



Univerza v Mariboru

Medicinska fakulteta

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Biokemija
Course title:	Biochemistry

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Splošna medicina	Splošna medicina	1	2
General Medicine-EMŠP	General Medicine	1	2

Vrsta predmeta / Course type

Obvezni/Compulsory

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
45	45		30		60	6

Nosilec predmeta / Lecturer:

Red. prof. dr. Uroš Potočnik

Jeziki /**Languages:****Predavanja / Lectures:****Vaje / Tutorial:**

Slovenski/Slovene

Slovenski/Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**Prerequisites:****Vsebina:****Content (Syllabus outline):**

- Uvod v biokemijo, molekulske osnove življenja, voda, biološko pomembni elementi, ioni in glavne skupine biomolekul:
 - Trigliceridi, monosaharidi in kompleksni ogljikovi hidrati, peptidi in aminokisline, nukleinske kisline in nukleotidi
- Uvod v strukturo beljakovin:
 - Aminokisline: struktura, povezava med strukturo in funkcijo, izoelektrična in izoiionska točka, analitika aminokislin.
 - Peptidi: biološko aktivni peptidi;

- Introduction to the biochemistry, molecular bases of life, water, elements and ions of biological importance, classification of biomolecules:
 - triglycerides, monosaccharides and complex carbohydrates, amino acids and peptides, nucleic acids and nucleotides
- Introduction to the protein structure:
 - aminoacids: structure, links between structure and function, isoelectric and isoionic point, analysis of aminoacids.
 - Peptides: biologically active peptides,

strukturne osnove delovanja peptidnih hormonov • Primarna, sekundarna, terciarna in kvartarna struktura beljakovin 3. Beljakovine: splošna zgradba in lastnosti, razdelitev po funkciji (encimi, transportne, skladiščne, kontraktilne, strukturne, obrambne in regulatorne beljakovine) 4. Fibrilarne in globularne beljakovine • Struktura in funkcija fibrilarnih beljakovin: keratin, kolagen, elastin • Monomerna in oligomerna struktura beljakovin: mioglobin in hemoglobin 5. Encimi: splošne značilnosti in osnove encimske kinetike • Mehanizmi encimskih reakcij, regulacija encimske aktivnosti (alosterična modulacija, kovalentna modifikacija, regulacija prek proteolitičnih encimov), klasifikacija in nomenklatura encimov • Koencimi • 6. Biokemijske komponente celic in tkiv • Biološke membrane – struktura in funkcija • Primeri membranskih beljakovin: transporterji za ione in beljakovine, receptorji • Celična površina – membranske karakteristike; krvne skupine • Citoskelet, kontraktilne beljakovine in molekularni motorji: miozin, aktin, troponin, tropomiozin, kinezin in dinein 7. Enostavni in sestavljeni polisaharidi, glikoproteini, celična stena 8. Metabolizem 9. Prebavni encimi, uvod v metabolne poti – regulacija metaboličnih poti, glavni eksperimentalni pristopi za študij metabolizma 10. Encimska razgradnja glikozidnih vezi 11. Oksidativni procesi v celici in pridobivanje energije 12. Metabolizem ogljikovih hidratov, uravnavanje sinteze in razgradnje ogljikovih hidratov 13. Metabolizem maščobnih kislin in trigliceridov 14. Metabolizem nukleotidov in nukleinskih	structurally based function of peptide hormones • Primary, secondary tertiary and quaternary structure of proteins. 3. Proteins: general structure and characteristics, classification by the function (enzymes, transport, contractile, accumulative, defence and regulatory proteins). 4. Fibrilar and globular proteins. • Structure and function of fibrillary proteins: keratin, collagen, elastin. • Monomeric and oligomeric structure of proteins: myoglobin and haemoglobin. 5. Enzymes: general features and bases of enzymatic kinetics. • Mechanism of enzymatic reactions, regulation of enzymatic activity (allosteric modulation, covalent modification, regulation of proteolytic enzymes), classification and nomenclature of enzymes. • Coenzymes. 6. Biochemical components of cells and tissues. • Biological membranes – structure and function. • Examples of membrane proteins: transporters, receptors. • Cell surface: membrane characteristics: blood groups. • Cytoskeleton: contractile proteins and molecular motors: myosin, actin, troponin, tropomyosin, kinesin and dinein. 7. Simple and complex polysaccharides, glycoproteins, cell wall. 8. Metabolism. 9. Digestive enzymes; introduction to the metabolic pathways, major experimental approaches to the study of metabolism. 10. Enzymatic digestion of glycoside bonds. 11. Oxidative processes in the cell and energy generation. 12. Metabolism of carbohydrates, regulation of anabolism and catabolism of carbohydrates. 13. Metabolism of fatty acids and triglycerides. 14. Metabolism of nucleotides and nucleic acids, regulation of their metabolism, diseases. 15. Metabolism of membrane lipids, anabolism
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kislin, uravnavanje metabolizma nukleotidov, bolezni povezane z metabolizmom nukleotidov 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 16. Metabolizem aminokislin, prebava proteinov, razgradnja aminokislin, biosinteza neesencialnih aminokislin, uravnavanje hitrosti metabolizma aminokislin, bolezni povezane z metaboličnimi defekti v metabolizmu aminokislin; aminokislina kot izhodne snovi v biosintezah biološko pomembnih spojin 17. Metabolizem hema 18. Vitamin: klasifikacija vitaminov, vodotopni vitamini, koencimi in prostetične skupine; lipidotopni vitamini. 19. Pomen biokemije za razlago in zdravljenje bolezni 20. Biosinteza proteinov, usmerjanje, znotrajcelični transport, zvijanje, kontrola kvalitete, degradacija 21. Membranske beljakovine, prenos snovi skozi biološke membrane, pasivni in aktivni transport, primeri pasivnega in aktivnega transporta pri človeku 22. Hormoni, sproščanje hormonov 23. Vloga hormonov v uravnavanju metaboličnih procesov 24. Metabolizem mineralov, vnos, zadrževanje in izločanje mineralnih snovi pri človeku (kalcij, magnezij, železo, cink, jod, itn.) 25. Metabolizem goriv v različnih metaboličnih stanjih (po obroku, med obroki, dolgotrajno stradanje) 26. Metabolične značilnosti posameznih tkiv in organov. Skeletna mišica, srčna mišica, jetra, maščevje, ledvica, živčevje, krvni elementi, koža, oko, pljuča, vezivno tkivo 27. Medsebojna odvisnost in vloga organov v metaboličnih procesih pri človeku. 28. Biokemija krvnih skupin in koagulacija krvi; 29. Signalna transdukcija 30. Metabolične bolezni, vključno dedni sindromi 31. Genomika, proteomika, farmakogenomika,	and catabolism of simple and complex triglycerides, bile acids, lipoproteins, prostaglandins, regulation of lipid metabolism. Diseases that arose from metabolism disorders. 16. Metabolism of amino acids and proteins, anabolism and catabolism of essential and non-essential amino acids, regulation of metabolism, diseases that arose from metabolic disorders, amino acids as precursors in biosynthesis of biologically important molecules.. 17. Haem metabolism. 18. Vitamins: classification, water soluble vitamins and coenzymes and prosthetic groups, fat soluble vitamins. 19. Importance of biochemistry for disease explanation and treatment. 20. Biosynthesis of proteins, conformations, folding, quality control, intracellular transport, protein degradation. 21. Membrane proteins: transport over the membrane, passive and active transport in human body. 22. Hormones and their release. 23. Role of hormones in the regulation of metabolic processes. 24. Metabolism of minerals, intake, storage and secretion of minerals in the human body (calcium, magnesium, zinc, iodine, ...). 25. Fuel metabolism in different states (the feed state, absorptive state, prolonged fasting) 26. Metabolic characteristics of individual tissues and organs (skeletal muscle, heart muscle, liver, adipose tissue, kidneys, nervous system, blood elements, skin, eye, lungs, connective tissue). 27. Interrelation and interactions of the organs in the metabolism of human body. 28. biochemistry of blood groups and coagulation; 29. signal transduction 30. Metabolic diseases, including hereditary syndromes 31. Recombinant DNA technology, genetic engineering, biotechnology; CRISPR technology 32. Genomics, proteomics, pharmacogenomics, personalized medicine, bioinformatics 33. Gene therapy; stem cell therapy 34. Biochemical and molecular basis of cancer
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- personalizirana medicina; bioinformatika;
32. Rekombinantna DNA tehnologija, genetsko inženirstvo, biotehnologija; tehnologija CRISPR
33. Genska terapija; terapija z matičnimi celicami
34. Biokemijske in molekularne osnove raka

