Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Fizika bioloških sistemov**
Course title:	**Systems Biology**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Biologija, 1. stopnja	**/**	**2**	**zimski / letni**
Biology, 1st level	**/**	**2**	**winter / summer**

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30		**15 (LV)**			**135**	**6**

Nosilec predmeta / Lecturer:	Marko MARHL

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Pogojev ni.	None.

Vsebina:	**Content (Syllabus outline):**
Na začetku je podan uvod v sistemsko biologijo, ki zajema predstavitev o tem, kako so lastnosti kompleksnih bioloških sistemov odvisne od delovanja in medsebojne povezanosti posameznih delov sistema. Predstavitev kompleksnih sistemov bo splošna in s tem širše uporabna. Poudarek je na povezanosti eksperimentalnega in teoretičnega dela, ki je osnova za uspešno	Introduction to Systems Biology shall be given with the aim of explaining how higher level properties of complex biological systems arise from the interactions among their parts. The complex system needs to be defined in general. It should be emphasised that for studying the complex systems experimental and theoretical approaches are required in order to be able to develop physical and quantitative models of

izdelavo kvantitativnih modelov opisa bioloških procesov. Študenti spoznajo temeljna orodja za kvantitativno obravnavo bioloških sistemov ter jih aplicirajo na izbranih primerih, ki so primerni za tovrstno obravnavo. Spoznajo osnove teorije nelinearnih dinamičnih sistemov ter se naučijo implementacije modelov v smislu računalniških programov. Modele izdelajo za izbrane biološke sisteme; poudarek je na opisu celičnih oscilatorjev.	biological processes. The program aims to introduce students to the tools that are available, and to help them to select important problems in biology that are possible to be tackled using quantitative and theoretical approaches. The students will learn about the basics of the theory of nonlinear dynamical systems and computational modelling of different biological system, in particular, cellular systems.

Temeljni literatura in viri / Readings:

- Choi Sangdun, Introduction to Systems Biology, Humana Press, 2007.
- Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman&Hall/CRC, Taylor and Francis Group, 2006.
- Edda Klipp, Systems Biology In Practice: Concepts, Implementation And Application, John Wiley & Sons Inc., 2005.
- Zoltan Szallasi, Joerg Stelling, Vipul Periwal, Systems Modeling in Cellular Biology, MIT Press, 2006.
- Andres Kriete, Roland Eils, Computational Systems Biology, Elsevier, 2005.

Cilji in kompetence:	**Objectives and competences:**
Cilj tega predmeta je, da se študenti naučijo sistemskega pristopa v biologiji in preprostih primerov modeliranja teh sistemov. Operativni cilji so: • predstaviti kompleksne sisteme; • ponazoriti zvezo med strukturo, dinamiko in evolucijo kompleksnih bioloških sistemov; • razviti sposobnosti za kvalitativno in kvantitativno analizo dinamike bioloških kompleksnih sistemov; • podati osnove matematičnega modeliranja izbranih bioloških sistemov (npr. celičnih oscilatorjev).	The objective of this course is for students to use system approach in biology and implement simple examples of modelling. The operative objectives are: • presenting complex systems; • establishing the relationship between structure, dynamics and evolution of complex biological systems; • developing skills for quantitative analysis of complex biological systems; • mathematical modelling of selected biological systems (e.g. cellular oscillators).

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po zaključku tega predmeta bo študent sposoben: • razumeti zvezo med strukturo, dinamiko in evolucijo kompleksnih bioloških sistemov; • uporabiti metode kvalitativne in kvantitativne analize dinamike bioloških sistemov;	**Knowledge and Understanding:** On completion of this course the student will be able to: • understand the relationship between structure, dynamics and evolution of complex biological systems; • implement methods for qualitative and quantitative analysis of biological systems;

• uporabljati osnovne metode matematičnega modeliranja izbranih bioloških sistemov (npr. celičnih oscilatorjev) **Prenesljive/ključne spretnosti in drugi atributi:** • *Spretnosti komuniciranja:* ustni zagovor vaj, pisno izražanje pri pisnem izpitu. • *Uporaba informacijske tehnologije:* uporaba računalniških programov za modeliranje sistemov. • *Reševanje problemov:* reševanje problemov z uporabo matematičnega modeliranja dinamike sistemov. • *Prenos znanja na druga področja:* prenos znanja s primerov iz fizike na področja populacijske dinamike, okoljskih problemov, bioloških sistemov, …	• use basic methods for mathematical modelling of selected biological systems (e.g. cellular oscillators). **Transferable/Key Skills and other attributes:** • *Communication skills:* oral defense of practical work, manner of expression at written examination. • *Use of information technology:* use of computer programs for systems modelling. • *Problem solving:* problem solving with implementing mathematical modelling of systems dynamics. • *Transfer of knowledge to other fields:* knowledge transfer from examples in physics to examples in population dynamics, environment and biological systems, …

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Predavanja • Teoretične vaje • Vaje na računalniku • Eksperimentalne vaje	• Lectures • Theoretical exercises • Computer exercises • Experiments

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
• Ustni izpit • Pisni izpit • praktično - seminar	40 40 20	• oral exam • written exam • practical - seminar

Reference nosilca / Lecturer's references:

GOSAK, Marko, MARKOVIČ, Rene, DOLENŠEK, Jurij, RUPNIK, Marjan, MARHL, Marko, STOŽER, Andraž, PERC, Matjaž. Network science of biological systems at different scales : a review. *Physics of life reviews*, ISSN 1873-1457, 2018, vol. 24, str. 118-135, doi: 10.1016/j.plrev.2017.11.003. [COBISS.SI-ID 512746040].

MARHL, Marko, GRUBELNIK, Vladimir, MAGDIČ, Marša, MARKOVIČ, Rene. Diabetes and metabolic syndrome as risk factors for COVID-19. *Diabetes & metabolic syndrome*, ISSN 1871-4021, 2020, vol. 14, iss. 4, str. 671-677, doi: 10.1016/j.dsx.2020.05.013. [COBISS.SI-ID 19193859].

GRUBELNIK, Vladimir, ZMAZEK, Jan, MARKOVIČ, Rene, GOSAK, Marko, MARHL, Marko. Modelling of energy-driven switch for glucagon and insulin secretion. *Journal of theoretical biology*, ISSN 0022-5193, 2020, vol. 493, str. 1-13, ilustr., doi: 10.1016/j.jtbi.2020.110213. [COBISS.SI-ID 25173256].

GRUBELNIK, Vladimir, ZMAZEK, Jan, MARKOVIČ, Rene, GOSAK, Marko, MARHL, Marko. Mitochondrial dysfunction in pancreatic alpha and beta cells associated with type 2 diabetes mellitus. *Life*, ISSN 2075-1729, 2020, vol. 10, no. 12, str. 1-16. https://www.mdpi.com/2075-1729/10/12/348, doi: 10.3390/life10120348. [COBISS.SI-ID 43234819].

ZMAZEK, Jan, GRUBELNIK, Vladimir, MARKOVIČ, Rene, MARHL, Marko. Role of cAMP in double switch of glucagon secretion. *Cells*, ISSN 2073-4409, 2021, vol. 10, iss. 4, 22 str. https://www.mdpi.com/2073-4409/10/4/896, doi: 10.3390/cells10040896. [COBISS.SI-ID 59694339].