



Univerza v Mariboru

Medicinska fakulteta

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Biokemija
Course title:	Biochemistry

Študijski program in stopnja Study programme and cycle	Študijska smer Study option	Letnik Year of study	Semester Semester
Dentalna medicina/Dental Medicine 2. stopnja/2nd cycle		1	2

Vrsta predmeta / Course type

Obvezni/Compulsory

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical training	Druge oblike študija Other forms of study	Samost. delo Individual work	ECTS
45	45	30			60	6

Nosilec predmeta / Lecturer:

Red. prof. dr. Uroš Potočnik, Doc. dr. Helena Sabina Čelešnik

Jeziki /

Predavanja / Lectures: slovenščina/slovene

Languages:

Vaje / Tutorial: slovenščina/slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

- Uvod v biokemijo
- Uvod v strukturo beljakovin:
  - Aminokisliline: struktura, povezava med strukturo in funkcijo, izoelektrična in izoionska točka, analitika aminokislin, biološka vloga.
  - Peptidi: biološko aktivni peptidi; strukturne osnove delovanja peptidnih hormonov
  - Primarna, sekundarna, terciarna in kvartarna struktura beljakovin
- Beljakovine: splošna zgradba in lastnosti, razdelitev po funkciji (encimi, transportne, skladiščne, kontraktilne, strukturne, obrambne in regulatorne beljakovine)
- Fibrilarne in globularne beljakovine
  - Struktura in funkcija fibrilarnih beljakovin: keratin, kolagen, elastin
  - Monomerna in oligomerna struktura beljakovin: mioglobin in hemoglobin
- Encimi: splošne značilnosti in osnove encimske kinetike
  - Mehanizmi encimskih reakcij, regulacija encimske aktivnosti (alosterična modulacija, kovalentna

Content (Syllabus outline):

- Introduction to the biochemistry
- Introduction to the protein structure:
  - aminoacids: structure, links between structure and function, isoelectric and isoionic point, analysis of aminoacids, biological role.
  - Peptides: biologically active peptides, structurally based function of peptide hormones
  - Primary, secondary tertiary and quaternary structure of proteins.
- Proteins: general structure and characteristics, classification by the function (enzymes, transport, contractile, accumulative, defence and regulatory proteins).
- Fibrilar and globular proteins.
  - Structure and function of fibrillary proteins: keratin, collagen, elastin.
  - Monomeric and oligomeric structure of proteins: myoglobin and haemoglobin.
- Enzymes: general features and bases of enzymatic kinetics.
  - Mechanism of enzymatic reactions, regulation of enzymatic activities (allosteric modulation, covalent

