



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

### UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Molekularna celična signalizacija
Course title:	Molecular Cell Signaling

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Doktorski študij Ekološke znanosti, 3. stopnja		1. ali 2.;	1.- 4.;
Doctoral Study Ecological Sciences, 3rd degree		1st or 2nd	1st-4th

Vrsta predmeta / Course type: Izbirni/Elective

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje Field work	Samost. delo Individ. work	ECTS
10	15		5		150	6

Nosilec predmeta / Lecturer: Doc. dr. Andraž Stožer

Jeziki / Predavanja / Lectures: slovenski / Slovene  
Languages: Vaje / Tutorial: slovenski / Slovene

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

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

**Pogoji za opravljanje študijskih obveznosti:**  
Vsaka izmed definiranih obveznosti mora biti zaključena s pozitivno oceno. Ocena enaka ali višja minimalni (6/10) na testu iz predavanj, seminarjev in vaj, ki vsebuje problemske naloge, je predpogoj za pristop k ustnemu izpitu.

**Prerequisites:**

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

**Prerequisites for completing the course:**  
Each of the defined commitments must be completed with a passing grade. A grade equal to or higher than the passing minimum (6/10) of the problem-based test based on lectures, seminars, and practicals is required for taking the oral examination.

**Vsebina:**

**Content (Syllabus outline):**

1. Molekularna narava zunajceličnih signalnih molekul
2. Molekularna farmakologija in toksikologija iono- in metabotropne sinapse
3. Elektrofiziologija ionotropnih receptorjev
4. Biokemija metabotropnih receptorjev
5. ATP, cAMP in kalcijevi ioni kot znotrajcelične celične signalne molekule iz zunaj- in znotrajceličnih virov
6. Kinetika znotrajceličnih signalnih molekul, oscilacije membranskega potenciala, presnove, kalcijevih ionov
7. Kontraktilni proteini, vezikli in druge tarčne molekule v znotrajcelični signalizaciji.
8. Kontraktacija in eksocitoza kot končna dogodka v sklopitvi med stimulacijo in kontrakcijo in med stimulacijo in sekrecijo
9. Kinetika kontrakcije in sekrecije
10. Funkcionalna sklopitev signalov med homo- in heterotipičnimi celicami v istem tkivu in sklopitev z drugimi, predvsem nadzornimi in tarčnimi tkivi.
11. Napredni fizikalni pristopi k analizi, interpretaciji in predstavitvi fizioloških podatkov
12. Komparativna fiziologija celične signalizacije, evolucijski, embriološki in ontogenetski vidiki celične signalizacije
13. Kratka zgodovina razvoja področja in pregled Nobelovih nagrad na področju
14. Eksperimentalni vidiki in smeri razvoja – integracija znanja z metodologijo

1. Molecular nature of extracellular signaling molecules
2. Molecular pharmacology and toxicology of the iono- and metabotropic synapse
3. Electrophysiology of ionotropic receptors
4. Biochemistry of metabotropic receptors
5. ATP, cAMP, and calcium ions as intracellular signaling molecules coming from extra- and intracellular sources
6. Kinetics of intracellular signaling molecules, oscillations of membrane potential, metabolism, and calcium ions
7. Contractile proteins, vesicles, and other target molecules in intracellular signaling.
8. Contraction and exocytosis as terminal events in stimulus-contraction and stimulus-secretion coupling
9. Kinetics of contraction and secretion
10. Functional coupling of signals between homo- and heterotypic cells within the same tissue and coupling with other regulatory and target tissues.
11. Advanced physical approaches to analysis, interpretation, and presentation of physiological data
12. Comparative physiology of cell signaling, evolutionary, embryological, and ontogenetic aspects of cell signaling
13. A short history of field development and an overview of Nobel prizes awarded in the field
14. Experimental aspects and developments – integration with the methodology

**Temeljni literatura in viri / Readings:**

Boron WF, Boulpaep EL. **Medical Physiology**. 3rd Edition. Elsevier, Philadelphia: 2016.  
 Ritter JM et al. **Rang & Dale's Pharmacology**, 9th Edition. Elsevier, Edinburgh: 2019.  
 Kandel ER, Schwartz JH, Jessel TM, Siegelbaum SA, Hudspeth AJ. **Principles of Neural Science**. Fifth Edition. McGraw-Hill, New York: 2013.  
 Rodwell VW, Bender DA, Botham KM, Kennely PJ, Weil PA. **Harper's Illustrated Biochemistry**. 30th Edition. McGraw Hill Education, New York: 2015.  
 Alberts BA, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P. **Molecular Biology of the Cell**. 6e. Garland Science, New York: 2014.

