

**UČNI NAČRT PREDMETA / COURSE SYLLABUS**

|                      |                                                                 |
|----------------------|-----------------------------------------------------------------|
| <b>Ime predmeta:</b> | Izbrane vsebine in novosti v biofiziki in medicinski fiziki     |
| <b>Course title:</b> | Selected topics and novelties in biophysics and medical physics |

| <b>Študijski program in stopnja</b><br><b>Study programme and cycle</b> | <b>Študijska smer</b><br><b>Study option</b> | <b>Letnik</b><br><b>Year of study</b> | <b>Semester</b><br><b>Semester</b> |
|-------------------------------------------------------------------------|----------------------------------------------|---------------------------------------|------------------------------------|
| Splošna medicina, enovit magistrski študijski program                   |                                              | Prvi                                  | 1.                                 |
| General medicine, Uniform master's degree study program                 |                                              | First                                 | 1st                                |

**Vrsta predmeta (obvezni ali izbirni) /**  
**Course type (compulsory or elective)**

izbirni  
elective

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

| <b>Predavanja</b><br><b>Lectures</b> | <b>Seminar</b><br><b>Seminar</b> | <b>Vaje</b><br><b>Tutorial</b> | <b>Klinične vaje</b><br><b>Clinical training</b> | <b>Druge oblike študija</b><br><b>Other forms of study</b> | <b>Samost. delo</b><br><b>Individual work</b> | <b>ECTS</b> |
|--------------------------------------|----------------------------------|--------------------------------|--------------------------------------------------|------------------------------------------------------------|-----------------------------------------------|-------------|
| 5                                    | 40                               | AV LV RV                       |                                                  |                                                            | 45                                            | 3           |

**Nosilec predmeta / Course coordinator:**

prof. dr. Marko Marhl

**Jeziki /Languages:**

**Predavanja / Lectures:**

slovenski/slovene

**Vaje / Tutorial:**

slovenski/slovene

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

**Prerequisites for enrolling in the course or for performing study obligations:**

**Vsebina (kratek pregled učnega načrta):**

Študent oziroma skupina študentov si po svoji presoji izbere eno temo izmed tukaj navedenih, lahko pa predlaga popolnoma drugo temo iz področij biofizike, biotehnologije, medicinske fizike ipd. in jo predstavi v seminarju ostalim študentom tega izbirnega predmeta.

Delo je lahko teoretično ali eksperimentalno.

Kalcij v celičnih procesih in signalizacija med celicami. Biofizikalni mehanizmi krčenja mišice in kontraktilnih proteinov. Dušikov monoksid in napetostno stanje stene žil. Molekularni motorji. Biofizikalni mehanizmi izbranih fizioloških procesov oziroma sistemov kot na primer so dihalni sistem, srčnožilni sistem, prenos živčnega signala, vid, sluh. Ionizirajoče sevanje in interakcija s humanim tkivom. Napredne eksperimentalne metode v

**Content (syllabus outline):**

A student or group of students can, at discretion, choose one topic from those mentioned here, however, it is possible to propose a completely different topic from the fields of biophysics, biotechnology, medical physics, etc., and present it in a seminar to other students of this elective course. Work can be theoretical or experimental.

Calcium in cell function and signaling between cells. Biophysical mechanisms of muscle contraction and contractile proteins. Nitric oxide and a stress state of arteries. Molecular motors. Biophysical mechanisms of selected physiological processes and systems such as the respiratory system, the cardiovascular system, the transmission of the nervous signal, vision, hearing and similar. Ionizing radiation and interaction with human tissue. Advanced experimental methods in diagnosis and

diagnostiki in terapiji kot na primer CT-rentgen, termografija, upodabljanje z magnetno resonanco, ultrazvok ipd. Medicinska sistemska biologija, kaj je to?

therapy such as CT-X-ray, thermography, magnetic resonance imaging, ultrasound, etc. Medical systems biology, what is it?

### Temeljni literatura in viri / Reading materials:

- J. Newman: Physics of the Life Sciences, Springer Science+Business Media, LLC, 2008.
- I. P. Herman, Physics of the Human Body, Springer-Verlag, 2007.
- R. Phillips, J. Kondev, J. Theriot, H.G. Garcia, Physical Biology of the Cell, Garland Science, 2012.

