

UČNI NAČRT PREDMETA / COURSE SYLLABUS

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| Predmet: | MODERNE METODE ORGANSKE SINTEZE |
| Course Title: | MODERN METHODS OF ORGANIC SYNTHESIS |

| Študijski program in stopnja Study Programme and Level | Študijska smer Study Field | Letnik Academic Year | Semester Semester |
|---|-------------------------------|-------------------------|----------------------|
| MAG Kemija, 2. stopnja | / | 1. | 2. |
| USP Chemistry, 2 nd Cycle | / | 1 st | 2 nd |

Vrsta predmeta / Course Type:

izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code:

K2I09

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

Nosilec predmeta / Lecturer:

prof. dr. Jurij Svete / Dr. Jurij Svete, Full 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: Moderni trendi v organski sintezi. Klasična organska sinteza: kratek pregled, zmožnosti, omejitve in metode povečanja učinkovitosti.
Reagenti v organski sintezi. Tvorba C–C, C–H, C–X, C=C in C=X vezi v organski sintezi: pregled reagentov v metodah alkiliranja, olefiniranja, ariliranja, aciliranja, halogeniranja, hidroksiliranja, aminiranja, oksidacije in redukcije. Organo-S, Si, P, B reagenti. Organokovinski reagenti.
Načrtovanje organskih sintez. Retrosintezna analiza. Sintoni in sintezni ekvivalenti.
Kemoselektivnost in regioselektivnost. Pregled značilnih pravokotnih setov s primeri najpogosteje uporabljenih zaščitnih skupin.
Stereoselektivnost. Osnovni principi stereoselektivne in asimetrične sinteze. Stereoselektivne nekatalitske reakcije. Asimetrične katalitske reakcije in asimetrična organokataliza.

Content (Syllabus outline):

Introduction: Modern trends in organic synthesis. Classical organic synthesis: survey, scope and limitations, methods for efficacy improvement.
Reagents in organic synthesis. Formation of C–C, C–H, C–X, C=C, and C=X bond in organic synthesis: survey on reagents for alkylation, olefination, arylation, acylation, halogenation, hydroxylation, amination, oxidations, and reductions. Organo-S, Si, P, B reagents. Organometallic reagents.
Planning organic syntheses. Retrosynthetic analysis. Synthons and synthetic equivalents.
Chemoselectivity and regioselectivity. Survey on typical orthogonal sets with examples of the most commonly used protecting groups.
Stereoselectivity: Basic principles of stereoselective and asymmetric synthesis. Stereoselective non-catalytic reactions. Asymmetric catalytic reactions, asymmetric organocatalysis.

Večkomponentne in tandemske (domino, kaskadne) reakcije.

Principi kombinatorne sinteze. Kombinatorna sinteza na polimernih nosilcih. Tipični polimerni nosilci, distančniki in vezniki. Kombinatorna sinteza v raztopini. Reagenti in izolacijske tehnike pri kombinatorni sintezi v raztopini.

Avtomatizacija laboratorijskih tehnik v organski sintezi. Izvedba in spremljanje reakcij. Izolacijske tehnike. Karakterizacija.

Multicomponent and tandem (domino, cascade) reactions.

Principles of combinatorial synthesis: Solid-phase combinatorial synthesis. Typical polymer supports, linkers, and spacers. Solution-phase combinatorial synthesis. Reagents and isolation techniques in solution-phase combinatorial synthesis.

Automation of laboratory techniques in organic synthesis . Reaction performing and monitoring. Isolation techniques. Compound characterisation.

Temeljna literatura in viri / Readings:

J. Clayden, N. Graves, S. Warren: *Organic Chemistry, 2nd Edition*, Oxford University Press, 2012, 1264 strani; ca. 15% (ca. 170 pages) and selected topics from synthetic organic chemistry (23, 24, 28, 32, 33, 41, 43).

