



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:

Pogojev ni.

Prerequisites:

None.

Vsebina:

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

Content (Syllabus outline):

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:

- V. Grubelnik in M. Marhl, Dinamika enodimenzionalnih sistemov, Univerzitetna založba Univerze v Mariboru, Maribor (2024).
- S. H. Strogatz, Nonlinear Dynamics and Chaos. With Applications to Phzsics, Biology, Chemistry, and Engineering, Perseus Books Publishing, New York (1994).
- H. P. Schecker, Physik-Modellieren, Grafikorientierte Modellbildungssysteme im Physikunterricht, Ernst Klett Verlag, Stuttgart (1998).

Dodatna literatura / Additional Readings

- J. B. Snape, I. J. Dunn, J. Ingham, J. E. Prenosil, Dynamics of Environmental Bioprocesses, Modelling and Simulation, VCH Verlagsgesellschaft, Weinheim 1995.
- Strokovni in znanstveni članki v revijah / Articles published in professional and scientific journal

Cilji in kompetence:

Cilj tega predmeta je, da se študenti naučijo systemskega 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).

Objectives and competences:

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:

Znanje in razumevanje:

Po zaključku tega predmeta bo študent sposoben:

Intended learning outcomes:

Knowledge and Understanding:

On completion of this course the student will be able to:

• razumeti zvezo med strukturo, dinamiko in evolucijo kompleksnih bioloških sistemov; • uporabiti metode kvalitativne in kvantitativne analize dinamike bioloških sistemov; • uporabljati osnovne metode matematičnega modeliranja izbranih bioloških sistemov (npr. celičnih oscilatorjev) Prenesljive/ključne spretnosti in drugi atributi: • <i>Spretnosti komuniciranja:</i> ustni zagovor vaj, pisno izražanje pri pisnem izpitu. • <i>Uporaba informacijske tehnologije:</i> uporaba računalniških programov za modeliranje sistemov. • <i>Reševanje problemov:</i> reševanje problemov z uporabo matematičnega modeliranja dinamike sistemov. • <i>Prenos znanja na druga področja:</i> prenos znanja s primerov iz fizike na področja populacijske dinamike, okoljskih problemov, bioloških sistemov, ...	• understand the relationship between structure, dynamics and evolution of complex biological systems; • implement methods for qualitative and quantitative analysis of biological systems; • use basic methods for mathematical modelling of selected biological systems (e.g. cellular oscillators). Transferable/Key Skills and other attributes: • <i>Communication skills:</i> oral defense of practical work, manner of expression at written examination. • <i>Use of information technology:</i> use of computer programs for systems modelling. • <i>Problem solving:</i> problem solving with implementing mathematical modelling of systems dynamics. • <i>Transfer of knowledge to other fields:</i> knowledge transfer from examples in physics to examples in population dynamics, environment and biological systems, ...
--	---

Metode poučevanja in učenja:

• Predavanja • Teoretične vaje • Vaje na računalniku • Eksperimentalne vaje
--

Learning and teaching methods:

• Lectures • Theoretical exercises • Computer exercises • Experiments
--

Načini ocenjevanja:

Način (pisni izpit, ustno izpraševanje, naloge, projekt)
• Ustni izpit • Pisni izpit • Seminarska naloga

Delež (v %) /

Weight (in %) /

Assessment:

Type (examination, oral, coursework, project):
• Oral exam • Written exam • Seminar paper

Reference nosilca / Lecturer's references:

1. GRUBELNIK, Vladimir, ZMAZEK, Jan, MARHL, Marko. The synergistic impact of glycolysis, mitochondrial OxPhos, and PEP cycling on ATP production in beta cells. <i>International journal of molecular sciences</i>. 2025, vol. 26, iss. 4, 17 str., ilustr. ISSN 1422-0067. https://doi.org/10.3390/ijms26041454, DOI: 10.3390/ijms26041454, DOI: 20.500.12556/DKUM-91817. [COBISS.SI-ID 225604099]

2. MANCE KRISTAN, Romana, JURGEC, Staša, POTOČNIK, Uroš, MARHL, Marko, GAŠPERŠIČ, Rok. The association between periodontal inflamed surface area (PISA), inflammatory biomarkers, and mitochondrial DNA copy number. *Journal of clinical medicine*. 2025, vol. 14, iss. 1, [article no.] 24, str. 1-19, ilustr. ISSN 2077-0383. <https://www.mdpi.com/2077-0383/14/1/24>, DOI: [10.3390/jcm14010024](https://doi.org/10.3390/jcm14010024). [COBISS.SI-ID [221396995](https://cobiss.si/221396995)]
3. MARHL, Marko, MARKOVIČ, Rene, GRUBELNIK, Vladimir, PERC, Matjaž. The changing world dynamics of research performance. *Scientometrics*. 2025, vol. 130, str. 469-488. ISSN 1588-2861. DOI: [10.1007/s11192-024-05199-6](https://doi.org/10.1007/s11192-024-05199-6), DOI: [20.500.12556/DKUM-91828](https://doi.org/20.500.12556/DKUM-91828). [COBISS.SI-ID [225609219](https://cobiss.si/225609219)]
4. GRUBELNIK, Vladimir, ZMAZEK, Jan, GOSAK, Marko, MARHL, Marko. The role of anaplerotic metabolism of glucose and glutamine in insulin secretion : a model approach. *Biophysical chemistry*. [Print ed.]. 2024, vol. 311, [article no.] 107270, 16 str., ilustr. ISSN 0301-4622. <https://www.sciencedirect.com/science/article/pii/S0301462224000991?via%3Dihub>, DOI: [10.1016/j.bpc.2024.107270](https://doi.org/10.1016/j.bpc.2024.107270), DOI: [20.500.12556/DKUM-89024](https://doi.org/20.500.12556/DKUM-89024). [COBISS.SI-ID [197803779](https://cobiss.si/197803779)]
5. MARHL, Marko. What do stimulated beta cells have in common with cancer cells?. *Biosystems*. [Print ed.]. Aug. 2024, vol. 242, [article no.] 105257, 11 str. ISSN 0303-2647. DOI: [10.1016/j.biosystems.2024.105257](https://doi.org/10.1016/j.biosystems.2024.105257), DOI: [20.500.12556/DKUM-89336](https://doi.org/20.500.12556/DKUM-89336). [COBISS.SI-ID [200576771](https://cobiss.si/200576771)]