<p>modifikacija, regulacija prek proteolitičnih encimov), klasifikacija in nomenklatura encimov</p> <ul style="list-style-type: none"> <li>• Koencimi</li> </ul> <ol style="list-style-type: none"> <li>6. Biokemijske komponente celic in tkiv</li> <li>7. Enostavni in sestavljeni polisaharidi, glikoproteini, celična stena</li> <li>8. Metabolizem</li> <li>9. Prebavni encimi, uvod v metabolne poti – regulacija metaboličnih poti, glavni eksperimentalni pristopi za študij metabolizma</li> <li>10. Encimska razgradnja glikozidnih vezi</li> <li>11. Oksidativni procesi v celici in pridobivanje energije</li> <li>12. Metabolizem ogljikovih hidratov, uravnavanje sinteze in razgradnje ogljikovih hidratov</li> <li>13. Metabolizem maščobnih kislin in trigliceridov</li> <li>14. Metabolizem nukleotidov in nukleinskih kislin, uravnavanje metabolizma nukleotidov, bolezni povezane z metabolizmom nukleotidov</li> <li>15. Metabolizem membranskih lipidov, celična razgradnja in biosinteza enostavnih in sestavljenih lipidov; biosinteza in razgradnja žolčnih kislin; metabolizem lipoproteinov; metabolizem prostaglandinov; uravnavanje metabolizma lipidov, bolezni povezane z metaboličnimi defekti v metabolizmu lipidov</li> <li>16. Metabolizem aminokislin, prebava proteinov, biološka vloga vitaminov</li> <li>17. Pomen biokemije za razlago in zdravljenje bolezni</li> <li>18. Biosinteza proteinov, usmerjanje, znotrajcelični transport, zvijanje, kontrola kvalitete, degradacija</li> <li>19. Membranske beljakovine, prenos snovi skozi biološke membrane, pasivni in aktivni transport, primeri pasivnega in aktivnega transporta pri človeku</li> <li>20. Vloga hormonov v uravnavanju metaboličnih procesov</li> <li>21. Metabolizem mineralov, vnos, zadrževanje in izločanje mineralnih snovi pri človeku (kalcij, magnezij, železo, cink, jod, itn.)</li> <li>22. Metabolizem goriv v različnih metabolnih stanjih (po obroku, med obroki, dolgotrajno stradanje)</li> <li>23. Metabolične značilnosti posameznih tkiv in organov. Skeletna mišica, srčna mišica, jetra, maščevje, ledvica, živčevje, krvni elementi, koža, oko, pljuča, vezivno tkivo</li> <li>24. Medsebojna odvisnost in vloga organov v metaboličnih procesih pri človeku.</li> <li>25. Biokemija krvnih skupin in koagulacija krvi;</li> <li>26. Signalna transdukcija</li> <li>27. Metabolne bolezni, vključno dedni sindromi</li> <li>28. Rekombinantna DNA tehnologija, genetsko inženirstvo, biotehnologija; tehnologija CRISPR; uporaba v stomatologiji</li> <li>29. Uvod v genomiko, proteomika, farmakogenomika, personalizirana medicina; bioinformatika;</li> <li>30. Genska terapija; terapija z matičnimi celicami</li> <li>31. Biokemijske in molekularne osnove raka</li> </ol>	<p>modification, regulation of proteolytic enzymes), classification and nomenclature of enzymes.</p> <ul style="list-style-type: none"> <li>• Coenzymes.</li> </ul> <ol style="list-style-type: none"> <li>6. Biochemical components of cells and tissues.</li> <li>7. Simple and complex polysaccharides, glycoproteins, cell wall.</li> <li>8. Metabolism.</li> <li>9. Digestive enzymes; introduction to the metabolic pathways, major experimental approaches to the study of metabolism.</li> <li>10. Enzymatic digestion of glycoside bonds.</li> <li>11. Oxidative processes in the cell and energy generation.</li> <li>12. Metabolism of carbohydrates, regulation of anabolism and catabolism of carbohydrates.</li> <li>13. Metabolism of fatty acids and triglycerides.</li> <li>14. Metabolism of nucleotides and nucleic acids, regulation of their metabolism, diseases.</li> <li>15. Metabolism of membrane lipids, anabolism and catabolism of simple and complex triglycerides, bile acids, lipoproteins, prostaglandins, regulation of lipid metabolism. Diseases that arose from metabolism disorders.</li> <li>16. Metabolism of amino acids and proteins, Haem metabolism, biological role of vitamins</li> <li>17. Importance of biochemistry for disease explanation and treatment.</li> <li>18. Biosynthesis of proteins, conformations, folding, quality control, intracellular transport, protein degradation.</li> <li>19. Membrane proteins: transport over the membrane, passive and active transport in human body.</li> <li>20. Role of hormones in the regulation of metabolic processes.</li> <li>21. Metabolism of minerals, intake, storage and secretion of minerals in the human body (calcium, magnesium, zinc, iodine, ...).</li> <li>22. Fuel metabolism in different states (the feed state, absorptive state, prolonged fasting)</li> <li>23. Metabolic characteristics of individual tissues and organs (skeletal muscle, heart muscle, liver, adipose tissue, kidneys, nervous system, blood elements, skin, eye, lungs, connective tissue).</li> <li>24. Interrelation and interactions of the organs in the metabolism of human body.</li> <li>25. biochemistry of blood groups and coagulation;</li> <li>26. signal transduction</li> <li>27. Metabolic diseases, including hereditary syndromes</li> <li>28. Recombinant DNA technology, genetic engineering, biotechnology; CRISPR technology; applications in stomatology;</li> <li>29. Introduction to Genomics, proteomics, farmacogenomics, personalized medicine, bioinformatics</li> <li>30. Gene therapy; stem cell therapy</li> <li>31. Biochemical and molecular basis of cancer</li> <li>32. Biochemistry of the saliva (composition, properties).</li> </ol>
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32. Biokemija slin (sestava, lastnosti)
33. Sestava in molekularna biologija trdih zobnih tkiv.
34. Regeneracija in reparacija trdih zobnih tkiv
35. Sestava in lastnosti obzobnih tkiv. Biokemijski procesi v obzobnih tkivih.
36. Proces biomineralizacije.
37. Biokemija pelikla.
38. Pomen ustnih bakterij in njihovih metaboličnih aktivnosti.

