



Univerza v Mariboru

Medicinska fakulteta

UČNI NAČRT PREDMETA / COURSE SYLLABUS

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| Ime predmeta: | Biofizika | | | | | | | |
| Course title: | Biophysics | | | | | | | |
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| Študijski program in stopnja Study programme and cycle | Študijska smer Study option | | | Letnik Year of study | Semester Semester | | | |
| Biomedicinska tehnologija/3. stopnja | | | | 1 | 1 ali 2 | | | |
| Biomedical Technology/3rd Degree | | | | | | | | |
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| Vrsta predmeta (obvezni ali izbirni) / Course type (compulsory or elective) | | | | Temeljni | | | | |
| | | | | Basic | | | | |
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| Univerzitetna koda predmeta / University course code: | | | | | | | | |
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| Predavanja Lectures | Seminar Seminar | Vaje Tutorial | | | Klinične vaje Clinical training | Druge oblike študija Other forms of study | Samost. delo Individual work | ECTS |
| 20 | 40 | 15 | | | | | 195 | 9 |
| | | AV | LV | RV | | | | |
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| Nosilec predmeta / Course coordinator: | Prof. dr. Marko Marhl | | | | | | | |
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| Jeziki /Languages: | Predavanja / Lectures: | | Slovenščina/Slovene | | | | | |
| | Vaje / Tutorial: | | Slovenščina/Slovene | | | | | |
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites for enrolling in the course or for performing study obligations: | | | | | | | |
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| Vsebina (kratek pregled učnega načrta): | Content (syllabus outline): | | | | | | | |
| Biophysika celice in celične membrane: mehanske lastnosti celične membrane, metabolizem celice, termodinamski potenciali in kemijski potencial, kislinsko-bazno ravnotežje, osmoza, difuzija in elektrodifuzija, membranski potencial, Nernstova enačba, Donnanovo ravnovesje, elektrodifuzijski potencial. Električna vzdražljivost celice in prenos električnega impulza. Biofizika celičnega skeleta in molekularni motorji (delovanje mišice). Izbrani fiziološki sistemi: kri in krvni obtok, čutila, okostje in mišice, živčevje. Regulacija bioloških sistemov (sistemska analiza, regulacija metaboličnih sistemov – kontrolna teorija). Biološki dinamični sistemi (celična signalizacija, razvoj populacije). Samoorganizacija bioloških sistemov. Teorije in modeli evolucije. Interakcija neionizirajočega | Cell and cell membrane biophysics: mechanical properties of a cell membrane, cellular metabolism, thermodynamic potentials and chemical potential, acid-base equilibrium, osmosis, diffusion and electrodiffusion, the membrane potential; Nernst equation, Donnan equilibrium, electrodiffusion potential. Electrical excitability and propagation of electric pulse. Biophysics of cytoskeleton and molecular motors (muscle contraction). Selected physiological systems: blood and cardiovascular system, senses, skeletal-muscular system, nervous system. Regulation of biological systems (system analysis, control theory of metabolic systems). Biological dynamic systems (cell signalling, growth of population). Self-organisation of biological systems. Theory and models of evolution. Interaction of non-ionising electromagnetic radiation with human | | | | | | | |

