2025/2026

Univerza v Mariboru
Medicinska fakulteta

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Ime predmeta:	**Biokemija**
Course title:	**Biochemistry**

Študijski program in stopnja Study programme and cycle	Študijska smer Study option	Letnik Year of study	Semester Semester
Splošna medicina, enovit magistrski študijski program		Prvi	1.
General medicine, Uniform master's degree study program		First	1.

Vrsta predmeta (obvezni ali izbirni) / Course type (compulsory or elective)	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
		AV	LV	RV				
45	45		30				60	6

Nosilec predmeta / Course coordinator:	**red. prof. dr. Uroš Potočnik**

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites for enrolling in the course or for performing study obligations:**
ŠTUDIJSKE OBVEZNOSTI ŠTUDENTOV: Opravljeno laboratorijsko delo – prisotnost na vajah (100 %). Opravljena seminarska naloga – prisotnost na seminarjih (80 %). POGOJI ZA PRISTOP K POSAMEZNEMU PREVERJANJU ZNANJA: Opravljeno laboratorijsko delo – pogoj za pristop k izpitu. Opravljene vaje in dnevnik – pogoj za pristop h kolokviju iz vaj. Opravljeni seminarji – pogoj za pristop k izpitu.	ACADEMIC OBLIGATIONS OF STUDENTS: Students should complete laboratory work and write reports. Presence at all laboratory work is mandatory (100 %). Students should write an essay on selected topic and give oral presentation (seminar). Presence at seminar presentations is mandatory (80 %). REQUIREMENTS FOR ACCESS TO INDIVIDUAL KNOWLEDGE CHECKING: Laboratory and seminary work project is condition for applying to written exam.

Vsebina (kratek pregled učnega načrta):	Content (syllabus outline):
1. 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 2. Uvod v strukturo beljakovin: • Aminokisline: struktura, povezava med strukturo in funkcijo, izoelektrična in izoionska točka, analitika aminokislin. • Peptidi: biološko aktivni peptidi; 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	1. Introduction to the biochemistry, molecular bases of life, water, elements and ions of biological importance, classification of biomolecules: • triglicerides, monosaccharides and complex carbohydrates, amino acids and peptids, nucleic acids and nucleotides 2. Introduction to the protein structure: • aminoacids: structure, links between structure and function, isoelectric and isoionic point, analysis of aminoacids. • Peptides: biologically active peptides, 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 fibrilary proteins: keratin, collagen, elastin. • Monomeric and oligomeric structure of proteins: myoglobin and haemoglobin. 5. Enyzmes: general features and bases of enzymatic kinetics. • Mechanism of enzymatic reactions, regulation of enzymatic actvitiy (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, troponine, 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.

14. Metabolizem nukleotidov in nukleinskih 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 neesencielnih aminokislin, uravnavanje hitrosti metabolizma aminokislin, bolezni povezane z metaboličnimi defekti v metabolizmu aminokislin; aminokisline 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 metabolnih stanjih (po obroku, med obroki, dolgogtrajno 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. Metabolne bolezni, vključno dedni sindromi 31. Genomika, proteomika, farmakogenomika, personalizirana medicina;bioinformatika; 32. Rekombinantna DNA tehnologija, genetsko inženirstvo, biotehnologija; tehnologija CRISPR 33. Genska terapija; terapija z matičnimi celicami 34.	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 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, farmacogenomics, personalized medicine, bioinformatics 33. Gene therapy; stem cell therapy

Temeljni literatura in viri / Reading materials:

Biokemija/Biochemistry

- Michael Lieberman, Allan Marks, Alisa Peet.: Marks' basic medical biochemistry : a clinical approach. 6th ed., [international ed.]. - Philadelphia [etc.] : Wolters Kluwer Health, ISBN 1-9751-5014-7 (broš.); 978-1-9751-5014-3 (broš.); cop. 2023Nelson, David Lee: Lehninger principles of biochemistry. 8th ed. New York, 2021..
- Medical biochemistry. Baynes, John W. ; Dominiczak, Marek H. 6th ed. Elsevier, cop. 2023
- Plemenitaš, Ana, 1952- ; Žakelj-Mavrič, Marija. Metabolizem tkiv in organov pri človeku - 1. izd., 1. natis. Ljubljana : DZS, 2022, jezik – slovenski. ISBN - 978-961-02-1012-2. COBISS.SI-ID - 127665155
- Temelji biokemije. Boyer, Rodney F. Ljubljana : Študentska založba, 2005. Jezik – slovenski. ISBN - 961-242-041-6
- Rodney Boyer, Concepts in Biochemistry, 3rd Ed. Wiley, , ISBN: 139780471661795; 2006

Dodatna literature in viri/ Additional Readings:

- 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
- Dewlin, Thomas M: Textbook of Biochemistry With Clinical Correlations , 8th Ed J. Wiley & sons, Hoboken (New Jersey), 2014 Nelson DL, Cox MM.;
- Lee W. Janson, M. Tischler, Medical Biochemistry: The Big Picture (LANGE The Big Picture), McGraw-Hill, 2012, ISBN:9780071637923.
- 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 človeškem organizmu. Biokemija integrira molekularne osnove temeljnih življenskih procesov in je nujna za razumevanje vzrokov bolezni ter molekularnih pristopov zdravljenja. Povezava znanj o molekularnih mehanizmih delovanja zdravega organizma in okvar, ki privedejo do bolezni.

