: lipids, amino acids, proteins (SE, LC 4-6, L 2-3)

Seminar VIII Online

Test no 3: electrophoretic techniques, fibrous and membrane proteins, glycoconjugates (SE, LC 7, L 4, 5)

Seminar IX Online

Tests retake 1

Seminar X Online

Tests retake 2

Practical classes

Classes

All classes are based on Handbook of chemistry: for students Faculty of Medicine and Faculty of Dentistry; ed. Iwona Kałtnik-Prastowska; Wrocław 2017

1. Chemical solutions: preparation of a solution of demanded concentration, simple and serial dilutions. Strip test, determination of glucose concentration and pH value of urine. Calculations and recalculations of concentrations.



2. Buffers. Preparation of buffer solutions, pH measurements, determination of buffer capacity by means of buffer titration with a strong base and strong acid. Calculation of buffer pH and capacity.

3. Saccharides. Synthesis of alpha-glucose pentaacetate. Oxidation of saccharides: reduction of picric acid. Differentiating monosaccharides and reducing disaccharides – Barfoed's test. Detection of monosaccharides – Molisch reaction. Condensation of phenylhydrazine and monosaccharides - identification of monosaccharides. Enolization (Seliwanoff's reaction). Sucrose hydrolysis - stability of the O-glycosidic linkage.

4. Lipids. Esterification of salicylic acid. Extraction of lipids from hen egg yolk. Hydrolysis of lecithin Oxidation of unsaturated fatty acids. Detection of cholesterol in natural products (Salkowski reaction). Hay's test with sulphur. Detection of hydroxyl groups in bile acids. Pattenkofer's reaction.

5. 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, identification of cysteine, the biuret assay. Reaction of a free amino group (Sanger reaction).

6. Proteins. Fractionation of serum proteins with ammonium sulphate. Dialysis. Denaturation of proteins.

7. The electrophoresis of serum proteins and lipoproteins in agarose. Execution of electrophoretic separation and visualisation of compounds. Densitometric analysis. Comparison of the results in physiological and pathological samples.

8. Making up of missed laboratory classes.

Other

Not applicable

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

Chemistry. An Introduction to General, Organic and Biological Chemistry. Timberlake KC, Benjamin Cummings, Pearson Education, Inc., 2015

2. Handbook of chemistry: for students Faculty of Medicine and Faculty of Dentistry; ed. Iwona Kątnik-Prastowska; Wrocław: Wrocław Medical University, 2017

3. Bioanalytical chemistry. Manz A, Pamme N, Ossifidis D, Imperial Colleg Press, 2004 USA. ISBN 1-86094-371-3

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

1. Introduction to organic chemistry; WH. Brown; Harcourt Brace and Company, Inc., 2000 USA.

2. Organic Chemistry; G Solomons, C Fryhle; ed JOHN WILEY & SONS., Inc., 2000 USA

3. Clinical chemistry: Principles, Procedures, Correlations; ML Bishop, JL Duben-Engelkirk, EP Fody; ed Lippincott Williams and Wilkins, Inc., 2000 USA

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 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, 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

Solutions: electrolytes and non-electrolytes; solubility; concentration of solutions – percentage and molar, molar mass 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 and reduction, polarity of organic compounds

Each student must be also familiar with the **course curriculum, schedule and rules** available on the Department website.

Conditions to receive credit for the course (specify the form 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 met by the student to pass it and criteria for specific grades)

IMPORTANT! Class attendance cannot be a condition for passing the subject.

1. All the laboratory classes must be completed and the written protocols evaluated positively.
2. Positive evaluation of each of the three control tests (60 % out of total pool of points). Tests are written and have diverse forms: multiple choice, calculations, chemical reactions, writing of chemical formulas of sugars, fats, amino acids, proteins.

Grade:	Criteria (only for courses/modules ending with an examination)
Very Good (5.0)	Not applicable
Good Plus (4.5)	Not applicable
Good (4.0)	Not applicable
Satisfactory Plus (3.5)	Not applicable
Satisfactory (3.0)	Not applicable
	Criteria (only for courses/modules ending with e credit)
Credit	Positive evaluation of each of the three control tests (60 % out of total pool of points). Tests are written and have diverse forms: multiple choice, calculations, chemical reactions, writing of chemical formulas of sugars, fats, amino acids, proteins.

Grade:	Criteria (examination evaluation criteria)
Very Good (5.0)	Not applicable
Good Plus (4.5)	Not applicable
Good (4.0)	Not applicable
Satisfactory Plus (3.5)	Not applicable
Satisfactory	Not applicable



(3.0)	
Unit realizing the subject	Department of Chemistry and Immunochemistry
Unit address	Skłodowskiej-Curie Street 48-50
Telephone	607 604 848
E-Mail	immunochemia@umed.wroc.pl

Person responsible for module	Dr hab. Mirosława Ferens-Sieczkowska, prof. nadzw.
Coordinator	Dr hab. Mirosława Ferens-Sieczkowska, prof. nadzw.
Telephone	607604848
E-Mail	mirosława.ferens-sieczkowska@umed.wroc.pl

List of persons conducting specific classes

Full name	Degree/scientific or professional title	Discipline	Performed profession	Form of classes
Mirosława Ferens-Sieczkowska	dr hab., prof. nadzw.	Medical Science	scientist/ academic teacher	Lectures
Anna Lemańska-Perek	dr	Medical Science	scientist/ academic teacher	Seminars and laboratory classes
Anna Kałuża	mgr	Medical Science	scientist/ academic teacher	Seminars and laboratory classes

Date of Syllabus development

25.09.2020

Syllabus developed by

Anna Lemańska-Perek

Signature of Faculty Dean

Uniwersytet Medyczny we Wrocławiu
WYDZIAŁ
LEKARSKO-STOMATOLOGICZNY
SZKIEŁAN
prof. dr hab. Marcin Mikulewicz

Signature of Head of teaching unit

Uniwersytet Medyczny we Wrocławiu
KATEDRA I ZAKŁAD CHEMII I IMMUNOCHEMII
Kierownik
dr hab. Mirosława Ferens-Sieczkowska, prof. nadzw.