

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	BIOLOŠKE MEMBRANE
<b>Course Title:</b>	BIOLOGICAL MEMBRANES

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
MAG Biokemija, 2. stopnja	/	1.	1.
USP Biochemistry, 2 <sup>nd</sup> Cycle	/	1 <sup>st</sup>	1 <sup>st</sup>

**Vrsta predmeta / Course Type:** izbirni strokovni / Elective Professional

**Univerzitetna koda predmeta / University Course Code:** BI2I01

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
30	15	30 LV	/	/	75	5

**Nosilec predmeta / Lecturer:** prof. dr. Igor Križaj / Dr. Igor Križaj, Full Professor

**Jeziki / Languages:**

<b>Predavanja / Lectures:</b>	slovenski / Slovenian
<b>Vaje / Tutorial:</b>	slovenski / Slovenian

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

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.	<b>Prerequisites:</b> The course has to be assigned to the student.
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**Vsebina:**

Predstavitev izvajanja predmeta in uvod. Struktura in dinamika bioloških membran (funkcija, lastnosti, sestava, membranski lipidi, membranski proteini ...). Čiščenje celic in njihovih delov (priprava membranskih struktur, izolacija in karakterizacija membranskih proteinov in lipidov, metodologija). Transport snovi čez biološke membrane (pasivni transport – difuzija in olajšana difuzija: transporterji in kanalčki; aktivni transport – ATP-gnane črpalke, V- in F-tip ATP-aza, ABC transporterji). Struktura in funkcija lipidnih mikrodomen (metodologija študija, lipidna in proteinska

**Content (Syllabus outline):**

Presentation of the course and introduction. Structure and dynamics of biological membranes (function, characteristics, composition, membrane lipids, and membrane proteins ...). Purification of cells and their parts (preparation of membrane structures, isolation and characterization of membrane proteins and lipids, methodology). Transport of substances through biological membranes (passive transport – diffusion and facilitated diffusion: transporters and channels; active transport – ATP-driven pumps, V- and F-type ATP-ases, ABC-transporters). Structure and function of lipid microdomains

sestava, kaveole, vloga v signalizaciji, homeostazi  $\text{Ca}^{2+}$ , razvrščanju in transportu bioloških molekul, patologija).

Medcelična signalizacija (endokrini, parakrini, in kontaktna; signalizacijske molekule; receptorji: povezani z G-proteini, ionski kanalčki, z lastno encimsko aktivnostjo; prenos živčnega signala; ukrivljanje membran).

Povezovanje celic v tkiva (pritrjevanje in združevanje celic v tkiva, pritrjevanje celic na medceličnino, kolageni v medceličnini, nekolagenske sestavine medceličnine ...).

Encimi, ki delujejo na membranah in na membrane (fosfolipaze  $A_2$  kot primer, medfazna encimatika).

Lipidi in signalizacija (derivati glicerola, derivati sfingozina, eikozanoidi, derivati holesterola ...).

(methodology of study, lipid and protein composition, caveolae, roles in signalization,  $\text{Ca}^{2+}$ -homeostasis, sorting and transport of molecules, pathology).

Signalization between cells (endocrine, paracrine and contact, signalization molecules, receptors: G-protein coupled, ion channels: voltage- and ligand-gated, with enzyme activity; nerve signal transduction; membrane bending).

Association of cells into tissues (attaching and integration of cells into tissues, attachment of cells on extra cellular matrix (ECM), collagens in ECM, non-collagen components of ECM ...).

Enzymes that act on membranes on the membranes (phospholipases  $A_2$  as an example, interfacial enzymology).

Lipids and signalization (derivatives of glycerol, derivatives of sphingosine, eicosanoids, derivatives of cholesterol ...).

#### Temeljna literatura in viri / Readings:

Izbrana poglavja iz splošnih učbenikov biokemije in molekularne biologije (Lodish, Voet, Stryer, Alberts); Mouritsen: Life – As a Matter of Fat. Springer 2005; Znanstveni in pregledni članki.

#### Cilji in kompetence:

Cilji predmeta so, da študent spozna sestavo bioloških membran, njihovo vlogo v celicah, procesih, ki na, v ali preko njih potekajo, da spozna metodologijo za analizo membranskih komponent, predvsem lipidov in membranskih proteinov.

Kompetence: Predmet usmerja študenta k samostojnemu teoretičnemu (analiza literature, sinteza zaključkov, sposobnost učenja in reševanja problemov) in eksperimentalnemu delu (organiziranje in načrtovanje dela, verbalna in pisna komunikacija).

#### Objectives and Competences:

Aims of the course are to familiarize the student with composition of biological membranes, roles of membranes in cells, processes that are occurring on, in or over the membranes, with methodology to analyse membrane components, in first place lipids and membrane proteins.

Competences: The course encourages student's autonomous theoretical (analysis of literature, formulation of conclusions, problem solving capability) and experimental work (organization and planning of the work, verbal and writing communication).