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| <p>elektromagnetnega sevanja s tkivom človeka. Interakcija ionizirajočega sevanja s tkivom.</p> <p>Pri obravnavi vsebin spoznamo nekaj ključnih biofizikalnih teoretičnih in eksperimentalnih raziskovalnih metod, ki so pomembne za znanstveno raziskovalno delo na področju medicine.</p> <p><i>Teoretične metode:</i> stabilnostna analiza dinamičnih sistemov, numerične metode in deterministično modeliranje, izračun Lyapunovih eksponentov, analiza kaotičnih atraktorjev, določanje fraktalne dimenzije, stohastično modeliranje in Gillespijev algoritem, metoda Monte Carlo, celični avtomati, teorija iger, teorija mrež, analiza časovnih vrst.</p> <p><i>Eksperimentalne metode:</i> optična mikroskopija, elektronska mikroskopija, analiza nanomaterialov in uporaba nanodelcev, nuklearna magnetna resonanca, elektronska paramagnetna resonanca.</p> | <p>tissue. Interaction with ionising radiation with tissues.</p> <p>In the frame of the proposed content, we learn some key theoretical and experimental research methods used in biophysics, which is crucial for the research work in the field of medicine.</p> <p><i>Theoretical methods:</i> stability analysis of dynamical systems, numerical methods and deterministic modelling, determination of Lyapunov exponents, analysis of chaotic attractors, determination of fractal dimension, stochastic modelling and Gillespie algorithm, Monte Carlo method, cellular automata, game theory, network theory, time-series analysis.</p> <p><i>Experimental methods:</i> optical (light) microscopy, electron microscopy, analysis of nanomaterials and the use of nanoparticles, nuclear magnetic resonance, electron paramagnetic resonance.</p> |
| <p>Temeljni literatura in viri / Reading materials:</p> | |
| <ul style="list-style-type: none"> – R. Glaser, Biophysics: An Introduction. Springer-Verlag, 2012. – P. F. Dillon, Biophysics: A Physiological Approach. Cambridge University Press, 2012. – J. Newman, Physics of the Life Sciences, Springer Science+Business Media. LLC, 2008. – S. A. Kane, Introduction to Physics in Modern Medicine. CRC Press, 2009. – R. Heinrich, S. Schuster, The Regulation of Cellular Systems. Chapman & Hall, 1996. – W. Greiner, L. Neise. H. Stöcker, Thermodynamics and Statistical Mechanics. Springer, 1997. – K. A. Dill, S. Bromberg, Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience, Second Edition. Garland Science, Taylor & Francis Group, 2011. – S. H. Strogatz, Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Perseus Books Publishing, 1994. – A.-L. Barabási, Network Science. Cambridge University Press, 2016. – D. J. Watts, Small Worlds: The Dynamics of Networks between Order and Randomness. Princeton University Press, 2003. – Fractals in Biology and Medicine, Eds: G.A. Losa, D. Merlini, T.F. Nonnenmacher, E.R. Weibel, Birkhäuser Verlag, 2005. – S. Camazine, J.-L. Deneubourg, N. R. Franks, J. Sneyd, G. Theraulaz, E. Bonebeau, Self-Organization in Biological Systems. Princeton University Press, 2001. – M. Broom, J. Rychtář, Game-Theoretical Models in Biology. CRC Press, Taylor & Francis Group, 2013. | |
| <p>Cilji in kompetence:</p> | <p>Objectives and competences:</p> |
| <p>Cilj predmeta je obravnavati strukturo in delovanje bioloških sistemov oziroma njihovih gradnikov na molekularni in makromolekularni ravni, na stopnji supramolekularne organiziranosti, na ravni celice in interakcije med njimi ter na ravni organov človeškega telesa. Pristop temelji na matematični formulaciji konceptov v biofiziki. Obravnavani primeri so izbrani iz biologije človeka in zato</p> | <p>The main objective of the course is to discuss the structure and function of biological systems at different levels of biological complexity from a molecular, macromolecular and supramolecular level to a cellular level and tissue as well as to organs of the human body. The course is based on mathematical formulation of biophysical concepts. The presented systems are selected from human</p> |

