

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	BIOORGANSKA KEMIJA
<b>Course Title:</b>	BIOORGANIC CHEMISTRY

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:**

obvezni / Mandatory

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

BI2T03

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. Bogdan Štefane /  
Dr. Bogdan Štefane, Associated Professor

**Jeziki / Languages:**

**Predavanja / Lectures:** slovenski / Slovenian

**Vaje / Tutorial:** slovenski / Slovenian

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

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

**Prerequisites:**

The course has to be assigned to the student.

**Vsebina:**

Uvod: korelacija med strukturo, lastnostmi in reaktivnost organskih spojin:

- struktura in stereo-elektronske lastnosti,
- reaktivnost funkcionalnih skupin,
- nekovalentne interakcije,
- prebiotska kemija,
- modularnost biooligomerov.

Pregled organskih reakcij v bioloških sistemih:

- pretvorbe na ogljikovem skeletu
- pretvorbe funkcionalnih skupin

Bioorganska kemija nukleinskih kislin:

- aromatičnost, kislost in bazičnost,
- stabilnost in modifikacija nukleinskih baz,
- kemijska sinteza oligonukleotidov,

**Content (Syllabus outline):**

Introduction: correlation between the structure, properties, and reactivity of organic compounds:

- structure and stereo-electronic properties,
- reactivity of functional groups,
- non-covalent interactions,
- prebiotic chemistry,
- modular design of biooligomers.

Survey on organic reactions in biological systems:

- transformations on the carbon framework
- transformations of functional groups

Bioorganic chemistry of nucleic acids:

- aromaticity, acidity, basicity,

- fotokemija nukleinskih kislin,
- nukleinske kisline kot tarča za učinkovine.

**Bioorganska kemija peptidov in proteinov:**

- kemijska sinteza oligopeptidov in proteinov
- interakcije proteini -mala molekula,
- mehanizem značilnih encimskih reakcij,
- modifikacija strukture peptidov,
- proteini kot tarča za učinkovine.

**Bioorganska kemija ogljikovih hidratov:**

- stereo elektronski efekti,
- kemija glikozidne vezi,
- mehanizem encimatskih glikozidacij.

**Osnove medicinske kemije:**

- izbira tarč iskanje spojin vodnic: pregled osnovnih tipov učinkovin
- osnove "in silico" modeliranja interakcij malih molekul z biološkimi molekulami
- sinteza spojin vodnic s principi kombinatorne sinteze
- optimizacija spojin vodnic
- primeri razvoja učinkovin

- stability and modification of nucleic bases,
- photochemistry of nucleic bases,
- nucleic acids as drug target.

**Bioorganic chemistry of peptides and proteins:**

- chemical synthesis of oligopeptides and proteins,
- interactions protein-small molecule,
- protein structure modification,
- proteins as drug targets.

**Bioorganic chemistry of carbohydrates:**

- stereo electronic effects,
- chemistry of glycosidic bond,
- mechanisms of enzymatic glycosidations.

**Fundamentals of medicinal chemistry:**

- choosing a target and finding a lead: survey on drug types
- introduction to "in silico" modelling of small molecule-biomolecule interactions,
- lead synthesis with principles of combinatorial synthesis,
- lead optimization,
- examples of drug discovery.

**Temeljna literatura in viri / Readings:**

- D. Van Vranken, G. A. Weiss: Introduction to Bioorganic Chemistry and Chemical Biology, Garland Science 2012. (selected topics, 40%)

**Dodatna literatura / Supplementary Readings:**

- J. Clayden, N. Graves, S. Warren: Organic Chemistry, 2nd Edition, Oxford University Press, 2012, 1264 strani (izbrane tematike iz bioorganske kemije / selected topics related to bioorganic chemistry).
- Pregledni članki, ki pokrivajo posamezne vsebine iz bioorganske kemije (praviloma v zadnjih 10 letih) / Review articles covering selected topics of bioorganic chemistry (recent papers published in the last decade).

**Cilji in kompetence:**

Namen predmeta je študenta seznaniti z osnovami bioorganske kemije, predstaviti in razložiti osnove reaktivnosti in pretvorb v bioloških sistemih in podati primere uporabe metod organske kemije v študijah bioloških procesov. Cilj je poznavanje in razumevanje povezave med strukturo, lastnostmi in reaktivnostjo bioloških molekul, poznavanje uporabe organsko-kemijskih metod v biokemiji in biologiji, ter poznavanje osnovnih

**Objectives and Competences:**

To obtain knowledge on fundamentals of bioorganic chemistry, to present and explain the fundamentals of reactivity and transformations in biological systems and to give examples of application of organo-chemical methods in study of biological processes. The aim is knowledge and understanding of correlation between the structure, properties, and reactivity of and biomolecules, application of organo-chemical

principov bioorganske sinteze.

methods in biochemistry and biology, and knowledge on the principles of bioorganic synthesis.

