2017/2018

Univerza v Mariboru

Medicinska fakulteta

UČNI NAČRT PREDMETA / SUBJECT SPECIFICATION	
Predmet:	Biofizika
Subject Title:	Biophysics

Študijski program Study programme	Študijska smer Study field	Letnik Year	Semester Semester
Splošna medicina General medicine	Splošna medicina General medicine	1	**1**

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
15	15		30		60	**4**

Nosilec predmeta / Lecturer: Red. prof. dr. Marko Marhl, doc. dr. Andrej Dobovišek

Jeziki / Languages:	**Predavanja / Lecture:**	slovenski/Slovene
	Vaje / Tutorial:	Slovenski/Slovene

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

Prerequisits:

Vsebina:

Biomehanika človeškega telesa: Izbrani primeri iz biomehanike skeleta in mišic (sila, navor, delo, energija, mehanska napetost in deformacije)

Hemodinamika in krvni obtok: obravnava gibanja neviskoznih in viskoznih tekočin (tlak v mirujočih tekočinah, laminarni in turbolentni tok tekočine, Reynoldsovo število, Bernoullijeva enačba in Poiseuillov zakon).

Električni pojavi v biološki celici: Električni tok, napetost in električna upornost. Ohmov zakon. Struktura celične membrane, lipidni dvosloj. Celična membrana kot električni kondenzator. Membranski potenciali: Nernstov potencial, Donnanov potencial, elektrodifuzijski potencial. Električni monopol in dipol, polarne molekule kot električni dipoli. Molekula vode kot električni dipol. Srce kot električni dipol.

Energijske pretvorbe v celici: Obravnava energijjskih pretvorb v celici z osnovnimi termodinamskimi zakoni. Prvi in drugi zakon termodinamike. Ravnovesno in stacionarno stanje celice. Prosta energija, entropija in (elektro)kemijski potencial. Celični metabolizem.

Biofizika očesa in ušesa: Osnovne lastnosti zvoka in svetlobe. Obravnava tankih leč in fizikalna obravnava

Content (Syllabus outline):

Biomechanics of the human body: Selected cases from biomechanics of skeleton and muscles (force, torque, work, energy, mechanic stress and deformations).

Hemodynamics and blood circulation: The flow of the non viscous and viscous fluids (hydrostatics fluids, laminar and turbulent fluid flow, Reynolds Number, Bernoulli Equation and Hagen-Poiseuille Equation.

Electric phenomena in biological cells: electric current, voltage and electrical resistance Ohm's law. The structure of the cell membrane, the lipid bilayer. Electric current, voltage and electric resistance; Ohm's law. The structure of the cell membrane, the lipid bilayer. Cell membrane as an electric capacitor. The cell membrane potential: Nernst potential, Donnan's potential, electro-diffusion potential. Electric monopoly and dipole, polar molecules such as electric dipoles, the water molecule and heart like electric dipoles.

Energy conversion in the cell: Treatment of energy conversion in the cell with the basic thermodynamic laws. The first and second law of thermodynamics. The equilibrium and steady state of the cells. Free energy, entropy and (electro) chemical potential. Cellular metabolism.

Biophysics of the eye and ear: Basic physical properties

daljnovidnosti in kratkovidnosti.
Jakost zvoka, vrste zvoka, meje slišnosti človeškega ušesa. Spektri valovanja.

Zgradba materije, atomi in molekule.
Bohrov model atoma in periodni sistem elementov.
Medatomske in medmolekularne sile.
Emisijski spekter vodika.

Radioaktivnost, zgradba in stabilnost atomskega jedra. Interakcija ionizirajočega sevanja s tkivom. Zaščita pred radioaktivnimi in ionizirajočimi sevanji. Dozimetrija.

Izbrani biološki procesi oziroma sistemi: - Dihanje in transport respiratornih plinov. - Voda: struktura, hidrofilne in hidrofobne interakcije. - Prehajanje vode in ionov preko celične membrane; osmoza.

Fizikalne osnove nekaterih radioloških metod.
Rentgenski (RTG žarki: njihov nastanek, spekter in absorpcija RTG žarkov. Uporaba v diagnostiki, absorpcija rentgenskih žarkov v snovi in RTG slikanje, CT rentgen.
Ultrazvok: Uporaba ultrazvoka v klinični praksi (meritev hitrosti krvi, meritev velikosti bioloških struktur, primer: premer žile).
Magnetna resonanca (MR) z upodabljanjem (MRI)
PET /CT– emisija pozitrona / računalniška tomografija(CT)
SPET /CT – emisija posameznega fotona /računalniška tomografija (CT)
Vpliv ionizirajočega sevanja na humano tkivo.
Dozimetrija.

