1. COURSE DECRIPTION – GENERAL INFORMATION			
1.1. Course teacher	Associate Professor Sanja Dabelić	1.6. Year of study	2nd
1.2. Name of the course	**Biological Chemistry**	1.7. Credit value (ECTS)	3.5
1.3. Associate teachers	Professor Jerka Dumić Associate Professor Gordana Maravić Vlahoviček Assistant Professor Sandra Šupraha Goreta Assistant Professor Olga Gornik Toma Keser, MPharm	1.8. Type of instruction (number of hours L+E+S+e-learning)	30+0+15 (e-learning - is not included in standard hours, but is used in teaching)
1.4. Study programme (undergraduate, graduate, integrated)	Pharmacy integrated study programme	1.9. Expected enrolment in the course	130
1.5. Status of the course	Compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd
2. COURSE DESCRIPTION			
2.1. Course objectives	To acquire the basic knowledge on the structure of biological macromolecules.To understand structure-function relationships of biological macromolecules, arrangement of biological membranes and transport across them, mechanisms of enzyme activity, and reaction-coupling in a living organism. To describe the principles of basic analytical and preparative biochemical techniques.		
2.2. Enrolment requirements and required entry competences for the course	Passed exam Cellular biology with genetics Input Competence: application of high school knowledge of chemistry, physics, mathematics and biology; understanding the structure and physiology of prokaryotic and eukaryotic cells, as well as the basic principles, theories and mechanisms of heredity.		
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Defining, analyzing and proposing actions related to research, development, production, analysis and quality control of drugs by applying the fundamentals of biochemistry.		

	• Critical assessment and application of scientific knowledge and available information in order to improve the profession, problem solving, application of new technologies and improving the existing ones.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After successfully completing the course, students will be able to: 1. Describe the structure of biological molecules / macromolecules and biological membranes; 2. Correlate the characteristics of individual functional groups, as well as the overall properties of biological molecules / macromolecules and biological membranes with their function; 3. Analyse the modes of transport across biological membranes; 4. Give examples of the abnormal structure / localization / activity of biological macromolecules that lead to the development of the disease or are used for the diagnosis / treatment of diseases; 5. Explain the principles of bioenergetics, thermodynamics and kinetics of reactions occuring in living organisms. 6. Describe the course of enzymatic reactions and mechanisms of enzyme catalysis; 7. Compare the mechanisms of modulation of enzymatic activity; 8. Define the principles of basic biochemical analysis techniques and protein purification; 9. Perform simple biochemical analysis – detect particular biological macromolecules in biological samples, purify proteins using fundamental purification methods, extract lipids and determine Vm and Km of enzymes;
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introductory lecture; Biochemistry - the logic of life, coupling of biochemistry and molecular life sciences; Biochemistry as a basis of biomedical sciences. Life conditions. The chemical composition of cells (elemental composition of living matter, the properties of water, functional groups and structure of biomolecules, properties of biological macromolecules: directionality, modular design, conformational dynamics, information, meaning (importance) of non-covalent forces, complementarity and molecular structure of cells). • Amino acids. Proteogenic amino acids. Ionization properties of amino acids. The chemical properties of amino acids. Classification of amino acids according to the various properties. Modification of proteogenic amino acids. Biologically important non-proteogenic amino acids. Buffers in biological systems and buffer capacity. • Theoretical basis of potentiometric titration of amino acids, biochemical techniques, enzyme kinetics, structure of carbohydrates, lipids and nucleic acids (preparation to access to the laboratory exercises). • Peptide bond. The properties of peptide bond. Biologically important peptides. Proteins. Protein classification. Primary, secondary, tertiary and quaternary structure. The functional and structural domains.