33. Composition and molecular biology of hard dental tissues.
34. Regeneration and repair of hard dental tissues.
35. Composition and properties of the surrounding tissues (peridontium). Biochemical processes in the peridontium.
36. Biomineralization.
37. Pellicle biochemistry.
38. The role of oral bacteria and their metabolic activities.

**Temeljni literatura in viri / Readings:**

1. D.L. Nelson, M.M. Cox. Lehninger Principles of Biochemistry, 7th ed, W.H. Freeman and Company, New York, 2012.
2. Rodney Boyer, Concepts in Biochemistry, 3rd Ed. Wiley, 2006, ISBN: 139780471661795.
3. Michael Lieberman, Allan Marks, Alisa Peet.: Marks' basic medical biochemistry : a clinical approach. 4th ed., Philadelphia : Lippincott Williams & Wilkins, 2013.

**Dopolnilna literature in viri/ Additional Readings:**

4. M. Levine: Topics in Dental Biochemistry, Springer-Verlag Berlin, Heidelberg, 2011, ISBN 978-3-540-88115-5
5. N. V. Bhagavan, Chung-Eun Ha.: Essentials of Medical Biochemistry 2nd Edition With Clinical Cases, Paperback ISBN: 9780124166875 ; Imprint: Academic Press ; Published Date: 1st June 2015
6. Dewlin, Thomas M: Textbook of Biochemistry With Clinical Correlations, 8th Ed J. Wiley & sons, Hoboken (New Jersey), 2014
7. Lee W. Janson, M. Tischler, Medical Biochemistry: The Big Picture (LANGE The Big Picture), McGraw-Hill, 2012, ISBN:9780071637923.
8. Florian Horn. Biochemie des Menschen, 5., korrigierte Auflage 2012 664 S. , 1180 Abb., Broschiert ISBN: 9783131308856

**Cilji in kompetence:**

Cilj tega predmeta je obnoviti osnovna znanja iz splošne kemije in poznavanja kemijske zgradbe molekul in reakcij, ter razumeti kemijske reakcije in procese v človeškem organizmu.

Študent se spozna z biomolekulami v človeškem telesu in s temeljnimi zakonitostmi ter mehanizmi biokemičnih dogajanj, ki predstavljajo osnovo za razumevanje življenjskih procesov v zdravem in bolezenskem stanju organizma.

Pridobi si osnovno znanje iz biokemičnih procesov, ki omogoča živim organizmom normalno delovanje in vzdrževanje optimalnih koncentracij celičnih sestavin in telesnih tekočin ter rast in razmnoževanje.

**Predvideni študijski rezultati:**

Znanje in razumevanje:

Študent bo sposoben prepoznati in razlikovati molekule. Razumel bo kemijske reakcije ter znal razložiti transportne pojave, ki potekajo v človeškem organizmu.

