Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA		1. ali 2.	**1., 2. ali 4.**
PHYSICS		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
10	**5**				**165**	**6**

Nosilec predmeta / Lecturer:	**Milan Brumen**

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovenian in/and angleški s slovenskim prevodom/English with translation in Slovenian
	Vaje / Tutorial:	slovenski/Slovenian in/and angleški s slovenskim prevodom/English with translation in Slovenian

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

Vsebina:	**Content (Syllabus outline):**
Biofizika celice: • celična membrana: mehanske lastnosti, transportni procesi, mehanizmi in modeli • biofizikalni modeli celičnih procesov: kislinsko bazno ravnotežje, regulacija volumna celice in homeostaza, skrčitev mišične celice, prenos živcnega impulza	Cellular Biophysics: • cell membrane: mechanical properties, transport processes, mechanisms and models • biophysical models of cellular processes: acid-base equilibrium, cell volume regulation and homeostasis, cell muscle contraction, nerve signal transduction

Bioelektromagnetizem:

- električne lastnosti celične membrane, modeli električnih potencialov na membrani
- biomagnetna polja v bioloških sistemih
- vpliv magnetnega polja in elektromagnetnega valovanja/sevanja na človeško telo

Komunikacija v bioloških sistemih:

- modeli bioloških oscilatorjev: metabolične oscilacije, mitotični oscilator, srčni ritem, cirkadiani ritem
- kontrolna analiza in regulacija celičnih procesov
- znotrajcelična signalizacija in medcelična komunikacija; signalne kaskade

Celice sestavljajo organizem:

- Brownovo gibanje in kemotaksa celic
- interakcije med celicami
- izbrani primeri iz medicine: modeli rasti tumorja in imunskih sistemov; krvni obtok in prenos respiratornih plinov

Interakcije celic z nano in mikrosistemi:

- interakcije celic z lipidnimi vesikli in polielektrolitskimi mikrokapsulami
- hrambeni in ciljni prenašalni sistemi ter mikrosenzorji
- adhezija celic na funkcionalne mejne plasti

Biolectromagnetism:

- electrical properties of cell membrane, models of electric potential across the membrane
- biomagnetic fields in biological systems
- effects of magnetic field and electromagnetic waves /radiation on humans

Communications in biological systems:

- models of biological oscillators: metabolic oscillations, mitotic oscillator, cardiac rhythm, circadian rhythm
- control analysis and regulation of cellular processes
- intracellular signalisation and intercellular
- communication; signalling cascades

Organism is constructed by cells:

- Brownian motion and chemotaxis of cells
- cell-cell interactions
- selected cases from medicine: models of tumour growth and immune systems, blood circulation and transport of respiratory gases

Interactions between cells and nano and Microsystems:

- cell interactions with lipid vesicles and polyelectrolyte microcapsules
- storage and target delivery systems, micro sensors
- cell adhesion on functional interfaces

Temeljni literatura in viri / Readings:

1) J.A. Tuszynski : Molecullar and Cellular Biophysics (Pure and Applied Physics), Chapman & Hall / CRC Press, Boca Raton 2007
2) A. Goldbeter: Biochemical Oscillations and Cellular Rhythms, Cambridge Univ. Press, Cambridge 1996
3) A. Deutsch, J. Howard, M. Falcke, W. Zimmermann (uredniki): Function and Regulation of Cellular Systems, Birkhäuser Verlag, Basel 2004