Temeljni literatura in viri / Readings:

Biokemija/Biochemistry

1. 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.
4. 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
5. Dewlin, Thomas M: Textbook of Biochemistry With Clinical Correlations , 8th Ed J. Wiley & sons, Hoboken (New Jersey), 2014 Nelson DL, Cox MM.;
6. Lee W. Janson, M. Tischler, Medical Biochemistry: The Big Picture (LANGE The Big Picture), McGraw-Hill, 2012, ISBN: 9780071637923.
7. 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.

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.

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

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

človeškem organizmu. Biokemija integrira molekularne osnove temeljnih življenjskih procesov in je nujna za razumevanje vzrokov bolezni ter molekularnih pristopov zdravljenja. Povezava znanj o molekularnih mehanizmi delovanja zdravega organizma in okvar, ki privedejo do bolezni. Prenesljive/ključne spretnosti in drugi atributi: Študent bo razvil bo spretnosti dela v skupini ter spretnost računanja. 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.	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. Biochemistry is correlated to the understanding of pathophysiology, pharmacology and most of the clinical subjects.
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Metode poučevanja in učenja:

Predavanja, skupinsko in individualno delo, seminarji, laboratorijske vaje. PBL.

Learning and teaching methods:

Lectures, group and individual work, projects, laboratory practicals, PBL.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Način (pisni izpit, ustno izpraševanje, naloge, projekt) pisni izpit opravljene lab. vaje in kolokvij, opravljen seminar ŠTUDIJSKE OBVEZNOSTI ŠTUDENTOV Opravljene vaje – prisotnost na vajah Opravljeni seminarji – prisotnost na seminarjih POGOJI ZA PRISTOP K POSAMEZNEMU PREVERJANJU ZNANJA Opravljen kolokvij iz vaj – pogoj za pristop k izpitu Opravljene vaje in dnevnik – pogoj za pristop h kolokviu iz vaj Opravljeni seminarji – pogoj za pristop k izpitu	70 % 20 % 10 %	Type (examination, oral, coursework, project): written examination assessment of laboratory practicals, assessment of project work ACADEMIC OBLIGATIONS OF STUDENTS: Students should complete laboratory work and write reports. Presence at all laboratory work is mandatory. Students should write an essay on selected topic and give oral presentation (seminar). Presence at seminar presentations is mandatory. REQUIREMENTS FOR ACCESS TO INDIVIDUAL KNOWLEDGE CHECKING: Laboratory and seminary work project is condition for applying to written exam 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.

Reference nosilca / Lecturer's references:

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, 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