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

Ob koncu predmeta bo študent sposoben: • prepoznati in razlikovati, navesti in strukturno opisati poglavitne makromolekule v celicah in tkivih ter pojasniti njihove funkcije v celici • razložiti različne kemijske reakcije, metabolne poti ter transportne pojave, ki potekajo v človeškem organizmu. • opisati molekularne osnove temeljnih življenjskih procesov, ki so nujne za razumevanje vzrokov bolezni ter molekularnih pristopov zdravljenja. • povezati znanja o molekularnih mehanizmih 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. Sposoben bo opisati in razložiti delovanje organizma na molekulski ravni. Sposoben bo integracije znanj s področja življenjskih ved, kajti biokemija je povezana s predmeti Molekularna biologija in Biologija celice. Pomaga tudi pri razumevanju Patofiziologije, Farmakologije in večine kliničnih predmetov.	organism and disorders that consequently lead to the disease. At the end of the course, the student will be able to: • identify, distinguish, list and describe structurally the main macromolecules in cells and tissues and explain their functions in the cell • explain the different chemical reactions, metabolic pathways and transport phenomena that take place in the human body. • describe the molecular basis of fundamental life processes that are essential for understanding the causes of disease and molecular approaches to treatment. • integrate knowledge about the molecular mechanisms of healthy organisms and the defects that lead to disease. Transferable/Key Skills and other attributes: The student will develop group work skills and computational skills. They will be able to describe and explain how an organism works at the molecular level. They will be able to integrate knowledge from the life sciences, as biochemistry is linked to Molecular Biology and Cell Biology. It also helps in understanding Pathophysiology, Pharmacology and most clinical subjects.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, skupinsko in individualno delo, seminarji, laboratorijske vaje. PBL.	Lectures, group and individual work, projects, laboratory practicals, PBL.

Načini ocenjevanja:	Delež (v %) / Share (in %)	**Assessment methods:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
pisni izpit	70	written exam
laboratorijsko delo	20	laboratory work
seminarska naloga	10	seminar paper
Opombe: Študentje lahko pisni izpit opravijo s kolokvijema. Kolokvija sta razdeljena na dva dela. Za opravljen pisni izpit morata biti oba kolokvija pozitivna. Ocenjevalna lestvica: 91–100 % = odlično (10); 81–90 % = prav dobro (9); 71–80 % = prav dobro (8); 61–70 % = dobro (7); 50–60 % = zadostno (6); 41–49 % = nezadostno (5); 31–40 % = nezadostno (4); 21–30 % =		Notes: Students can pass the written exam with midterm exams. The midterm exams are divided in two sets. For the recognition of written examination must all be positive. Grading scale: 91-100 % = excellent (10); 81-90 % = very good (9); 71-80 % = very good (8); 61-70 % = good (7); 50-60 % = adequate

nezadostno (3); 11–20 % = nezadostno (2); 0–10 % = nezadostno (1).		(6); 41-49 % = inadequate (5); 31-40 % = inadequate (4); 21-30 % = inadequate (3); 11-20 % = inadequate (2); 0-10 % = inadequate (1).

Reference nosilca / Course coordinator's references:

GOLE, Boris, PERNAT DROBEŽ, Cvetka, JEZERNIK, Gregor, POTOČNIK, Uroš. The expression IL1B correlates negatively with the clinical response to adalimumab in Crohn's disease patients : an ex vivo approach using peripheral blood mononuclear cells. Life Sciences. [Online ed.]. 2023, [v tisku][27 str.], ilustr. ISSN 1879-0631. https://doi.org/10.1016/j.lfs.2023.121822, https://www.sciencedirect.com/science/article/pii/S0024320523004563, DOI: 10.1016/j.lfs.2023.121822. [COBISS.SI-ID 154108931], [JCR, SNIP]
financer: ARRS, Programi, P3-0427, SI, Sistemski pristopi k raziskavam človeškega genoma za personalizirano medicino kroničnih imunskih bolezni; ARRS, Projekti, J3-9258, SI, Molekularno genetski biooznačevalci in mehanizmi neodzivnosti na biološko zdravljenje z anti-TNF bolnikov s kroničnimi imunskimi boleznimi
kategorija: 1A1 (Z, A', A1/2);