Cilji in kompetence:	**Objectives and competences:**
Študenti poglobijo znanje s področja celične biofizike na trenutno najbolj vročih problemih. Spoznajo pomembnost in moč interdisciplinarnih znanj ter način razmišljanja pri reševanju struktur in funkcij kompleksnih bioloških sistemov na celični in tkivni ravni ter ravni organizma. Spoznajo najnovejše raziskave in delo 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 at cell and tissue level as well as at level of organism. 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 in celične biofizike, celične fiziologije in fizikalne biokemije. Prenesljive/ključne spretnosti in drugi atributi: Reševanje oz. raziskovanje interdisciplinarnih problemov v bioloških vedah s fizikalnimi in matematičnimi orodji modeliranja. Celosten pristop k reševanju biofizikalnih problemov.	Knowledge and understanding: Gaining additional knowledge and upgrading interdisciplinary approach in the fields of cell biophysics, cell physiology and physical biochemistry. Transferable/Key Skills and other attributes: Solving and exploring interdisciplinary problems in biology sciences with physical and mathematical tools of modelling. Gained global approach on solving a biophysical problem.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in v seminarju samostojna obravnava izbranih problemov s seminarsko nalogo. Delo z ustreznimi računalniškimi orodji.	Lectures, and in seminar, presentation and discussion selected problems in terms of coursework. Work with appropriate computer software tools.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt) Seminarska naloga Ustni izpit	 **50%** **50%**	Type (examination, oral, coursework, project): Coursework Oral exam

Reference nosilca / Lecturer's references:

1. UREVC, Janez, HALILOVIČ, Miroslav, BRUMEN, Milan, ŠTOK, Boris. An approach to consider the arterial residual stresses in modelling of a patient-specific artery. *Advances in mechanical engineering*, ISSN 1687-8140, Nov. 2016, vol. 8, [nr.] 11, f. 1-19, ilustr. http://ade.sagepub.com/content/8/11/1687814016679312.full.pdf+html, doi: 10.1177/1687814016679312. [COBISS.SI-ID 15115035]

2. UREVC, Janez, ŽUN, Iztok, BRUMEN, Milan, ŠTOK, Boris. Modeling the effect of red blood cells deformability on blood flow conditions in human carotid artery bifurcation. *Journal of biomechanical engineering*, ISSN 0148-0731, Nov. 2016, vol. 139, iss. 1, f. [1-11], ilustr. http://biomechanical.asmedigitalcollection.asme.org/article.aspx?articleid=2580905, doi: 10.1115/1.4035122. [COBISS.SI-ID 15115291]

3. FAJMUT, Aleš, EMERŠIČ, Tadej, DOBOVIŠEK, Andrej, ANTIĆ, Nataša, SCHÄFER, Dirk, BRUMEN, Milan. Dynamic model of eicosanoid production with special reference to non-steroidal anti-inflammatory drug-triggered hypersensitivity. *IET systems biology*, ISSN 1751-8849. [Print ed.], 2015, vol. 9, iss. 5, str. 204-215, doi: 10.1049/iet-syb.2014.0037. [COBISS.SI-ID 21404168]

4. UREVC, Janez, BRUMEN, Milan, FLIS, Vojko, ŠTOK, Boris. Applying thermomechanical analogy to predict the arterial residual stress state. *Strojniški vestnik*, ISSN 0039-2480, Jan. 2015, vol. 61, no. 1, str. 5-23, ilustr., doi: 10.5545/sv-jme.2014.2061. [COBISS.SI-ID 13856795]

5. DOBOVIŠEK, Andrej, FAJMUT, Aleš, BRUMEN, Milan. Strategy for NSAID administration to aspirin-intolerant asthmatics in combination with PGE [sub] 2 analogue: a theoretical approach. *Medical & biological engineering & computing*, ISSN 0140-0118. [Print ed.], 2012, vol. 50, no. 1, str. 33-42, doi: 10.1007/s11517-011-0844-x. [COBISS.SI-ID 18845192]

6. BOHINC, Klemen, SHRESTHA, Ahis, BRUMEN, Milan, MAY, Sylvio. Poisson-Helmholtz-Boltzmann model of the electric double layer : analysis of monovalent ionic mixtures. *Physical review. E, Statistical, nonlinear, and soft matter physics*, ISSN 1539-3755, 2012, vol. 85, no. 3, str. 031130-1-031130-12, doi: 10.1103/PhysRevE.85.031130. [COBISS.SI-ID 4353131]