



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

### UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	Napredne metode v fiziologiji
<b>Course title:</b>	Advanced Methods in Physiology

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Biologija in ekologija z naravovarstvom, 2. stopnja	/	1. ali 2.	Poletni/ Zimski
Biology and Ecology with Nature Conservation, 2 <sup>nd</sup> cycle	/	1 <sup>st</sup> or 2 <sup>nd</sup>	Summer/ Winter

**Vrsta predmeta / Course type**

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

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
12	18	15			180	6

**Nosilec predmeta / Lecturer:**

**Jeziki / Languages:**  
**Predavanja / Lectures:**   
**Vaje / Tutorial:**

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

**Pogoji za vključitev v delo:** Pogojev ni.

**Prerequisites:**

**Prerequisites for attending the course:** None.

**Vsebina:**

**Content (Syllabus outline):**

a) Elektrofiziološke in slikovne celične metode

1. Uvod v napredne metode v fiziologiji: od posameznih celic do organizma kot celote
2. Metoda znotrajceličnega merjenja membranskega potenciala celic.
3. Metoda vpete krpice membrane (patch-clamp) za določevanje aktivnosti ionskih kanalov
3. Konfokalno slikanje spremembe znotrajcelične koncentracije kalcijevih ionov za določevanje celične aktivnosti
4. Uporaba CCD kamere in njena učinkovitost za merjenje znotrajcelične koncentracije kalcijevih ionov v primerjavi s konfokalnim merjenjem
5. Teoretične osnove in merjenje eksocitoze s pomočjo merjenja sprememb kapacitivnosti celic
6. Določevanje občutljivosti eksocitoze na kalcijeve ione.

b) Elektrofiziološke metode na nivoju organskih sistemov

1. Elektrofiziološke osnove delovanja srca, EKG
2. Elektrofiziološke osnove delovanja možganov, EEG
3. Elektrofiziološke osnove delovanja motoričnega sistema, EMG in refleksi

c) Analiza in obdelava podatkov

1. Napredne metode obdelovanja podatkov: procesiranje in filtriranje podatkov s pomočjo programskih orodij. Napredne metode analize serije slik.

a) Electrophysiological and imaging cellular techniques

1. Introduction to advanced methods in physiology: from individual cells to the organism as a whole
2. Intracellular sharp electrode measurement of membrane potential
3. The patch-clamp method to measure activity of ion channels
3. Confocal imaging of intracellular calcium concentration changes to determine cell activity
4. Use of the CCD camera and comparing its efficacy to measure intracellular calcium concentration compared with confocal imaging
5. Theoretical basis and method of measuring exocytosis employing capacitance changes
6. Measuring sensitivity of exocytosis for calcium ions

b) Electrophysiological methods on the level of organs

1. Electrophysiological basis of heart action, ECG
2. Electrophysiological basis of brain activity, EEG
3. Electrophysiological basis of the motor system, EMG and reflexes

c) Analysis and data preparation

1. Advanced methods of data analysis: processing and filtering of data using programmable software. Advanced methods of image analysis.

**Temeljni literatura in viri / Readings:**

Temeljni viri / Basic:

Ogden D. Microelectrode Techniques: The Plymouth Workshop Handbook. Second Edition. The Company of Biologists 1994.

Pawley J. Handbook of Biological Confocal Microscopy. Third edition. Springer, 2006.

Priporočeni viri / Recommended:

Hille B. Ion Channels of Excitable Membranes. Third edition. Sinauer 2001.

Molleham A. Patch Clamping An Introductory Guide to Patch Clamp Electrophysiology. Wiley & Sons 2003.

Boron WF, Boulpaep EL. Concise Medical Physiology. Saunders, Philadelphia: 2020.

Stožer A, Križančić-Bombek L, Dolenšek J, Skelin M. Izbrana poglavja iz fiziologije z navodili za vaje. Univerza v Mariboru, Medicinska fakulteta, Maribor, 2. izdaja: 2021.