AVBELJ, Monika, HAFNER BRATKOVIČ, Iva, LAINŠČEK, Duško, MANČEK KEBER, Mateja, PETERNELJ, Tina Tinkara, PANTER, Gabriela, TREON, Steven P., GOLE, Boris, POTOČNIK, Uroš, JERALA, Roman. Cleavage-mediated regulation of Myd88 signaling by inflammasome-activated caspase-1. Frontiers in immunology. Jan. 2022, vol. 12, str. 1-14, ilustr. ISSN 1664-3224. https://www.frontiersin.org/articles/10.3389/fimmu.2021.790258/full, https://doi.org/10.3389/fimmu.2021.790258, DOI: 10.3389/fimmu.2021.790258. [COBISS.SI-ID 93261315], [JCR, SNIP, WoS do 7. 8. 2022: št. citatov (TC): 2, čistih citatov (CI): 2, čistih citatov na avtorja (CIAu): 0,20, Scopus do 22. 7. 2022: št. citatov (TC): 2, čistih citatov (CI): 2, čistih citatov na avtorja (CIAu): 0,20]

kategorija: 1A1 (Z, A'', A', A1/2);

PRAŠNIKAR, Erika, KUNEJ, Tanja, GORENJAK, Mario, POTOČNIK, Uroš, KOVAČIČ, Borut, KNEZ, Jure. Transcriptomics of receptive endometrium in women with sonographic features of adenomyosis. Reproductive biology and endocrinology. 2022, vol. 20, art. 2, str. 1-16, ilustr. ISSN 1477-7827. https://rbej.biomedcentral.com/articles/10.1186/s12958-021-00871-5, https://doi.org/10.1186/s12958-021-00871-5, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=134676, DOI: 10.1186/s12958-021-00871-5. [COBISS.SI-ID 91852035], [JCR, SNIP, WoS do 31. 1. 2023: št. citatov (TC): 2, čistih citatov (CI): 2, čistih citatov na avtorja (CIAu): 0,33, Scopus do 9. 2. 2023: št. citatov (TC): 3, čistih citatov (CI): 3, čistih citatov na avtorja (CIAu): 0,50]
financer: ARRS, Programi, P3-0327, SI, Reprodukcija človeka - laboratorijski in eksperimentalni vidiki
kategorija: 1A1 (Z, A', A1/2);

GORENJAK, Mario, JEZERNIK, Gregor, KRUŠIČ, Martina, SKOK, Pavel, POTOČNIK, Uroš. Identification of novel loci involved in adalimumab response in Crohn’s disease patients using integration of genome profiling and isoform-level immune-cell deconvoluted transcriptome profiling of colon tissue. Pharmaceutics. [Online ed.]. Sep. 2022, vol. 14, issue 9, str. 1-16, ilustr. ISSN 1999-4923. https://doi.org/10.3390/pharmaceutics14091893, https://www.mdpi.com/1999-4923/14/9/1893, DOI: 10.3390/pharmaceutics14091893. [COBISS.SI-ID 120609795], [JCR, SNIP, WoS, Scopus]
financer: ARRS, Programi, P3-0427, SI, Sistemski pristopi k raziskavam človeškega genoma za personalizirano medicino kroničnih imunskih bolezni; ARRS, Projekti, J3-9258, SI, Molekularno genetski biooznačevalci in mehanizmi neodzivnosti na biološko zdravljenje z anti-TNF bolnikov s kroničnimi imunskimi boleznimi
kategorija: 1A1 (Z, A', A1/2);

SHAHBAZI KHAMAS, Shahriyar, VAN DIJK, Y, ABDEL-AZIZ, Mahmoud I., NEERINCX, Anne H., BLANKESTIJN, Jelle M., VIJVERBERG, Susanne J, HASHIMOTO, Simone, BUSH, Andrew, KRANEVELD, Aletta D., HEDMAN, Anna M., GORENJAK, Mario, POTOČNIK, Uroš, et al. Exhaled volatile organic compounds for asthma control classification in children with moderate to severe asthma: results from the SysPharmPediA study. American journal of respiratory and critical care medicine. [Online ed.]. Nov. 2024, vol. 210, issue 9, str. 1091-1100, ilustr. ISSN 1535-4970. https://www.atsjournals.org/doi/abs/10.1164/rccm.202312-2270OC, https://doi.org/10.1164/rccm.202312-2270OC, DOI: 10.1164/rccm.202312-2270OC. [COBISS.SI-ID 193777923], [JCR, SNIP, WoS do 14. 1. 2025: št. citatov (TC): 4, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 0.26, Scopus do 23. 1. 2025: št. citatov (TC): 4, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 0.26]
kategorija: 1A1 (Z, A'', A', A1/2)