Kratek Pregled vsebin laboratorijskih vaj pri predmetu biofizika:

- meritve moči mišic pri navpičnem skoku
-sile in navori na podlaket

-merjenje tlaka in krvnega tlaka
-merjenje pretoka tekočin

- leče, lupa, mikroskop, model očesa,
-daljnovidnost in kratkovidnost,
-določanje velikosti slepe pege in določanje gostote fotoreceptorjev na očesnem ozadju
-merjenje električnih količin, Ohmov zakon.
- merjenje membranskega električnega potenciala,
- elektrokardiografija,

-spektri svetlobe in optična spektrometrija, pulzni oksimeter
-spektri zvoka, ton, zven, šum
- rentgenska kristalografija
- osnove ultrazvočnih meritev
-ultrazvočne meritve na žilah
-ultrazvočni CT simulacija RTG/CT

of light and sound. The transversal and longitudinal waves. Geometric optics, imaging with thin lenses; a simple model of the eye, farsightedness and nearsightedness. Sound, sound types, limits of audibility of the human ear. The spectra of electromagnetic waves and sound.

Structure of Matter: Atoms and molecules.
Bohr model and the periodic system.
Atomic and molecular forces.
The emission spectrum of hydrogen

Radioactivity, Structure and stability of atomic nucleus. The interaction of ionizing radiation with human tissue. Protection against radioactive and ionizing radiation. Dosimetry.

Selected biological processes and systems: - Breathing and transport of respiratory gases. - Water: structure, hydrophilic and hydrophobic interactions. - Penetration of water and ions across the cell membrane; osmosis.

Physical fundamentals of some radiological methods.
X-rays (X-ray beams: their origins, and the absorption spectrum of X-ray radiation. The use in diagnostic, X-ray absorption in the material, and x-ray imaging, X-ray CT.
Ultrasound: Ultrasound in clinical practice (measurement of blood flow, measurement of the size of biological structures, such as the diameter of blood vessels).
Magnetic resonance (MR) imaging (MRI)
PET / CT positron emission computed tomography / computed tomography (CT)
SPET / CT - single photon emission / computed tomography
The impact of ionizing radiation on human tissue.
Dosimetry.

A brief overview of the experiments on the subject of biophysics:

- Measurements of muscle strength in the vertical jump
-forces and torque to the forearm
--measurement of the outside pressure and blood pressure
-measurement of the outside fluid flow

- lens, loupe, microscope, model of the human eye; - observing farsightedness and nearsightedness.
-the size of blind spots and to determine the density of photoreceptors in the eye
- basic physics of ultrasound measurements in medicine
- selected theoretical and computing examples in radiology: irradiation of tumours
- the spectra of light and optical spectroscopy, pulse oxygen meter
-spektri sound, tone, sound, noise
- X-ray crystallography

-izbrani teoretični in računski primeri iz radiologije: obsevanje tumorjev	

Temeljni literatura in viri / Textbooks:

1. Patrick F. Dillon: Biophysics. A Physiological Approach, 2012 Cambridge University Press
2. P K Skrivastava: Elementary Biophysics, An Introduction, Alpha Science International Ltd., Harrow, U.K., 2005.
3. Jay Newman: Physic of the Life Sciences, 2008 Springer Science + Bussiness Media, LLC

4. Radiologija, uredniki: Ludvik Tabor, Vladimir Jevtić, Dušan Pavčnik, Medicinski razgledi, 2001 Ljubljana
5. Diagnostična in intervencijska radiologija. Splošni del. Urednik Vladimir Jevtič, sourednika Miloš Šurlan, Jože Matela. Založba Pivec 2014 Maribor.

Cilji:	**Objectives:**
Osvojiti osnovne fizikalne koncepte in zakonitosti pomembne za razumevanje fizikalnih aspektov bioloških procesov na ravneh organizma, organa, tkiva in celic ter supramolekularnih in makromolekularnih struktur. Poseben poudarek je namenjen uporabi fizike v radiologiji in njenim fizikalnim osnovam ter nekaterim kliničnim primerom, ki so izbrani za ilustracijo posameznih radioloških metod. Študentom želimo približati izbrane fizikalne pojave, ki so osnova fizioloških procesov v človeškem organizmu ter nekaterih metod v diagnostiki in zdravljenju.	To attain the knowledge of the fundamental concepts and laws in physics important for mainly qualitative understanding various biological processes running on different levels of biological organisation such as organisms, organs, tissues, cells, and supramolecular and macromolecular structures. To get acquainted with phenomena in physics which serve as fundamental understanding of physiological processes in human as well as of some diagnostic methods and methods of medical treatment.
Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študentje osvojijo znanje temeljnih fizikalnih konceptov in zakonov usmerjenih v razumevanje različnih procesov v biologiji in fiziologiji človeka ter uporabi teh konceptov v medicini in radiologiji. Prenesljive/ključne spretnosti in drugi atributi: Študentje znajo uporabiti preproste fizikalne in matematične modele za študij strukture in funkcije izbranih bioloških sistemov in primerov iz humane fiziologije. Študentje si razširijo razgledanost na področju naravoslovja. Znajo analizirati in interpretirati izmerjene eksperimentalne podatke.	Knowledge and Understanding: Students get knowledge of fundamental concepts and laws in physics applied to understanding various processes in human biology and physiology. Transferable/Key Skills and other attributes: Students are able to use simple mathematical models for studies of structure and function of selected biological systems and cases in human physiology. They become well broadly versed in science. They know how to present and interpret their measured experimental data.
	Learning and teaching methods:
Metode poučevanja in učenja:	
Predavanja. Seminar. Laboratorijske vaje.	Lectures. Course work. Lab work.