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

Poglavitni cilj predmeta je pridobitev znanj o strukturi in funkciji hormonov, neurotransmitorjev in drugih ekstracelularnih signalnih molekul, o njihovi vezavi na receptorje, postreceptorskih znotrajceličnih signalnih poteh in celičnem odzivu. Prav tako bo študent dobil poglobljen vpogled v komunikacijo med celicami določenega tkiva in s celicami drugih nadzornih in tarčnih tkiv. Na osnovi znanja o normalni strukturi in funkciji bo študent dobil vpogled tudi v genetiko, toksikologijo in patofiziologijo najpogostejših bolezni sodobnega časa.

Med kompetencami bo študent razvijal predvsem:

- zmožnost analize in sinteze
- zmožnost uporabe znanja v praksi
- ustvarjalnost
- zmožnost učenja
- medosebne spretnosti
- znanje drugega jezika
- ustna in pisna komunikacija

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

The major aim of the course is to gain knowledge on structure and function of hormones, neurotransmitters and other extracellular signaling molecules, their receptor binding, postreceptor intracellular signaling pathways and the cellular response. In addition, students will gain a deep insight into intercellular communication between cells of a given tissue, as well as with cells of other control and target tissues. On the basis of the knowledge about normal structure and function, students will gain insight into genetics, toxicology, and pathophysiology of most common diseases.

Among the competences, the student will predominantly develop the following:

- the ability to analyze and synthesize
- the ability to apply knowledge
- creativity
- the ability to learn
- interpersonal abilities
- knowledge of a foreign language
- oral and written communication

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

##### **Znanje in razumevanje:**

**Študent uporablja, analizira, sintetizira in kritično vrednoti na področju spodnjih ključnih vsebin:**

- Struktura in funkcija zunajceličnih signalnih molekul
- Odgovor električno vzdražnih in

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

##### **Knowledge and understanding:**

**The student uses, analyzes, synthesizes, and critically evaluates the below key contents:**

- Structure and function of extracellular signaling molecules
- Responses of electrically excitable and

<p>nevzdražnih celic</p> <ul style="list-style-type: none"> <li>- Znotrajcelična signalna kaskada</li> <li>- Medcelična komunikacija</li> <li>- Zdravila, motilci in toksini</li> <li>- Metode za preučevanje signalizacije</li> </ul> <p><b>Prenesljive/ključne spretnosti in drugi atributi:</b></p> <ul style="list-style-type: none"> <li>- Komunikacija</li> <li>- Vodenje in upravljanje</li> <li>- Raziskovanje</li> <li>- Timsko delo</li> <li>- Samoupravljanje</li> </ul>
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<p>non-excitabile cells</p> <ul style="list-style-type: none"> <li>- Intracellular signaling cascade</li> <li>- Intercellular communication</li> <li>- Drugs, disruptors, and toxins</li> <li>- Methods for studying signaling</li> </ul> <p><b>Transferable/Key Skills and other attributes:</b></p> <ul style="list-style-type: none"> <li>- Communication</li> <li>- Leadership and management</li> <li>- Research</li> <li>- Teamwork</li> <li>- Self-management</li> </ul>
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**Metode poučevanja in učenja:**

**Learning and teaching methods:**

<p>Interaktivna predavanja E-učenje Problem-based seminarji</p>
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<p>Interactive frontal method E-learning Problem-based seminars</p>
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<b>Načini ocenjevanja:</b>	Delež (v %) / Weight (in %)	<b>Assessment:</b>
Pisne naloge	70 %	Coursework
Ustni izpit	30 %	Oral examination

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

GOSAK, Marko, MARKOVIČ, Rene, DOLENŠEK, Jurij, RUPNIK, Marjan, MARHL, Marko, **STOŽER, Andraž**, PERC, Matjaž. Network science of biological systems at different scales : a review. *Physics of life reviews*, ISSN 1873-1457, 2018, vol. 24, str. 118-135

SKELIN, Maša, DOLENŠEK, Jurij, RUPNIK, Marjan, **STOŽER, Andraž**. The triggering pathway to insulin secretion : functional similarities and differences between the human and the mouse [beta] cells and their translational relevance. *Islets*, ISSN 1938-2022, 2017, vol. 9, no. 6, str. 109-139

**STOŽER, Andraž**, HOJS, Radovan, DOLENŠEK, Jurij. Beta cell functional adaptation and dysfunction in insulin resistance and the role of chronic kidney disease. *Nephron journals*, ISSN 2235-3186, 2019, f. 1-5

MARQUARD, Jan, SKELIN, Maša, **STOŽER, Andraž**, RUPNIK, Marjan, et al. Characterization of pancreatic NMDA receptors as possible drug targets for diabetes treatment. *Nature medicine*, ISSN 1078-8956, Apr. 2015, vol. 21, no. 4, str. 363-372

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