



**Univerza v Mariboru**  
**University of Maribor**

**Fakulteta za naravoslovje in**  
**matematiko**

**Faculty of natural sciences and**  
**mathematics**



### UČNI NAČRT PREDMETA / SUBJECT SPECIFICATION

|                       |                               |
|-----------------------|-------------------------------|
| <b>Predmet:</b>       | Fizika bioloških sistemov     |
| <b>Subject Title:</b> | Physics of Biological Systems |

| Študijski program<br>Study programme        | Študijska smer<br>Study field | Letnik<br>Year | Semester<br>Semester |
|---------------------------------------------|-------------------------------|----------------|----------------------|
| Izobraževalna fizika<br>Educational Physics |                               | 1              | 1                    |

**Univerzitetna koda predmeta / University subject code:**

| Predavanja<br>Lectures | Seminar<br>Seminar | Sem. vaje<br>Tutorial | Lab. vaje<br>Labor work | Teren. vaje<br>Field work | Samost. delo<br>Individ. work | ECTS |
|------------------------|--------------------|-----------------------|-------------------------|---------------------------|-------------------------------|------|
| 30                     | 15                 | 15                    |                         |                           | 180                           | 8    |

**Nosilec predmeta / Lecturer:**

dr. Aleš Fajmut

**Jeziki /**

**Languages:**

**Predavanja / Lecture:**

**Vaje / Tutorial:**

slovenski/Slovene

Slovenski /Slovene

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

Formalno oziroma neformalno osvojeno znanje iz vsebin predmetov Mehanika, Termodinamika, Elektromagnetizem, Nihanje in valovanje, Moderna fizika in Kemija.

**Prerequisites:**

Formal or informal knowledge from subjects Mechanics, Thermodynamics, Electromagnetism, Oscillations and Wave motion, Modern Physics and Chemistry.

**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 krvnožilnega 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  
4) Nihanje in valovanje: celični in biokemijski oscilatorji; zvok, ultrazvok, detektorji in

**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) Vibrational and wave motion: biochemical and cellular oscillators; sound, ultrasound and detectors,

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.

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:

Seznani 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.  
 Prenesljive/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  
 Ustni izpit  
 Seminarska naloga

35%  
 35%  
 30%

Written exam  
 Oral exam  
 Course work