Načini ocenjevanja:	Delež (v %) / weight (in %)	**Assessment:**

Sklepni kolokvij iz laboratorijskih vaj oziroma pisni izpit	40%	Final test on lab work or written exam
Seminar	20%	Course work.
Ustni izpit	40%	Oral examination.
ŠTUDIJSKE OBVEZNOSTI ŠTUDENTOV 1. Opravljene laboratorijske vaje. Obvezna prisotnost na vajah. Opravljene vse laboratorijske vaje in izdelana poročila o vseh laboratorijskih vajah po programu.		ACADEMIC OBLIGATIONS OF STUDENTS: Lab work completed (obligatory participation, measurements and reports completed, final test on lab work or written exam)
2. Opravljen seminar (obvezna prisotnost, aktivna udeležba, izdelana in učitelju oddana seminarska naloga ter predstavljena v seminarju.		Course work done (obligatory and active participation, written and/or oral presentation)
3. Opravljen ustni izpit s pozitivno oceno.		Oral examination done
POGOJI ZA PRISTOP K USTNEMU IZPITU: -opravljene laboratorijske vaje, -opravljen seminar - pozitiven sklepni kolokvij iz laboratorijskih vaj ali pozitiven pisni izpit (pozitivno opravljen sklepni kolokvij iz vaj nadomesti pisni izpit).		REQUIREMENTS FOR ACCESS TO INDIVIDUAL KNOWLEDGE CHECKING: Lab work completed and course work done.

Reference nosilca / Lecturer's references: prof. dr. Marko Marhl

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. [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. [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. [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. [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]

2017/2018

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. [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]

Reference nosilca / Lecturer's references: doc. dr. Andrej Dobovišek

2016

VITAS, Marko, DOBOVIŠEK, Andrej. On a quest of reverse translation. *Foundations of chemistry*, ISSN 1386-4238, 2016, 17 str., doi: 10.1007/s10698-016-9260-5. [COBISS.SI-ID 22581768]

2015

FAJMUT, Aleš, EMERŠIČ, Tadej, DOBOVIŠEK, Andrej, ANTIĆ, Nataša, SCHÄFER, Dirk, BRUMEN, Milan. Dynamic model of eicosanoid production with special reference to non-steroidal anti-inflammatory drug-triggered hypersensitivity. *IET systems biology*, ISSN 1751-8849. [Print ed.], 2015, vol. 9, iss. 5, str. 204-215, doi: 10.1049/iet-syb.2014.0037. [COBISS.SI-ID 21404168], [JCR, SNIP, WoS do 19. 10. 2015: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0, Scopus do 12. 10. 2015: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0]

2014

DOBOVIŠEK, Andrej, ŽUPANOVIĆ, Paško, BRUMEN, Milan, JURETIĆ, Davor. Maximum entropy production and maximum Shannon entropy as Germane principles for the evolution of enzyme kinetics. V: DEWAR, Roderick C. (ur.). *Beyond the second law : entropy production and non-equilibrium systems*, (Springer complexity), (Understanding complex systems, ISSN 1860-0832). Berlin; Heidelberg: Springer, cop. 2014, str. 361-382, graf. prikazi. [COBISS.SI-ID 20311048]

2012

DOBOVIŠEK, Andrej, FAJMUT, Aleš, BRUMEN, Milan. Strategy for NSAID administration to aspirin-intolerant asthmatics in combination with PGE [sub] 2 analogue: a theoretical approach. *Medical & biological engineering & computing*, ISSN 0140-0118. [Print ed.], 2012, vol. 50, no. 1, str. 33-42, doi: 10.1007/s11517-011-0844-x. [COBISS.SI-ID 18845192], [JCR, SNIP, WoS do 4. 11. 2015: št. citatov (TC): 1, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0, Scopus do 4. 11. 2015: št. citatov (TC): 4, čistih citatov (CI): 3, normirano št. čistih citatov (NC):

2011

DOBOVIŠEK, Andrej, FAJMUT, Aleš, BRUMEN, Milan. Role of expression of prostaglandin synthases 1 and 2 and leukotriene C [sub] 4 synthase in aspirin-intolerant asthma: a theoretical study. *Journal of pharmacokinetics and pharmacodynamics*, ISSN 1567-567X, 2011, vol. 38, no. 2, str. 261-278, doi: 10.1007/s10928-011-9192-6. [COBISS.SI-ID 18203144], [JCR, SNIP, WoS do 5. 11. 2015: št. citatov (TC): 3, čistih citatov (CI): 1, normirano št. čistih citatov (NC): 0, Scopus do 5. 11. 2015: št. citatov (TC): 6, čistih citatov (CI): 4, normirano št. čistih citatov (NC): 1]