Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Izbrana poglavja iz molekularne biofizike**
Course title:	**Selected topics in molecular biophysics**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA, 3. stopnja		**1. ali 2.**	**1., 2. ali 4.**
PHYSICS, 3rd cycle		**1. ali 2.**	**1., 2. or 4.**

Vrsta predmeta / Course type: Izbirni za vse module

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje Field work	Samost. delo Individ. work	ECTS
15					165	6

Nosilec predmeta / Lecturer: **Janez Štrancar**

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Ni posebnih zahtev.	No special prerequisites.

Vsebina:	**Content (Syllabus outline):**
Strukturiranje vode: • tekmovanje interakcij v različnih lokalnih okoljih • pogled na različnih časovnih skalah Kompleksne strukture na osnovi DNK molekul:	Water Structure: • Interaction competition in various local environments • View through different time scales DNA-based complex structures:

- osnove kvadropleksov in drugih kompleksnih DNK struktur,
- energetski, kinetični in dinamični vidik,
- DNK kvadropleksi v biologiji in človeškem genomu
- G-kvartet v supramolekularni kemiji in nanotehnologiji.

Raziskovanje struktur proteinov:

- dinamika različnih strukturnih elementov proteinov
- vpliv okolja proteinov na njihove lastnosti
- moč in slabosti klasičnih visoko ločljivih eksperimentalnih metod za določanje proteinskih struktur
- alternativne metode in njihove kombinacije za določanje proteinskih struktur

Samoorganizacija proteinskih molekul v virusih:

- življenjski cikel virusa
- energetika virusov, urejenost proteinskih mrež

Molekularni stroji:

- ATPase, miozinski motorji
- funkcija mikrotubulov
- ionski kanali v delovanju

Pomen lateralne heterogenosti bioloških membran:

- fazni diagrami hidriranih lipidnih mešanic, koeksistenca faz in njihova dinamika, tekmovanje energije in entropije
- interakcija peptidov in toksinov z membranami

- Basics of quadruplex and other DNA structures
- Energy, kinetic, dynamic view
- DNA quadruplex in biology and human genome
- G-quartet in supramolecular chemistry and
- Nanotechnology

Protein structure exploration:

Dynamics of different protein structural elements

Environmental impact on protein structural properties

Advantages / disadvantages of classical high-resolution experimental methods for protein structure determination

Alternative methods and their combinations for protein structure determination

Self-organization of protein molecules in viruses:

- Virus life cycle
- Energetics of viruses, ordering in protein networks

Molecular machines:

- ATPase, myosin motors,
- Function of microtubule
- Ion channels in action

The importance of biomembrane lateral heterogeneity:

- Phase diagrams of hydrated lipid mixtures, phase coexistence and their dynamics, energy / entropy competition
- Peptide-membrane / toxin-membrane interaction

• membranske domene in rafti - pogled skozi različne eksperimentalne metode	• Function role of membrane domains and rafts – an overview through different experimental methods
<u>Ekstracelularne polisaharidne mreže</u>:	<u>Extra-cellular polysaccharide networks</u>:
• samoorganizacija polisaharidnih mrež	• Self-assembly of polysaccharide networks
• biološko/biofizikalno relevantne posledice strukturiranosti prostora in usmerjene difuzije	• Biologically / biophysically relevant consequences of spatial structure / rheology and constrained diffusion
<u>Samosestavljanje kompleksov nanomaterialov, proteinov in lipidov</u>:	<u>Self-assembly of nanoparticles, proteins and lipids</u>:
• pojav biokorone	• Biocorona
• pojav lipidnega ovijanja	• Lipid wrapping
• membranska destabilizacija	• Membrane destabilization
• nove pojavnosti celične smrti	• New phenomena of cell death

Temeljni literatura in viri / Readings:

1) Israelachvili, J. N. (1991). *Intermolecular and surface forces* (2nd ed., str. XXI, 450). Academic Press. https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/88858
2) Nossal, R., & Lecar, H. (1991). *Molecular and cell biophysics* (str. XII, 387). Addison Wesley Publishing Company, The Advanced Book Program. https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/863252
3) Beckerman, M. (2005). *Molecular and Cellular Signaling*. Springer. http://link.springer.com/book/10.1007/b136493
4) Ahmed H Zewail. (2008). *Physical Biology: From Atoms To Medicine*. World Scientific Publishing Company. **Celotno besedilo dostopno v**
5) **EBSCOhost Ebook Academic Collection - World Wide**
6) Kauffman, S. (1996). *At home in the universe: the search for laws of self-organization and complexity* (str. 321). Penguin Books. https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/2465814
7) KOKOT, Boštjan, KOKOT, Hana, UMEK, Polona, VAN MIDDEN, Katarina Petra, PAJK, Stane, GARVAS, Maja, EGGELING, Christian, KOKLIČ, Tilen, URBANČIČ, Iztok, ŠTRANCAR, Janez. How to control fluorescent labeling of metal oxide nanoparticles for artefact-free live cell microscopy. Nanotechnology, ISSN 1361-6528, 2021, vol. 15, no. 8, str. 1102-1123, doi: 10.1080/17435390.2021.1973607.