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| posebej zanimivi za medicino. Pri obravnavi primerov so izpostavljene teoretične in eksperimentalne raziskovalne metode. | | biology with indicated applications to medicine. In particular, a special attention is given to learn about theoretical and experimental research methods. |
| Predvideni študijski rezultati: | | Intended learning outcomes: |
| Znanje in razumevanje: Usvojeno pregledno interdisciplinarno znanje o strukturnih lastnosti in delovanju bioloških sistemov na različnih ravneh organiziranosti od molekule do organizma. | | Knowledge and understanding: Broad interdisciplinary knowledge of structure and function of different biological systems considered at different levels of complexity from molecules to human organs. |
| Prenosljive/ključne spretnosti in drugi atributi: Sposobnost vključitve v poglobljeno raziskovalno delo z namenom nadaljevanja doktorskega študija in izdelave doktorata na različnih problemih biofizike in medicine. | | Transferable/key competences and other abilities: Ability of a student to be involved deeply in research in order to continue his/her doctoral studies leading to PhD thesis on various problems from biophysics and medicine. |
| Metode poučevanja in učenja: | | Learning and teaching methods: |
| Predavanja Seminarji Vaje | | Lectures Seminars Tutorial |
| Načini ocenjevanja: | Delež (v %) / Share (in %) | Assessment methods: |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt) | 10 % | Method (written or oral exam, coursework, project): |
| Vsaj 50% prisotnost in aktivno sodelovanje pri predavanjih, seminarjih in vajah | 40 % | Min. 50% attendance and active participation in lectures, seminars, and laboratory work |
| Seminarska naloga | | Seminar work |
| Ustno preverjanje znanja z zagovorom seminarja | 50 % | Oral examination with defence of the seminar work |
| Reference nosilca / Course coordinator's references: | | |
| <p>"GOSAK, Marko, STOŽER, Andraž, MARKOVIČ, Rene, DOLENŠEK, Jurij, PERC, Matjaž, RUPNIK, Marjan, MARHL, Marko. Critical and supercritical spatiotemporal calcium dynamics in beta cells. <i>Frontiers in physiology</i>, ISSN 1664-042X, 2017, vol. 8, str. 1-17, ilustr., doi: 10.3389/fphys.2017.01106. [COBISS.SI-ID 512760376], [JCR, SNIP, WoS do 13. 10. 2019: št. citatov (TC): 9, čistih citatov (CI): 6, čistih citatov na avtorja (CIAu): 0.86, Scopus do 29. 11. 2019: št. citatov (TC): 11, čistih citatov (CI): 7, čistih citatov na avtorja (CIAu): 1.00] kategorija: 1A1 (Z, A', A1/2); uvrstitev: SCI, Scopus, MBP; tip dela je verificiral OSICM točke: 14.32, št. avtorjev: 7 "</p> <p>"GRUBELNIK, Vladimir, MARKOVIČ, Rene, LIPOVŠEK DELAKORDA, Saška, LEITINGER, Gerd, GOSAK, Marko, DOLENŠEK, Jurij, VALLADOLID-ACEBES, Ismael, BERGGREN, Per-Olof, STOŽER, Andraž, PERC, Matjaž, MARHL, Marko. Modelling of dysregulated glucagon secretion in type 2 diabetes by considering mitochondrial alterations in pancreatic α-cells. <i>Royal Society Open Science</i>, ISSN 2054-5703, 2020, vol. 7, iss. 1, str. 1-17, doi: 10.1098/rsos.191171. [COBISS.SI-ID 25073672], [JCR, SNIP, WoS do 7. 2. 2020: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0] financer: ARRS, Programi, P1-0055, SI, Biofizika polimerov, membran, gelov, koloidov in celic; financer: ARRS, Programi, P1-0403, SI, Računsko intenzivni kompleksni sistemi; financer: ARRS, Programi, P3-0396, SI, Celične in tkivne mreže; financer: ARRS, Projekti, J3-9289, SI, Vloga cikličnega adenozin monofosfata v normalni fiziologiji celic beta in med razvojem sladkorne bolezni</p> | | |

tipa 2; financer: ARRS, Projekti, N3-0048, SI, Vloga ionskih kanalov TRPM3 in TRPM5 pri uravnavanju mrežne aktivnosti v otočkih trebušne slinavke; financer: ARRS, Programi, I0-0029, SI, Infrastrukturalna dejavnost Univerze v Mariboru; financer: ARRS, Projekti, J1-7009, SI, Fazni prehodi proti kooperaciji v sklopljenih populacijah; financer: ARRS, Projekti, J7-7226, SI, Vloga ventromedialnega jedra hipotalamusa pri zaznavanju glukoze v telesu; financer: ARRS, Projekti, J4-9302, SI, Raziskave medceličnih komunikacij v večceličnih skupnostih različnih izolatov bakterije iz rodu *Bacillus*; financer: ARRS, Projekti, J1-9112, SI, Kvantna lokalizacija v kaotičnih sistemih kategorija: 1A2 (Z, A1/2); uvrstitev: SCI, Scopus, MBP; tip dela je verificiral OSICM točke: 8.95, št. avtorjev: 11"

"GRUBELNIK, Vladimir, ZMAZEK, Jan, MARKOVIČ, Rene, GOSAK, Marko, MARHL, Marko. Mitochondrial dysfunction in pancreatic alpha and beta cells associated with type 2 diabetes mellitus. *Life*, ISSN 2075-1729, 2020, vol. 10, no. 12, str. 1-16. <https://www.mdpi.com/2075-1729/10/12/348>, doi: 10.3390/life10120348. [COBISS.SI-ID 43234819], [JCR, SNIP, WoS do 13. 1. 2021: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0, Scopus do 11. 1. 2021: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0] financer: ARRS, Programi, P1-0055, SI, Biofizika polimerov, membran, gelov, koloidov in celic; financer: ARRS, Programi, P3-0396, SI, Celične in tkivne mreže; 1A2 (Z, A1/2); uvrstitev: SCI, Scopus, MBP; tip dela je verificiral OSICM točke: 19.91, št. avtorjev: 5"