Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Molekularna biofizika
Course title:	Molecular Biophysics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika 2. st.		1,2	1,2,3,4
Physics 2nd degree			

Vrsta predmeta / Course type	izbirni/elective
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
15	15	15			105	5

Nosilec predmeta / Lecturer:	Aleš Fajmut

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Vsaka obveznost študenta v načinih ocenjevanja mora biti opravljena s pozitivno oceno. Opravljen projekt je pogoj za pristop k teoretičnemu izpitu.	Each student requirement within the assessment methods must be completed with a passing grade. Completed project is a prerequisite for taking the theoretical exam.

Vsebina:	**Content (Syllabus outline):**
1. Kemijske vezi, medatomske in medmolekularne interakcije. Struktura bioloških makromolekul (beljakovine, nukleinske kisline, polisaharidi) in supramolekularnih kompleksov (lipoproteini, biološka membrana). Kooperativna vezava ligandov na makromolekule in alosterični pojavi. Encimske reakcije. Zveza med strukturo in biološko funkcijo makromolekularnih in supramolekularnih sistemov ter regulacija	1. Chemical bonds, intra- and inter- molecular forces. Structure of biological macromolecules (proteins, nucleic acids, polysaccharides) and supramolecular complexes (lipoproteins, biological membrane). Cooperative ligand binding to macromolecules and allosteric phenomena. Enzymatic reactions. Relation between structure and function of macromolecular and supramolecular systems, regulation of biological activity. Water, its

biološke aktivnosti. Voda, njena struktura in pomen za biološke sisteme. Dinamika konformacijskih sprememb makromolekul. 2. Biofizika celičnega skeleta in molekularnih strojev subceličnih dimenzij. Mikrotubuli, mikrofilamenti. Proteinski motorji: miozini, kinezini. 3. Biofizika celične membrane in celice. Struktura biološke celice. Osmozno ravnovesje in kislinsko-bazno ravnotežje. Metabolizem celice. Mehanske lastnosti celične membrane, oblika celice. Transport preko celične membrane. Električna vzdražljivost celice in prenos električnega impulza. 4. Pregled eksperimentalnih metod v molekularni biofiziki V okviru seminarja študent izbere eno izmed razpisanih tem za projektno nalogo, ki ima obliko krajšega strokovnega prispevka. Študent po izdelavi in pregledu naloge pripravi predstavitev pred kolegi. Seminarske vaje so namenjene reševanju problemov in praktičnim izračunom.	structure and meaning for biological systems. Dynamics of conformational changes of macromolecules. 2. Biophysics of cytoskeleton and molecular machines of subcellular scales. Microtubules, microfilaments. Motor proteins: myosins, kinesins. 3. Cell and cell membrane biophysics. Structure of biological cell. Osmotic and acid-base equilibrium. Cell metabolism. Mechanical properties of cell membrane; cell shape and its transformation. Electrical excitability of the cell and propagation of the nerve pulse. 4. Overview of experimental methods in molecular biophysics. The seminar is intended for the presentations of student projects, which should have the form of a shorter professional paper. After preparing and reviewing the project, the student prepares a presentation in front of colleagues. Tutorials are intended for the problem solving and the calculus of practical examples.

Temeljni literatura in viri / Readings:

J.A. Tuszynski in M. Kurzynski: Introduction to Molecular Biophysics, CRC Press 2003
P. R. Bergethon: The Physical Basis of Biochemistry. The Foundations of Molecular Biophysics, Springer, New York 1998
I. N. Serdyuk, N. R. Zaccai, J. Zaccai: Methods in Molecular Biophysics (Structure, Dynamics, Function), Cambridge Press, 2007
M. B. Jackson: Molecular and cellular biophysics, Cambridge University Press, Cambridge 2006

Pojasnilo/Remark: Med temeljno študijsko literaturo sodijo samo tista poglavja iz omenjenih knjig, ki so del vsebine predmeta v okviru predavanj in laboratorijskih vaj. / Only those chapters from the abovementioned books that are considered within the syllabus outline of the course, including lectures and tutorials, are regarded as core readings.