	• Proteins - native conformation and denaturation of proteins. Fibrous proteins - keratin, collagen, silk. Globular proteins - myoglobin, hemoglobin, immunoglobulins. The evolution of protein structure. Post-translational modifications of proteins. • Biochemical techniques for protein purification. Sedimentation technique. Chromatographic techniques. Electrophoretic techniques. Determination of the protein primary structure. • Nucleic acid - nucleotides, nucleic acid structure. Complementarity of DNA double helix. DNA conformations. Thermic denaturation of DNA. Types of RNA. Secondary, tertiary structure of RNA. The flow of genetic information. • Carbohydrates. Monosaccharides. The stereochemistry of monosaccharides. Cyclization of monosaccharides. Chemical reactions of monosaccharides. Reductive properties of carbohydrates. Biologically important derivatives of monosaccharides. The glycosidic bond. Disaccharides. Oligosaccharides. Polysaccharides. The biological roles of carbohydrates. • Lipids - classification of lipids. Fatty acids. Triacylglycerols (neutral lipids). Waxes. Phospholipids and sphingolipids. Chemical reactions and properties of lipids. Soaps and detergents. Isoprenoid lipids - steroids, carotenoids, isoprenoid vitamins. Eicosanoids. • Glycoconjugates - classification, structural and functional characteristics. Synthesis of glycan / glycoconjugates. Glycoproteins. Proteoglycans. Glycolipids. Glycocylphosphatidyl-inositol anchors. Lectins. Glycan-lectin-interactions as a basis of many important biological processes. Examples of glycans in health, disease, diagnosis and treatment of disease. • The structural and functional characteristics of the membrane lipids. Biological membranes - supramolecular structures with many functions. Micelles, lipid bilayers, liposomes. Physical and chemical properties of biological membranes. Membrane proteins. Transport across the membrane. The transport mechanisms (passive, facilitated/assisted, active). Thermodynamics / energetics and kinetics of membrane transport. Concentration and electrochemical gradients. • Bioenergetics. Life - non-equilibrium steady state. Thermodynamics of biological reactions -Energy potential of reactions. Metastability of open system, the driving force of biological reactions.Cellular concentration ratios. Thermodynamic laws govern biological processes. Coupling endergonic and exergonic reactions. ATP - the energy currency.Potential of group transfer. • Enzymes - biological catalysts. Classification of enzymes. Active centre. Specificity and acceleration. Isoenzymes. Coenzymes - role of coenzymes. • Enzyme catalysis. The mechanisms of enzyme catalysis. Thermodynamics of enzyme-catalysed reactions. Rate of the enzymatic reaction. • Michaelis-Menten kinetics. Inhibition of enzymatic reactions. Regulation of metabolism. EXERCISES: • Potentiometric titration of amino acids - ionization properties of amino acids, assessment (determination) of the molecular weight of amino acides, the determination of the buffer capacity. • Gel-filtration of haemoglobin.Purification of immunoglobulin G from human serum (selective precipitation and desalting by gel-filtration). • Purification of immunoglobulin G from human serum (ion-exchange chromatography, detecting the presence

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<tr><td></td><td colspan="6">and estimation of purity of IgG).
• Enzyme kinetics - the time course of the enzymatic reaction, the dependence of the initial rate of enzyme reaction on the concentration of substrate and enzyme.
• Carbohydrates-detection of starch, carbohydrates, reductive carbohydrates, proteins, glucose in biological samples, degradation of disaccharides to monosaccharides.</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>Lectures</u>
seminars and workshops
<u>exercises</u>
online in entirety
mixed e-learning
field work</td><td colspan="2">independent study
multimedia and the internet
<u>laboratory</u>
work with the mentor
(other)</td><td>2.7. Comments:
e-learning - is not included in standard hours, but is used in teaching and contains exams for knowledge-self-evaluation with solutions, links to different pages, video and audio materials, etc.</td></tr>
<tr><td>2.8. Student responsibilities</td><td colspan="6">The students are required to attend classes that take place in the form of lectures and practical classes (exercises).
To be eligible to attend exercise, the students are required to describe basic macromolecule structure and principles of methods that are related to the exercise subject. The students, for the achievement of credits and grades in specified courses, are required to take the written and oral exam and pass them both successfully.</td></tr>
<tr><td rowspan="6">2.9. Screening of student’s work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)</td><td>Class attendance</td><td>1</td><td>Research</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Experimental work</td><td>0.5</td><td>Report</td><td></td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Oral exam</td><td>1.5</td><td>(Other—describe)</td><td></td></tr>
<tr><td>Written exam</td><td>0.5</td><td>Project</td><td></td><td>(Other—describe)</td><td></td></tr>
<tr><td></td><td colspan="5"></td></tr>
<tr><td>2.10. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="6">The students are evaluated according to the performance in the written (20%) and oral examination (80%), which can be accessed only after the attended lectures and practical exercises. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled information management and integration.</td></tr>
<tr><td rowspan="3">2.11. Required literature (available at the library and via other media)</td><td colspan="6">Title</td></tr>
<tr><td colspan="6">Dumić, J., Dabelić, S., Gornik, O., Maravić Vlahoviček, G., Novak, R., Šupraha Goreta, S. Biološka kemija – praktikum, Farmaceutsko-biokemijski fakultet Sveučilišta u Zagrebu, Zagreb, 2010., ISBN 978-953-6256-61-7.
J. M. Berg, J. L. Tymoczko, L. Stryer, Biokemija, Školska knjiga, Zagreb, 6. englesko izdanje, 1 hrvatsko, 2013., ISBN 978-953-0-309928-9</td></tr>
<tr><td colspan="6">Dabelić S. and Dumić J. Biological Chemistry Powerpoint presentations – for the present academic year</td></tr>
<tr><td>2.12. Optional literature</td><td colspan="6">D. L. Nelson, M.M. Cox, Lehninger, Principles of Biochemistry, W.H. freeman and Co, Sixth Ed, 2013.
Voet, Voet – Biochemistry, John Wiley&Sons, Second Ed, 1995 (or later editions)</td></tr>
</table>

	G.M. Cooper, R.E Hausmann, Stanica: molekularni pristup, Medicinska naklada, Peto izdanje, 2010. ISBN 953-176-248-1
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1,2,6,8 and 9 are checked orally before and during laboratory exercise and outcomes 1-9 are checked by written and oral exam.