Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	**Metode biofizikalnega modeliranja**
Course title:	**Methods of biophysical modelling**

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. or 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	Mentorstvo Mentorship	Samost. delo Individ. work	ECTS
10	5				165	6

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:
Ni posebnih zahtev.	No special prerequisites.

Vsebina:	Content (Syllabus outline):
- modeliranje encimske kinetike in mrež biokemijskih reakcij - kontrolna analiza - modeliranje prenosa signalov v celici - optimizacijske metode in določanje parametrov	- modelling of enzyme kinetics and networks of biochemical reactions - control analysis - modelling of signal transduction in the cell - optimization methods and parameter estimation

- modeliranje fizioloških sistemov (srce, krvni obtok, izmenjava plinov, krčenje mišic, regulacija volumna celice…) - farmakokinetični modeli	- modelling of physiological systems (heart, blood flow, gas exchange, muscle contraction, cell volume regulation…) - pharmacokinetic models

Temeljni literatura in viri / Readings:

1) E. Klipp, R. Herwig, A. Kowald, C. Wierling, H. Lehrach, Systems biology in practice, Wiley-vch, 2005, Weinheim

2) F.C. Hoppensteadt, C.S. Peskin, Modelling and simulation in medicine and the life science, Springer, 2002, New York

3) J. Keener, J. Sneyd, Mathematical Physiology, Springer, 1998, New York

4) Sauro H. M. Enzyme kinetics for systems biology, Ambrosius Publishing, 2011, Seattle

Scientific papers

Cilji in kompetence:	**Objectives and competences:**
Študent je po uspešno opravljenem izpitu zmožen: - obravnavati in uporabljati najzahtevnejše teoretične biofizikalne koncepte in metode modeliranja živih sistemov od ravni medmolekularnih interakcij do ravni delovanja celice, tkiva in organizma - identificiranja in obravnave najkompleksnejših problemov v bio-znanostih ter pristopa k iskanju njihovih rešitev s pomočjo metod teoretičnega biofizikalnega modeliranja - znanstvenoraziskovalnega sodelovanja, komunikacije ter prenosa znanj na področju raziskav v naravoslovnih interdisciplinarnih vedah	After passing the exam, the student is able: - to tackle and apply the most demanding theoretical biophysical concepts and methods of modeling the living systems from the level of intermolecular interactions to the level of cell, tissue and organism - to identify and treat the most complex problems in bio-sciences and to select the right strategies for their solutions using theoretical methods of biophysical modeling - of cooperation in scientific research as well as of communication and transfer of knowledge within interdisciplinary research in natural sciences

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po zaključku predmeta je študent zmožen: - kvalitativno in kvantitativno (s fizikalno-matematičnimi odvisnostmi) opisati najzahtevnejše teoretične biofizikalne koncepte - aplicirati te koncepte na konkretnih primerih najkompleksnejših modelov bioloških sistemov	Knowledge and understanding: Upon completion of the course, the student is able: - to describe qualitatively and quantitatively (with physical and mathematical dependencies) the most demanding theoretical biophysical concepts

- samostojno nadgraditi in/ali izgraditi kompleksne modele bioloških sistemov in jih analitično ali z računalniškimi orodji rešiti ter z njimi napovedati nove izvirne rezultate - na podlagi rezultatov matematičnega modeliranja oblikovati in oblikovati nove hipoteze Prenesljive/ključne spretnosti in drugi atributi: - sposobnost poglobljenega reševanja kompleksnih interdisciplinarnih problemov v bioloških vedah z matematično-fizikalnimi orodji in računalniško podprtimi numeričnimi metodami - sposobnost apliciranja univerzalnosti v fiziki in celostnega pristopa k reševanju kompleksnih biofizikalnih problemov - sposobnost raziskovalnega dela v interdisciplinarnem okolju	- to apply these concepts to concrete examples of the most complex models of biological systems - to upgrade and/or to build *de novo* complex models of biological systems and to solve them analytically or with computer tools and to predict new original results with them - to formulate new hypotheses based on the results of mathematical modeling Transferable/Key Skills and other attributes: - the ability to solve complex interdisciplinary problems in biological sciences with mathematical and physical tools as well as computer-aided numerical methods - the ability to apply universality in physics and an integrated approach to solving complex biophysical problems - the ability of research work in an interdisciplinary environment

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in študij primerov	Lectures and case study

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ustni zagovor	50	Oral exam
Projektna naloga (v njej študent nadgradi ali izgradi model izbranega biološkega sistema in z njim napove nove rezultate in oblikuje nove hipoteze. Naloga ima obliko krajšega znanstvenega prispevka. Študent po izdelavi in pregledu naloge pripravi predstavitev pred kolegi in predavateljem.)	50	Project assignment (within the project assignment the student upgrades an existing selected model or builds a new one. Based on the model simulations he/she predicts new results and creates new hypotheses. The project assignment should have the form of a shorter scientific contribution. After preparing and reviewing the project, the student prepares its presentation in front of the colleagues and a lecturer.)
Vsaka izmed naštetih obveznosti mora biti opravljena s pozitivno oceno.		Each of the listed commitments must be assessed with a positive grade.

Reference nosilca / Lecturer's references:

1. DOBOVIŠEK, Andrej, MARKOVIČ, Rene, BRUMEN, Milan, FAJMUT, Aleš. The maximum entropy production and maximum Shannon information entropy in enzyme kinetics. Physica. A, Statistical mechanics and its applications, ISSN 0378-4371. [Print ed.], 2018, vol. 496, str. 220-232, doi: 10.1016/j.physa.2017.12.111. [COBISS.SI-ID 23601416],

2. DOBOVIŠEK, Andrej, VITAS, Marko, BRUMEN, Milan, FAJMUT, Aleš. Energy conservation and maximal entropy production in enzyme reactions. Biosystems, ISSN 0303-2647. [Print ed.], 2017, vol. 158, str. 47-56, doi: 10.1016/j.biosystems.2017.06.001. [COBISS.SI-ID 23218696]

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. GOSAK, Marko, MARKOVIČ, Rene, FAJMUT, Aleš, MARHL, Marko, HAWLINA, Marko, ANDJELIĆ, Sofija. The analysis of intracellular and intercellular calcium signaling in human anterior lens capsule epithelial cells with regard to different types and stages of the cataract. PloS one, ISSN 1932-6203, 2015, vol. 10, iss. 12. http://dx.doi.org/10.1371/journal.pone.0143781, doi: 10.1371/journal.pone.0143781. [COBISS.SI-ID 2645676]