Cilji in kompetence:	**Objectives and competences:**

Študent je po uspešno opravljenem izpitu zmožen: - razumeti obravnavane zahtevnejše teoretične biofizikalne koncepte na molekularni ravni ter na ravni medmolekularnih in supramolekularnih interakcij - pojasniti povezavo med strukturo in funkcijo gradnikov bioloških sistemov na različnih ravneh njihovega delovanja - strokovnega sodelovanja, komunikacije ter prenosa znanj na področju naravoslovnih interdisciplinarnih ved in medicine	After passing the exam, the student is able to: - understand complex theoretical biophysical concepts at the molecular level, and at the level of intermolecular and supramolecular interactions - clarify the connection between the structure and function of the biological systems building blocks at different levels of their functioning - professional cooperation, communication and transfer of knowledge in the field of interdisciplinary sciences and medicine
Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po zaključku predmeta je študent zmožen: - kvalitativno in kvantitativno (s fizikalno-matematičnimi odvisnostmi) opisati obravnavane teoretične biofizikalne koncepte na molekularni in supramolekularni skali - aplicirati te koncepte na konkretnih primerih analize strukture in funkcije gradnikov bioloških sistemov - pojasniti zvezo med interakcijami in strukturo gradnikov bioloških sistemov - utemeljiti vpliv strukture na funkcijo gradnikov bioloških sistemov na različnih ravneh njihovega delovanja Prenesljive/ključne spretnosti in drugi atributi: - sposobnost prenosa bazičnih fizikalnih znanj iz teorije v prakso - sposobnost vključitve v raziskovalno delo na različnih problemih fizike kompleksnih sistemov in biofizike	Knowledge and Understanding: Upon completion of the course, the student is able to: - qualitatively and quantitatively (with physical and mathematical dependencies) describe the theoretical biophysical concepts discussed on the molecular and supramolecular scale - apply these concepts to particular cases of analysis of the structure and function of the building blocks of biological systems - elucidate the relationship between interactions and the structure of building blocks of biological systems - explain the influence of the structure on the function of the biological systems building blocks at different levels of their operation Transferable/Key Skills and other attributes: - the ability to transfer basic physical knowledge from theory to practice - the ability to engage in research work on various problems of physics of complex systems and biophysics
Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja podkrepljena s simulacijami Seminar; pisne in ustne predstavitve projektnih nalog iz izbrane teme Seminarske vaje	Lectures, supported by simulations Seminar; oral and written presentations of projects from selected topics Tutorials

Delež (v %) /

Načini ocenjevanja:	Weight (in %)	**Assessment:**
Teoretični izpit	70	Theoretical exam
Projekt	30	Project

Reference nosilca / Lecturer's references:

1. DOBOVIŠEK, Andrej, BLAŽEVIČ, Tina, KRALJ, Samo, FAJMUT, Aleš. Enzyme cascade to enzyme complex phase-transition-like transformation studied by the maximum entropy production principle. Cell reports physical science. 2025, vol. 6, iss. 2, [article no.] 102400, 11 str. ISSN 2666-3864. https://doi.org/10.1016/j.xcrp.2024.102400, [COBISS.SI-ID 225246211]
2. DOBOVIŠEK, Andrej, VITAS, Marko, BLAŽEVIČ, Tina, MARKOVIČ, Rene, MARHL, Marko, FAJMUT, Aleš. Self-organization of enzyme-catalyzed reactions studied by the maximum entropy production principle. International journal of molecular sciences. 2023, vol. 24, iss. 10, 21 str. ISSN 1422-0067, DOI: 10.3390/ijms24108734 [COBISS.SI-ID 152729603]
3. FAJMUT, Aleš. Molecular mechanisms and targets of cyclic guanosine monophosphate (cGMP) in vascular smooth muscles. V: SAKUMA, Kunihiro (ur.). Muscle cell and tissue : novel molecular targets and current advances. London: IntechOpen, cop. 2021. Str. 1-31. ISBN 978-1-83968-651-1, ISBN 978-1-83968-650-4, ISBN 978-1-83968-652-8. https://www.intechopen.com/chapters/76823, DOI: 10.5772/intechopen.97708. [COBISS.SI-ID 79467011]