### Dopolnilno gradivo:

- R. Glaser, Biophysics: An Introduction, Springer-Verlag, 2012.
- P. F. Dillon, Biophysics: A Physiological Approach, Cambridge University Press, 2012.
- P. K. Skrivastava: Elementary Biophysics, An Introduction, Alpha Science International Ltd., Harrow, U.K., 2005.
- S. Amador Kane, Introduction to Physics in Modern Medicine, CRC Press, 2009.
- Diagnostična in intervencijska radiologija. Splošni del. Urednik V. Jevtič, sourednika M. Šurlan, J. Matela. Založba Pivec, 2014.

### Cilji in kompetence:

Na osnovi fizikalnih konceptov in zakonitosti ter biofizikalnih mehanizmov osvojiti razumevanje fizioloških procesov v človeškem organizmu ter bioloških procesov na ravneh tkiva, celice ter supramolekularnih in makromolekularnih struktur. Razumeti fizikalne osnove naprednih diagnostičnih in terapevtskih metod medicinske fizike. Doseči vedenje o načinu samostojne obravnave izbrane teme ter njene predstavitev svojim kolegom v seminarju v ustrezni pisni in ustni obliki.

### Objectives and competences:

To comprehend human physiological processes as well as biological processes running on different levels of biological organisation such as tissues, cells, and supramolecular and macromolecular structures, from the point of view of physical concepts and laws and biophysical mechanisms. To comprehend basic physics of advanced diagnostic methods and therapeutic methods of medical physics. To achieve knowledge on the method of self-treatment of a selected topic and its presentation to their colleagues in a seminar in appropriate oral and written form.

### Predvideni študijski rezultati:

Znanje in razumevanje:

Študentje osvojijo razumevanje različnih procesov v biologiji in fiziologiji na osnovi fizikalnih konceptov in zakonov ter biofizikalnih mehanizmov in modelov.

Razumejo osnovne principe delovanja eksperimentalne opreme v diagnostiki in terapiji.

Prenesljive/ključne spretnosti in drugi atributi:

Študentje znajo uporabiti biofizikalne modele za obravnavo strukture in funkcije izbranih bioloških sistemov in primerov iz humane fiziologije. Znajo samostojno raziskati izbran problem in ga predstaviti v pisni in ustni obliki v seminarju.

### Intended learning outcomes:

Knowledge and Understanding:

Students get understanding of various processes in biology and physiology based on concepts and laws in physics as well as on biophysical mechanisms and models. They understand the basic physical principles of experimental equipment in diagnostics and therapy.

Transferable/Key Skills and other attributes:

Students are able to use biophysical models for discussing structure and function of selected biological systems and cases in human physiology. They are able to explore the chosen problem and present it in oral and written form in the seminar.

### Metode poučevanja in učenja:

Predavanja.  
Seminar.

### Learning and teaching methods:

Lectures.  
Course work.

### Načini ocenjevanja:

Delež (v %) /  
Share (in %)

### Assessment methods:

|                                                                       |    |                                                                                  |
|-----------------------------------------------------------------------|----|----------------------------------------------------------------------------------|
| Seminar:<br>Seminarska naloga (pisna)                                 | 50 | Seminar:<br>Course work (written)                                                |
| Ustna predstavitev seminarske naloge                                  | 50 | Oral presentation of course work                                                 |
| ŠTUDIJSKE OBVEZNOSTI ŠTUDENTOV:                                       |    | ACADEMIC OBLIGATIONS OF STUDENTS:                                                |
| Obvezna prisotnost na seminarjih                                      |    | Compulsory participation at seminars                                             |
| Izdelava pisne seminarske naloge                                      |    | Course work written.                                                             |
| Ustna Ppt predstavitev seminarske naloge                              |    | Oral Ppt presentation of course work                                             |
| POGOJI ZA PRISTOP K POSAMEZNEMU<br>PREVERJANJU ZNANJA:                |    | REQUIREMENTS FOR ACCESS TO INDIVIDUAL<br>KNOWLEDGE CHECKING:                     |
| Pravočasno oddana pisna seminarska naloga                             |    | Written seminar work which which has to be<br>submitted to the lecturer in time. |
| Pravočasno oddana priprava na ustno<br>predstavitev seminarske naloge |    | Arrangements of the oral presentation discussed<br>with the lecturer in time.    |

