Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Biofizika I**
Course title:	**Biophysics I**

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

Vrsta predmeta / Course type

Obvezni za modul Biofizika 1

Izbirni za modul Fizika 1,2, 3

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
10					**290**	**10**

Nosilec predmeta / Lecturer: **Janez Štrancar**

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

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

Ni posebnih zahtev.

Prerequisits:

No special prerequisites.

Vsebina:

Strukturiranje vode:

- tekmovanje interakcij v različnih lokalnih okoljih
- pogled na različnih časovnih skalah

Content (Syllabus outline):

Water Structure:

- Interaction competition in various local environments
- View through different time scales

Kompleksne strukture na osnovi DNK molekul:

- 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,

DNA-based complex structures:

- 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

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

Temeljni literatura in viri / Readings:

1) J. Israelaschvili: Intermolecular Interactions & Surface Forces. Academic Press, London, 1992.
2) R.J. Nossal in H. Lecar: Molecular and Cell Biophyics. Addison Wesley, NY, 1991.
3) S. Kauffman: At home in the universe: the search for laws of complexity. Penguin Science, London 1995.
4) Ahmed H. Zewail: Physical Biology: From Atoms to Medicine (Paperback), Imperial College Press, 2008
5) Tom Waigh: Applied Biophysics: A Molecular Approach for Physical Scientists, Willey-Interscience, 2007
6) Martin Beckerman: Molecular and Cellular Signaling, Springer, 2005

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

Študenti poglobijo znanje s področja molekularne biofizike na trenutno najbolj vročih problemih. Razumejo pomembnost in moč interdisciplinarnih znanj ter način razmišljanja pri reševanju struktur in funkcij kompleksnih bioloških sistemov. Nadgradijo svoje poznavanje o najnovejših raziskavah in delu raziskovalnih skupin na tem področju v regiji.	Students acquire advanced knowledge on molecular biophysics on the current hot topics. Students learn an importance and power of the interdisciplinary skills as well as the way of thinking while resolving structure and function of complex biological systems. Students get familiar with up-to-date research work and research teams working in that field in the region.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poglabljanje in nadgradnja interdisciplinarnih znanj s področij molekularne biofizike in mejnih področij molekularne biologije ter fizikalne biokemije. Prenesljive/ključne spretnosti in drugi atributi: • sposobnost reševanja konkretnih interdisciplinarnih raziskovalnih problemov v molekularno bioloških 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, • poglobljeno razumevanje teoretskih in metodoloških molekularno biofizikalnih konceptov.	Knowledge and understanding: Gaining additional knowledge and upgrading interdisciplinary approach in the fields of molecular biophysics, molecular biology and physical biochemistry. 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 understanding of theoretical and methodological molecular biophysical concepts.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminar in izdelava seminarske naloge iz področja molekularne biofizike.	Lectures, seminar and work out of seminar work 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:

1. MLAKAR, Nina, PAVLICA, Zlatko, PETELIN, Milan, ŠTRANCAR, Janez, ZRIMŠEK, Petra, PAVLIČ, Alenka. Animal and human dentin microstructure and elemental compositon. *Central european journal of medicine*, ISSN 1644-3640. [Online ed.], 2014, vol. 9, iss. 3, str. 468-476, doi: 10.2478/s11536-013-0295x. [COBISS.SI-ID 3850106]

2. URBANČIČ, Iztok, LJUBETIČ, Ajasja, ŠTRANCAR, Janez. Resolving internal motional correlations to complete the conformational entropy meter. *The journal of physical chemistry letters*, ISSN 1948-7185, 2014, vol. 5, no. 20, str. 3593-3600, doi: 10.1021/jz5020828. [COBISS.SI-ID 28004647]

3. LJUBETIČ, Ajasja, URBANČIČ, Iztok, ŠTRANCAR, Janez. Recovering position-dependent diffusion from biased molecular dynamics simulations. *The journal of physical chemistry letters*, ISSN 1948-7185, 2014, vol. 140, no. 8, str. 084109-1-084109 -11, doi: 10.1063/1.4866448. [COBISS.SI-ID 28006951]

4. KRIVEC, Matic, DILLERT, Ralph, BAHNEMANN, Detlef W., MEHLE, Alma, ŠTRANCAR, Janez, DRAŽIĆ, Goran. The nature of chlorine-inhibition of photocatalytic degradation of dichloroacetic acid in a TiO[sub]2-based microreactor. *PCCP. Physical chemistry chemical physics*, ISSN 1463-9076, 2014, vol. 16, issue 28, str. 14867-14873, doi: 10.1039/C4CP01043D. [COBISS.SI-ID 27660327]

5. URBANČIČ, Iztok, LJUBETIČ, Ajasja, ARSOV, Zoran, ŠTRANCAR, Janez. Coexistence of probe conformations in lipid phases : a polarized fluorescence microspectroscopy study. *Biophysical journal*, ISSN 0006-3495, 2013, vol. 105, no. 4, str. 919-927, doi: 10.1016/j.bpj.2013.07.005. [COBISS.SI-ID 26970919]