### **Predvideni študijski rezultati:**

#### Znanje in razumevanje

Študent pri predmetu pridobi:

- znanje in razumevanje korelacije med strukturo, lastnostmi in reaktivnostjo biomolekul,
- pozna in razume interakcije med malimi in biološkimi molekulami,
- principe organsko-kemijskih metod v bioloških študijah,
- namen in načine modifikacij biomolekul,
- osnovne principe razvoja učinkovin.

#### Uporaba

Pridobljeno znanje je uporabno na širokem področju biokemije in medicinske kemije, zlasti pa pri uporabi metod organske kemije v biokemijskih študijah in pri uporabi biokemijskih metod v organski kemiji.

#### Refleksija

Študent je na osnovi pridobljenega znanja sposoben razumeti relacijo med lastnostmi specifičnega tipa biomolekul in njihovo strukturo. Razume njihove interakcije z malimi molekulami in je sposoben načrtovati modifikacije in sintezo malih- in biomolekul in to tudi preizkusiti v praksi. Študent pozna in razume osnovne principe razvoja učinkovin.

#### Prenosljive spretnosti

identifikacija in reševanje problemov,  
- kritična analiza in sinteza,  
- dostopanje do literaturnih virov,  
- poznavanje in uporaba specializiranih računalniških programov  
- zbiranje, interpretacija in kritično vrednotenje podatkov.

### **Intended Learning Outcomes:**

#### Knowledge and Comprehension

Student acquires knowledge and understanding on:

- correlation between the structure, properties, and reactivity of biomolecules,
- interactions between small and biomolecules,
- principles of organo-chemical methods in biological studies,
- the purpose and ways of modification of biomolecules,
- basic principles of drug discovery.

#### Application

This knowledge is applicable in a wide area of biochemistry and medicinal chemistry with emphasis on application of organo-chemical methods in biochemistry and biochemical methods in organic chemistry.

#### Analysis

The student is able to understand structure-properties relationship for a given type of biomolecules. The student understands interaction between small molecules and biomolecules and is able to plan their modifications and synthesis. The student knows and understands the basic principles of drug discovery.

#### Skill-transference Ability

identification and solving the problems  
- critical analysis and synthesis  
- accessing and the use of literature sources  
- knowing and the use of specialized software  
- collection, interpretation, and critical data evaluation

### **Metode poučevanja in učenja:**

Predavanja; seminarji in laboratorijske vaje

### **Learning and Teaching Methods:**

Lectures, seminars, and laboratory trainings

### **Načini ocenjevanja:**

Delež (v %) /

Weight (in %) **Assessment:**

<p>Pisni in ustni izpit. Opravljene vaje so pogoj za pristop k izpitu. Ocene: 6-10 (pozitivno), 1-5 (negativno).</p>		<p>Written and oral examination. Completed laboratory course is prerequisite for the exam. Grades: 6-10 (positive), 1-5 (negative)</p>
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**Reference nosilca / Lecturer's references:**

1. **ŠTEFANE, Bogdan**. Selective addition of organolithium reagents to BF<sub>2</sub>-chelates of  $\alpha$ -ketoesters. *Organic letters*, ISSN 1523-7060, 2010, vol. 12, no. 13, str. 2900-2903, doi: 10.1021/ol100620j. [COBISS.SI-ID 34162181]
2. WANG, Jingxin, **ŠTEFANE, Bogdan**, JABER, Deana, SMITH, Jacqueline A. I., VICKERY, Christopher, DIOP, Mouhamed, SINTIM, Herman O. Remote C-H functionalization : using the N-O moiety as a atom-economical tether to obtain 1,5- and the rare 1,7-C-H insertions. *Angewandte Chemie*, ISSN 1433-7851. [Print ed.], 2010, vol. 49, no. 23, str. 3964-3968, doi: 10.1002/anie.201000160. [COBISS.SI-ID 34061573]
3. NAKAYAMA, Shizuka, KELSEY, Ilana, WANG, Jingxin, ROELOFS, Kevin, **ŠTEFANE, Bogdan**, LUO, Yiling, LEE, Vincent T., SINTIM, Herman O. Thiazole orange-induced c-di-GMP quadruplex formation facilitates a simple fluorescent detection of this ubiquitous biofilm regulating molecule. *Journal of the American Chemical Society*, ISSN 0002-7863, 2011, vol. 133, no. 13, str. 4856-4864, doi: 10.1021/ja1091062. [COBISS.SI-ID 34845957]