#### **Cilji in kompetence:**

Poglavitni cilj predmeta je pridobitev nekaterih teoretičnih znanj in praktičnih veščin, ki jih potrebuje raziskovalec – fiziolog in sicer na različnih organizacijskih nivojih: meritve ionskih kanalov, meritve izločanja snovi, slikanje sprememb kalcijeve koncentracije na nivoju posameznih celic in neinvazivno zunajcelično merjenje signalov mišic, srca in možgan na nivoju organov.

Teoretične osnove in praktično obdelovanje in interpretacijo v meritvah pridobljenih surovih podatkov.

#### **Objectives and competences:**

The major aim of the course is to gain some the theoretical knowledge and practical skill needed for researcher in physiology, on different organizational levels: measuring ion channels, exocytosis, and calcium imaging on the single cell organizational level, and noninvasive extracellular measurements from muscles, hearth and brain on the organ organizational level.

Theoretical basis and practical processing and interpretation of experimentally acquired raw data.el.

#### **Predvideni študijski rezultati:**

Po uspešno opravljene učne enote naj bi bili študenti zmožni:

- kritično evalvirati in samostojno izvesti meritve aktivnosti raziskovalnega organizma na nivoju posameznih celic (metoda ostre elektrode, metoda vpete krpice membrane, merjenje membranske kapacitivnosti in konfokalno slikanje) in na nivoju organov (konfokalno slikanje, EKG, EEG, EMG).
- samostojno pripraviti, obdelati in razumeti fiziološke podatke, pridobljene v poskusu.
- neposredno se vključiti v raziskovalne laboratorije doma in po svetu.

#### **Intended learning outcomes:**

By the end of this course students should be able to:

- evaluate and perform measurements of model organism activity on the organizational level of single cells (sharp electrode technique, patch clamp technique, capacitance measurement, and confocal imaging), and on the level of organs (confocal imaging, ECG, EEG, EMG).
- autonomously prepare, analyze and interpret physiological data obtained in experiments.
- join research groups home and abroad.

#### **Metode poučevanja in učenja:**

#### **Learning and teaching methods:**

Interaktivna predavanja E-učenje Problem-based seminars Praktične vaje	Interactive frontal method E-learning Problem-based seminars Practicals
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Delež (v %) /

**Načini ocenjevanja:**

Weight (in %) **Assessment:**

Kolokvij	<b>25 %</b>	Written examination based on tutorials and based on seminars and lectures
Pisni izpit	<b>50 %</b>	
Ustni izpit	<b>25 %</b>	Oral examination

**Reference nosilca / Lecturer's references:**

1. Dolenšek J, Kos T, Stožer A, and Špernjak A. Teachers perception of the use on a low-cost pulse rate sensor for biology education. *Advances in Physiology Education* 46: 238-245, 2022.
2. Marolt U, Paradiž Leitgeb E, Pohorec V, Lipovšek S, Venglovecz V, Gál E, Ébert A, Menyhárt I, Potrč S, Gosak M, Dolenšek J, and Stožer A. Calcium imaging in intact mouse acinar cells in acute pancreas tissue slices. *PLOS ONE* 17: e0268644, 2022.
3. Pohorec V, Križančič Bombek L, Skelin Klemen M, Dolenšek J, and Stožer A. Glucose-Stimulated Calcium Dynamics in Beta Cells From Male C57BL/6J, C57BL/6N, and NMRI Mice: A Comparison of Activation, Activity, and Deactivation Properties in Tissue Slices. *Frontiers in endocrinology* 13: 2022.
4. Serdinšek T, Lipovšek S, Leitinger G, But I, Stožer A, and Dolenšek J. A Novel in situ Approach to Studying Detrusor Smooth Muscle Cells in Mice. *Scientific reports* 10: 2685, 2020.
5. Stožer A, Klemen MS, Gosak M, Bombek LK, Pohorec V, Rupnik MS, and Dolenšek J. Glucose-dependent activation, activity, and deactivation of beta cell networks in acute mouse pancreas tissue slices. *Am J Physiol-Endoc M* 321: E305-E323, 2021.
6. Skelin Klemen, M., J. Dolenšek, L. Križančič Bombek, V. Pohorec, M. Gosak, M. Slak Rupnik and A. Stožer (2023). "The effect of forskolin and the role of Epac2A during activation, activity, and deactivation of beta cell networks." *Frontiers in Endocrinology* 14.