#### Predvideni študijski rezultati:

##### Znanje in razumevanje

Študent pri predmetu poglobi znanje o strukturnih elementih, organizaciji in procesih, ki potekajo na in preko bioloških membran. Spozna moderne raziskovalne pristope študija

#### Intended Learning Outcomes:

##### Knowledge and Comprehension

Student deepens his knowledge about structural elements, organization and processes that are conducted on and over the biological membranes. Student is familiarized with

membranskih sistemov in procesov na membranah. Skozi praktične primere iz literature spoznava pomembnost bioloških membran in dogajanj na njih.	modern approaches of the study of membrane systems and processes on membranes. Through practical examples from the literature the importance of biological membranes and processes involving them are brought closer to students.
<u>Uporaba</u> Znanje pridobljeno pri tem predmetu omogoča razumevanje (pato)fiziološke vloge lipidov, proteinov in ostalih molekul, gradnikov bioloških membran, pa tudi molekul, ki vplivajo na lastnosti bioloških membran. To znanje je osnova za raziskave mehanizmov številnih patologij, ki so povezane z lipidno signalizacijo in procesi na membranah ter načrtovanja ustreznih terapij.	<u>Application</u> The knowledge acquired during this course enables understanding of (patho)physiological role of lipids, proteins and other molecules, building blocks of biological membranes as well as molecules that influence characteristics of biological membranes. This knowledge is fundamental for the research of mechanisms of diverse pathologies linked to lipid signalization and other processes on membranes and development of suitable therapies.
<u>Refleksija</u> Študent naj bi pridobil občutek za razmišljanje o bioloških membranah kot posebnem okolju, v katerem mnogokrat veljajo zakonitosti, ki se precej razlikujejo od tistih v raztopinah.	<u>Analysis</u> Student should acquire awareness to think about biological membranes as a special environment in which many times different laws apply from those in solutions.
<u>Prenosljive spretnosti</u> Izkušnje pri reševanju problemov. Timsko delo (pri seminarskih in laboratorijskih vajah). Zbiranje in interpretiranje rezultatov ter njihovo kritično vrednotenje. Uporaba domače in tuje literature. Podajanje poročil o opravljenem delu.	<u>Skill-transference Ability</u> Experience at solving problems. Team work (at seminar and laboratory exercises). Collection and interpretation of results and their critical evaluation. The use of domestic and foreign literature. Delivering reports about accomplished tasks.

#### Metode poučevanja in učenja:

Predavanja, seminarji z voden diskusijo, problemsko osnovano učenje, demonstracije v laboratoriju, konzultacije.

#### Learning and Teaching Methods:

Lectures, seminars with tutorial discussion, problem based learning, laboratory demonstrations, consultations.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Pisni izpit	90 %	Writing examination
Seminarska naloga	10 %	Seminar work
Ocene: pozitivno 6-10; negativno 1-5		Grades: positive 6-10; negative 1-5

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

- SKOČAJ, Matej, BAKRAČ, Biserka, **KRIŽAJ, Igor**, MAČEK, Peter, ANDERLUH, Gregor, SEPČIČ, Kristina. The sensing of membrane microdomains based on pore-forming toxins. Current medicinal chemistry, ISSN 0929-8673, 2013, vol. 20, no. 4, str. 491-501, doi: 10.2174/092986713804910094. [COBISS.SI-ID 2710351].
- OTA, Katja, LEONARDI, Adrijana, MIKELJ, Miha, SKOČAJ, Matej, WOHLSCHLAGER, Therese, KÜNZLER, Markus, AEBI, Markus, NARAT, Mojca, **KRIŽAJ, Igor**, ANDERLUH, Gregor, SEPČIČ,

Kristina, MAČEK, Peter. Membrane cholesterol and sphingomyelin, and ostreolysin A are obligatory for pore-formation by a MACPF/CDC-like pore-forming protein, pleurotolysin B. *Biochimie*, ISSN 0300-9084, 2013, vol. 95, iss. 10, str. 1855-1864, doi:

10.1016/j.biochi.2013.06.012. [COBISS.SI-ID 26868007]

3. MATTIAZZI, Mojca, SUN, Yidi, WOLINSKI, Heimo, BAVDEK, Andrej, PETAN, Toni, ANDERLUH, Gregor, KOHLWEIN, Sepp D., DRUBIN, David, **KRIŽAJ, Igor**, PETROVIČ, Uroš. A neurotoxic phospholipase A [sub] 2 impairs yeast amphiphysin activity and reduces endocytosis. *PloS one*, ISSN 1932-6203, 2012, vol. 7, iss. 7, str. 1-13, e40931, doi: 10.1371/journal.pone.0040931.

[COBISS.SI-ID 5026074].

4. MATTIAZZI, Mojca, JAMBHEKAR, Ashwini, KAFERLE, Petra, DERISI, Joseph, **KRIŽAJ, Igor**, PETROVIČ, Uroš. Genetic interactions between a phospholipase A2 and the Rim101 pathway components in *S. cerevisiae* reveal a role for this pathway in response to changes in membrane composition and shape. *Molecular genetics and genomics*, ISSN 1617-4615, 2010, vol. 283, no. 6, str. 519-530, doi: 10.1007/s00438-010-0533-8. [COBISS.SI-ID 23541287].

5. KOVAČIČ, Lidija, NOVINEC, Marko, PETAN, Toni, **KRIŽAJ, Igor**. Structural basis of the significant calmodulin-induced increase in the enzymatic activity of secreted phospholipases A2. *Protein engineering, design & selection*, ISSN 1741-0126, 2010, vol. 23, no. 6, str. 479-487, doi: 10.1093/protein/gzq019. [COBISS.SI-ID 23512103].