Dodatna:

Waigh, T. (2007). *Applied biophysics: A molecular approach for physical scientists*. Wiley-Interscience.

Cilji in kompetence:	**Objectives and competences:**
Študenti so sposobni sestavljat obstoječa znanja in najnovejše raziskave z lastnim raziskovalnim delom na področju molekularnih znanosti s posebnim poudarkom na uporabi fizikalnih pristopov in načina reševanja molekularnih problemov	Students can couple existing knowledge and the latest research with their own research work in fields of molecular sciences with special focus on implementation of physical approach and ways of solving molecular problems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poglobljena analiza trenutnega znanja in glavnih tem na področju molekularne biofizike in mejnih področij molekularne biologije ter fizikalne biokemije. Vrednotenje lastnih rezultatov v luči najnovejših raziskav Zmožnost sinteze naprednih fizikalnih konceptov kot so samosestavljanje, dinamika in kompleksnost struktur in mrež s klasičnimi molekularno biološkimi in biokemijskimi koncepti Prenesljive/ključne spretnosti in drugi atributi: • sposobnost reševanja konkretnih interdisciplinarnih raziskovalnih problemov v molekularno biološkh vedah s fizikalnimi orodji, univerzalnosti v fiziki in celostnim pristopom k reševanju biofizikalnih problemov, • sposobnost oblikovanja in implementacije izvirnih znanstvenih rešitev v danih biofizikalnih in interdisciplinarnih problemov, • poglobljena analiza teoretskih in metodoloških molekularno biofizikalnih konceptov.	Knowledge and understanding: Deep analysis of the current frontiers and expertise in the field of molecular biophysics, molecular biology and physical biochemistry. Evaluation of own results with respect to the state-of-the-art Ability of synthesis of advanced physical concepts such as selfassembly, dynamics and complexity of structures and networks with classical molecular biology and biochemical concepts Transferable/Key Skills and other attributes: • ability of solving interdisciplinary problems in molecular biology sciences with physical tools, universalities in physics and gained global approach on solving a biophysical problem, • ability of defining and implementing unique scientific solution within defined biophysical and interdisciplinary problems • deeper analysis of theoretical and methodological molecular biophysical concepts.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, Problemsko učenje , seminar in izdelava seminarske naloge oz. članka iz področja molekularne biofizike.	Lectures, problem-based learning, seminar and work out of seminar work or paper from the field of molecular biophysics.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt) Ustni izpit	 **100%**	Type (examination, oral, coursework, project): Oral exam

Reference nosilca / Lecturer's references:

PODLIPEC, Rok, ARSOV, Zoran, KOKLIČ, Tilen, ŠTRANCAR, Janez. Characterization of blood coagulation dynamics and oxygenation in ex- vivo retinal vessels by fluorescence hyperspectral imaging (fHSI). Journal of biophotonics. [in press] 2020, 12 str. ISSN 1864-0648. DOI: 10.1002/jbio.202000021. [COBISS.SI-ID 16418819]

SEBASTIJANOVIĆ, Aleksandar, AZZURRA CAMASSA, Laura Maria, MALMBORG, Vilhelm, KRALJ, Slavko, PAGELS, Joakim, VOGEL, Ulla, ZIENOLDDINY-NARUI, Shan, URBANČIČ, Iztok, KOKLIČ, Tilen, ŠTRANCAR, Janez. Particulate matter constituents trigger the formation of extracellularamyloid β and tau -containing plaques and neurite shortening in vitro. Nanotoxicology. 2024, vol. 18, iss. 4, str. 335-353, ilustr. ISSN 1743-5404. https://www.tandfonline.com/doi/full/10.1080/17435390.2024.2362367, DOI: 10.1080/17435390.2024.2362367. [COBISS.SI-ID 199841027]

LEROUX, Mélanie, KOKOT, Boštjan, KOKOT, Hana, KOKLIČ, Tilen, ŠTRANCAR, Janez, et al. Aerosol–cell exposure system applied to semi-adherent cells for aerosolization of lung surfactant and nanoparticles followed by high quality RNA extraction. Nanomaterials. [Online ed.]. 2022, vol. 12, no. 8, str. 1362-1-1362-23. ISSN 2079-4991. DOI: 10.3390/nano12081362. [COBISS.SI-ID 105193987]