Biokemija integrira molekularne osnove temeljnih življenjskih procesov in je nujna za razumevanje vzrokov bolezni ter molekularnih pristopov zdravljenja. Povezuje znanje o molekularnih mehanizmih delovanja zdravega organizma in okvar, ki privedejo do bolezni.

Prenesljive/ključne spretnosti in drugi atributi:

Študent bo razvil spretnosti dela v skupini ter spretnost računanja.

**Objectives and competences:**

The objective of this course is to renew the basic knowledge of general chemistry and knowledge of the chemical structure of molecules and reactions, and to understand the chemical reactions and processes in human body.

Students get acquainted with biomolecules in the human body with fundamental characteristics and mechanisms of biochemical reactions as a basis for understanding of life and processes in the healthy and ill state of the organism.

Students acquire the basic knowledge in biochemical processes to maintain the normal and optimal function of the human body.

**Intended learning outcomes:**

Knowledge and Understanding:

On completion of this course the student will be able to recognize and differentiate molecules, to understand the chemical reactions in human body and know to explain transport phenomenon in human body

An integrative approach of fundamental living processes and understanding of disease incidence and molecular approaches of healing. Integrative knowledge of molecular mechanisms of functioning of the healthy organism and disorders that consequently lead to the disease.

Transferable/Key Skills and other attributes:

Student will be able to work in team and to improve the skills of computation.

Spoznavanje delovanja organizma na molekularni ravni. Biokemija je povezana s predmeti Molekularna biologija in Biologija celice. Pomaga pri razumevanju Patofiziologije, Farmakologije in večine kliničnih predmetov.

Biochemistry is correlated to the understanding of pathophysiology, pharmacology and most of the clinical subjects.

**Metode poučevanja in učenja:**

**Learning and teaching methods:**

Predavanja  
Seminarji  
Vaje (laboratorijske)

Lectures  
Seminars  
Tutorial (laboratory)

**Načini ocenjevanja:**

**Delež (v %) /  
Weight (in %)**

**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project): written examination
pisni izpit	70 %	assessment of laboratory practical's,
opravljene lab. vaje in kolokvij,	20 %	assessment of project work
opravljen seminar	10 %	
ŠTUDIJSKE OBVEZNOSTI ŠTUDENTOV		ACADEMIC OBLIGATIONS OF STUDENTS:
Opravljene vaje – prisotnost na vajah		Students should complete laboratory work and write reports. Presence at all laboratory work is mandatory.
Opravljene seminarji – prisotnost na seminarjih		Students should write an essay on selected topic and give oral presentation (seminar). Presence at seminar presentations is mandatory.
POGOJI ZA PRISTOP K POSAMEZNEMU PREVERJANJU ZNANJA		REQUIREMENTS FOR ACCESS TO INDIVIDUAL KNOWLEDGE CHECKING:
Opravljene kolokvij iz vaj – pogoj za pristop k izpitu		Laboratory and seminary work project is condition for applying to written exam
Opravljene vaje in dnevnik – pogoj za pristop h kolokvij iz vaj		Students can pass the exam with colloquia which is highly recommended. Colloquia are divided in three sets. For the recognition of written examination must all be positive.
Opravljene seminarji – pogoj za pristop k izpitu		

**Reference nosilca / Lecturer's references:**

**UROŠ POTOČNIK**

JOSTINS, Luke, MITROVIČ, Mitja, POTOČNIK, Uroš, et al. Host-microbe interactions have shaped the genetic architecture of inflammatory bowel disease. **Nature**, ISSN 0028-0836. [Print ed.], 2012, vol. 491, no. 7422, str. 119-124, doi: 10.1038/nature11582. [COBISS.SI-ID 512230968], [JCR, SNIP, WoS do 5. 6. 2016: št. citatov (TC): 945, čistih citatov (CI): 940, čistih citatov na avtorja (CIAu): 46.32, normirano št. čistih citatov (NC): 374, Scopus do 5. 5. 2016: št. citatov (TC): 986, čistih citatov (CI): 979, čistih citatov na avtorja (CIAu): 48.25, normirano št. čistih citatov (NC): 1558], SCI impact factor=36.28

