



Univerza v Mariboru
University of Maribor

Fakulteta za naravoslovje in
matematiko

Faculty of natural sciences and
mathematics



UČNI NAČRT PREDMETA / SUBJECT SPECIFICATION

Predmet:	Fizika bioloških sistemov
Subject Title:	Physics of Biological Systems

Študijski program Study programme	Študijska smer Study field	Letnik Year	Semester Semester
Izobraževalna fizika Educational Physics		2 or 3	4 or 5 or 6

Univerzitetna koda predmeta / University subject code:

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Labor work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
30	15	30			105	6

Nosilec predmeta / Lecturer:

Jeziki / Predavanja / Lecture:
Languages: Vaje / Tutorial:

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

Formalno oziroma neformalno osvojeno znanje iz vsebin predmetov Fizika I, Fizika II, Fizika III.

Prerequisites:

Formal or informal knowledge from subjects Physics I, Physics II, Physics III.

Vsebina:

Pregled izbranih zgledov iz biologije ter njihova obravnava s koncepti in metodami teoretične in eksperimentalne biofizike.

- 1) Biomehanika: sile v kosteh in mišicah; dinamika gibanja organizma; trki, zlomi, poškodbe; delovanje krvožilnega sistema in transport respiratornih plinov.
- 2) Termodinamika: 1. zakon termodinamike in metabolizem, toplota, delo in moč organizma; 2. zakon termodinamike in pogoji minimalne proste energije ter maksimalne entropije v bioloških sistemih; tok vode in topljencev preko selektivno prepustne celične membrane; kooperativna vezava kisika na hemoglobin, mehanizem encimske reakcije; regulacijski sistemi in mehanizmi, regulacija telesne temperature, regulacija volumna celice.
- 3) Elektromagnetizem: difuzija ionov, Donnanovo ravnovesje, membranski potencial; akcijski potencial in širjenje električnega pulza po živčni celici, model Hodgkina in Huxleya; magnetno polje in orientacija organizmov, šibka magnetna polja

Content (Syllabus outline):

Selected illustrative examples from biology studied by concepts and methods of theoretical and experimental biophysics.

- 1) Biomechanics: forces in bones and muscles; motion of living things; impacts, fractures, injuries; flow of blood in the circulatory system; transport of respiratory gases.
- 2) Thermodynamics: the first law of thermodynamics, metabolism, heat, work and power of human and animals; the second law of thermodynamics, conditions of minimal free energy and maximal entropy in biological systems; flow of water and solute across the selective cell membrane; cooperative binding of oxygen to haemoglobin, mechanism of enzyme reactions; regulatory systems and mechanisms, body temperature regulation, cell volume regulation.
- 3) Electromagnetism: diffusion of ions, the Donnan equilibrium, membrane potential; action potential and nerve impulses, the Hodgkin and Huxley model; magnetic fields and orientation of organisms, weak magnetic fields in biology

4) Nihanje in valovanje: celični in biokemijski oscilatorji; zvok, ultrazvok, detektorji in mehanoreceptorji zvoka, Dopplerjev pojav; svetloba, oko in fotoreceptorji svetlobe.
 5) Molekularna biofizika: kemijske vezi; struktura vode; struktura in funkcija beljakovin (encimi, transportne beljakovine), nukleinskih kislin (genetska informacija), molekularnih motorjev, biološke membrane, virusov.
 6) Izvor in evolucija življenja.

4) Vibrational and wave motion: biochemical and cellular oscillators; sound, ultrasound and detectors, the Doppler effect; light, eye and photoreceptors.
 5) Molecular biophysics: chemical bonds; molecular structure of water; structure and function of proteins (enzymes, transport-mediated proteins), nucleic acids (genetic information), molecular motors, biological membranes, viruses,.
 6) Origin and evolution of life.

Temeljni literatura in viri / Textbook:

- G: B. Benedek in F:M:H: Villars: Physics with Illustrative Examples from Medicine and Biology: Mechanics, Statistical Physics, Electricity and Magnetism, Springer 2000
- M. Cerdonio in R.W. Noble: Introductory Biophysics, World Scientific 1986
- R. Nossal in H. Lecar: Molecular and Cell Biophysics, Addison-Wesley 1991
- R. Glaser: Biophysics, Springer 2001

Cilji:

Seznanim študenta z izbranimi biološkimi sistemi in jih obravnavati s koncepti in metodami teoretične biofizike. Pri tem je poudarek na preprostih matematičnih modelih.

Objectives:

The main objective is to discuss selected biological systems with the concepts and methods of theoretical biophysics. The course is focused to formulation of simple mathematical models.

Predvideni študijski rezultati:

Znanje in razumevanje:
 Študent osvoji znanje o strukturi bioloških sistemov in njihovo delovanje razume na osnovi fizikalnih konceptov in zakonitosti.
 Prenosljive/ključne spretnosti in drugi atributi:
 Študent zna uporabiti preproste matematične modele za kvantitativno obravnavo strukture in funkcije bioloških sistemov.

Intended learning outcomes:

Knowledge and Understanding:
 Students get knowledge of structure and function of selected biological systems based on fundamental principles and concepts of physics.
 Transferable/Key Skills and other attributes:
 Students are able to use simple mathematical models for quantitative studies of structure and function of biological systems.

Metode poučevanja in učenja:

Predavanja
 Seminar; seminarska naloga iz izbranega področja iz biofizike.
 Seminarske oziroma računske vaje.

Learning and teaching methods:

Lectures
 Seminar; coursework from selected field in biophysics
 Tutorials

Načini ocenjevanja:

Delež (v %) /
 Weight (in %)

Assessment:

Pisni izpit	35%	Written exam Oral exam Course work
Ustni izpit	35%	
Seminarska naloga	30%	