#### Reference nosilca / Course coordinator's references:

GOSAK, Marko, STOŽER, Andraž, MARKOVIČ, Rene, DOLENŠEK, Jurij, **MARHL, Marko**, RUPNIK, Marjan, PERC, Matjaž. The relationship between node degree and dissipation rate in networks of diffusively coupled oscillators and its significance for pancreatic beta cells. *Chaos*, ISSN 1054-1500, July 2015, vol. 25, iss. 7, 073115-1-073115-8, doi: [10.1063/1.4926673](https://doi.org/10.1063/1.4926673). [COBISS.SI-ID [512523576](https://www.cobiss.si/id/512523576)], [JCR, SNIP, WoS do 28. 5. 2017: št. citatov (TC): 2, čistih citatov (CI): 1, Scopus do 28. 4. 2017: št. citatov (TC): 2, čistih citatov (CI): 1]

GOSAK, Marko, DOLENŠEK, Jurij, MARKOVIČ, Rene, RUPNIK, Marjan, **MARHL, Marko**, STOŽER, Andraž. Multilayer network representation of membrane potential and cytosolic calcium concentration dynamics in beta cells. *Chaos, solitons and fractals*. [Print ed.], 2015, vol. 80, str. 76-82, ilustr. <http://www.sciencedirect.com/science/article/pii/S0960077915001794>, doi: [10.1016/j.chaos.2015.06.009](https://doi.org/10.1016/j.chaos.2015.06.009). [COBISS.SI-ID [512513080](https://www.cobiss.si/id/512513080)], [JCR, SNIP, WoS do 2. 2. 2016: št. citatov (TC): 2, čistih citatov (CI): 0, Scopus do 2. 3. 2016: št. citatov (TC): 2, čistih citatov (CI): 0]

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](https://doi.org/10.1371/journal.pone.0143781). [COBISS.SI-ID [2645676](https://www.cobiss.si/id/2645676)], [JCR, SNIP, WoS do 22. 1. 2017: št. citatov (TC): 1, čistih citatov (CI): 1, Scopus do 28. 1. 2017: št. citatov (TC): 1, čistih citatov (CI): 1]

MARKOVIČ, Rene, STOŽER, Andraž, GOSAK, Marko, DOLENŠEK, Jurij, **MARHL, Marko**, RUPNIK, Marjan. Progressive glucose stimulation of islet beta cells reveals a transition from segregated to integrated modular functional connectivity patterns. *Scientific reports*, ISSN 2045-2322, vol. 5, 2015, 10 str. <http://www.nature.com/srep/2015/150119/srep07845/full/srep07845.html>, doi: [10.1038/srep07845](https://doi.org/10.1038/srep07845). [COBISS.SI-ID [512466488](https://www.cobiss.si/id/512466488)], [JCR, SNIP, WoS do 28. 5. 2017: št. citatov (TC): 9, čistih citatov (CI): 5, Scopus do 28. 5. 2017: št. citatov (TC): 11, čistih citatov (CI): 7]

MARKOVIČ, Rene, PELTAN, Julien, GOSAK, Marko, HORVAT, Denis, ŽALIK, Borut, SEGUY, Benjamin, CHAUVEL, Remi, MALANDAIN, Gregoire, COUFFINHAL, Thierry, DUPLÁA, Cécile, **MARHL, Marko**, ROUX, Etienne. Planar cell polarity genes frizzled4 and frizzled6 exert patterning influence on arterial vessel morphogenesis. *PloS one*, ISSN 1932-6203, 2017, vol. 12, iss. 3, str. 1-19, doi: [10.1371/journal.pone.0171033](https://doi.org/10.1371/journal.pone.0171033). [COBISS.SI-ID [22990856](#)], [[JCR](#), [SNIP](#), [WoS](#) do 24. 3. 2017: št. citatov (TC): 0, čistih citatov (CI): 0, [Scopus](#) do 29. 5. 2017: št. citatov (TC): 1, čistih citatov (CI): 1]