CLEYNEN, Isabelle, BOUCHER, Gabrielle, JOSTINS, Luke, SCHUMM, Philip L., ZEISSIG, Sebastian, AHMAD, Tariq, ANDERSEN, Vibeke, ANDREWS, Jane M, ANNESE, Vito, BRAND, Stephan, et al., MITROVIČ, Mitja (sodelavec pri raziskavi), POTOČNIK, Uroš (sodelavec pri raziskavi), et al. Inherited determinants of Crohn's disease and ulcerative colitis phenotypes : a genetic association study. **The Lancet**, ISSN 1474-547X. [Online ed.], 2016, vol. 387, iss. 10014, str. 156-167. [http://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(15\)00465-1/abstract](http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)00465-1/abstract), doi: 10.1016/S0140-6736(15)00465-1. [COBISS.SI-ID 512567352], [JCR, SNIP, WoS do 1. 6. 2016: št. citatov (TC): 3, čistih citatov (CI): 3, čistih citatov na avtorja (CIAu): 0.13, normirano št. čistih citatov (NC): 1, Scopus do 1. 6. 2016: št. citatov (TC): 4, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 0.17, normirano št. čistih citatov (NC): 1]; SCI impact factor= 45.22

HUANG, Hailiang, FANG, Ming, JOSTINS, Luke, UMIČEVIĆ MIRKOV, Maša, BOUCHER, Gabrielle, ANDERSON, Carl A., ANDERSEN, Vibeke, CLEYNEN, Isabelle, CORTES, Adrian, CRINS, François, et al., MITROVIČ, Mitja (sodelavec pri raziskavi), POTOČNIK, Uroš (sodelavec pri raziskavi), et al. Fine-mapping inflammatory bowel disease loci to single-variant resolution. **Nature**, ISSN 1476-4687. [Online ed.], 2017

[http://www.nature.com/nature/journal/vaop/ncurrent/full/nature22969.html?WT.feed\\_name=subjects\\_computational-biology-and-bioinformatics](http://www.nature.com/nature/journal/vaop/ncurrent/full/nature22969.html?WT.feed_name=subjects_computational-biology-and-bioinformatics), doi: 10.1038/nature22969. [COBISS.SI-ID 512723768],

SCI impact factor= 38.14

RIVAS, Manuel A, MITROVIČ, Mitja, POTOČNIK, Uroš, et al. Deep resequencing of GWAS loci identifies independent rare variants associated with inflammatory bowel disease. *Nature genetics*, ISSN 1061-4036, 2011, vol. 43, no. 11, str. 1066-1073, doi: 10.1038/ng.952. [COBISS.SI-ID 15421974], [JCR, SNIP, WoS do 6. 6. 2016: št. citatov (TC): 280, čistih citatov (CI): 279, čistih citatov na avtorja (CIAu): 12.61, normirano št. čistih citatov (NC): 77, Scopus do 6. 5. 2016: št. citatov (TC): 299, čistih citatov (CI): 297, čistih citatov na avtorja (CIAu): 13.42, normirano št. čistih citatov (NC): 82] SCI impact factor=35.53

BERCE, Vojko, PINTO KOZMUS, Carina, POTOČNIK, Uroš. Association among ORMDL3 gene expression, 17q21 polymorphism and response to treatment with inhaled corticosteroids in children with asthma. *Pharmacogenomics journal*, ISSN 1470-269X, Dec. 2013, vol. 13, issue 6, 523-529.

<http://www.nature.com/tpj/journal/vaop/ncurrent/full/tpj201236a.html>, doi: 10.1038/tpj.2012.36. [COBISS.SI-ID 4406079], [JCR, SNIP, WoS do 4. 2. 2016: št. citatov (TC): 6, čistih citatov (CI): 5, čistih citatov na avtorja (CIAu): 1.67, normirano št. čistih citatov (NC): 2, Scopus do 4. 12. 2015: št. citatov (TC): 8, čistih citatov (CI): 7, čistih citatov na avtorja (CIAu): 2.33, normirano št. čistih citatov (NC): 3]; SCI impact factor= 5.513

KODER, Silvo, REPNIK, Katja, FERKOLJ, Ivan, PERNAT DROBEŽ, Cvetka, SKOK, Pavel, WEERSMA, Rinse K., POTOČNIK, Uroš. Genetic polymorphism in ATG16L1 gene influences the response to adalimumab in Crohn's disease patients. *Pharmacogenomics*, ISSN 1462-2416, 2015, vol. 16, no. 3, str. 191-204, doi: 10.2217/pgs.14.172. [COBISS.SI-ID 512474168], [JCR, SNIP, WoS do 25. 6. 2017: št. citatov (TC): 9, čistih citatov (CI): 7, čistih citatov na avtorja (CIAu): 1.00, Scopus do 27. 6. 2017: št. citatov (TC): 9, čistih citatov (CI): 7, čistih citatov na avtorja (CIAu): 1.00]; SCI impact factor= 2.71

#### **HELENA SABINA ČELEŠNIK**

DEANA, Atilio, ČELEŠNIK, Helena Sabina, BELASCO, Joel G. The bacterial enzyme RppH triggers messenger RNA degradation by 5' pyrophosphate removal. *Nature*, ISSN 0028-0836. [Print ed.], 2008, vol. 451, no. 7176, str. 355-358, doi: 10.1038/nature06475. [COBISS.SI-ID 36254469], [JCR, SNIP]; impact factor = 31.434

RICHARDS, Jamie, LIU, Quansheng, PELLEGRINI, Oliver, ČELEŠNIK, Helena Sabina, YAO, Shiyi, BECHHOFER, David H., CONDON, Ciarán, BELASCO, Joel G. An RNA pyrophosphohydrolase triggers 5'-exonucleolytic degradation of mRNA in *Bacillus subtilis*. *Molecular cell*, ISSN 1097-2765. [Print ed.], 2011, vol. 43, no. 6, str. 940-949, doi: 10.1016/j.molcel.2011.07.023. [COBISS.SI-ID 36255237]; impact factor = 14.178

ČELEŠNIK, Helena Sabina, DEANA, Atilio, BELASCO, Joel G. Initiation of RNA decay in *Escherichia coli* by 5' pyrophosphate removal. *Molecular cell*, ISSN 1097-2765. [Print ed.], 2007, vol. 27, no. 1, str. 79-90, doi: 10.1016/j.molcel.2007.05.038. [COBISS.SI-ID 36251909], [JCR, SNIP]; impact factor = 13.156

MESSING, Simon A., GABELLI, Sandra B., LIU, Quansheng, ČELEŠNIK, Helena Sabina, BELASCO, Joel G., PIÑEIRO, Silvia A., AMZEL, L. Mario. Structure and biological function of the RNA pyrophosphohydrolase BdRppH from *Bdellovibrio bacteriovorus*. *Structure*, ISSN 0969-2126. [Print ed.], 2009, vol. 17, no. 3, str. 472-481, doi: 10.1016/j.str.2008.12.022. [COBISS.SI-ID 36254725], [JCR, SNIP]; impact factor = 5.904

ČELEŠNIK, Helena Sabina, DEANA, Atilio, BELASCO, Joel G. Pablo analysis of RNA: 5'-phosphorylation state and 5'-end mapping. *Methods in enzymology*, ISSN 0076-6879, 2008, vol. 447, str. 83-89, doi: 10.1016/S0076-6879(08)02205-2. [COBISS.SI-ID 36252165], [JCR, SNIP]; impact factor = 2.312