Dodatna literatura / Supplementary Readings:

J.-H. Führhop, G. Li, *Organic Synthesis Concepts and Methods*, 3rd, completely revised and enlarged Edition, Wiley-VCH, Weinheim, 2003, 517 pages (selected topics).

W. Carruthers, I. Coldham, *Modern Methods of Organic Synthesis*, Cambridge University Press, Cambridge, 2004, 506 pages (selected topics).

Review articles covering selected topics on synthetic chemistry (recent papers published in the last decade).

Cilji in kompetence:

Cilj predmeta:

-poznavanje modernih pristopov k sintezi organskih spojin in sodobnih trendov na tem področju

-poznavanje principov stereoselektivne, asimetrične in kombinatorne sinteze

-poznavanje večkomponentnih in tandemskih reakcij ter 'klik' kemije in njihove uporabe v moderni organski sintezi

-poznavanje modernih eksperimentalnih metod, tehnik in reagentov v organski sintezi

Predmetno specifične kompetence:

-načrtovanje organskih sintez: kreiranje nabora možnih sinteznih poti in racionalna izbira najprimernejše poti,

-izbira ustreznih sinteznih metod in tehnik in izbira reagentov,

-načrtovanje in izvedba usmerjene oz. ciljne sinteze,

-načrtovanje in sinteza kombinatornih knjižnic.

Objectives and Competences:

Objectives:

- Knowledge on modern approaches in organic chemistry.

- Knowledge on principles of stereoselective, asymmetric, and combinatorial chemistry

- Knowledge on multicomponent and tandem reactions and 'click' chemistry and their application in modern organic synthesis

- Knowledge on modern experimental methods, techniques, and reagents in organic synthesis

Competences:

- Planning of organic syntheses: elaboration of possible synthetic routes and rational choice of the most suitable synthetic approach

- Choice of suitable synthetic methods, techniques, and reagents

- Planning directed and target syntheses

- Planning and synthesis of combinatorial libraries

Predvideni študijski rezultati:

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| <u>Znanje in razumevanje</u> Znanje: -klasične in moderne metode v organski sintezi -načrtovanje in izvedba sintez organskih spojin Razumevanje: -splošnih principov moderne organske sinteze -principov stereoselektivne, asimetrične in kombinatorne sinteze |
| <u>Uporaba</u> Racionalno načrtovanje in praktična izvedba organskih sintez (usmerjene in ciljne sinteze organskih spojin in sinteze kombinatornih knjižnic). |
| <u>Refleksija</u> Študent bo na osnovi pridobljenega znanja sposoben načrtovati sintezo enostavnih in kompliciranih organskih spojin in nato primerjati in kritično ovrednotiti možne sintezne poti. Na podlagi pridobljenega znanja se bo spodoben odločiti za najbolj racionalno sintezno pot in jo tudi preizkusiti v praksi. |
| <u>Prenosljive spretnosti</u> -Dostopanje do literaturnih virov -Zbiranje, interpretacija in kritično vrednotenje podatkov -Identifikacija in reševanje problemov -Poročanje (pisno in ustno) -Kritična analiza, sinteza |

Intended Learning Outcomes:

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| <u>Knowledge and Comprehension</u> Knowledge: - classical and modern methods in organic synthesis - planning and performance of the syntheses of organic compounds Comprehension: - general principles of modern organic synthesis - principles of stereoselective, asymmetric, and combinatorial synthesis |
| <u>Application</u> Rational planning and practical performance of organic syntheses (directed and target synthesis of organic compounds and the synthesis of combinatorial libraries) |
| <u>Analysis</u> On the basis of the acquired knowledge, the student is able to plan the synthesis of simple and complex organic compounds and to critically evaluate possible synthetic pathways. The student is able to choose and practically evaluate the most suitable (rational) synthetic approach. |
| <u>Skill-transference Ability</u> - access to and the use of literature sources - collection, interpretation, and critical data evaluation - identification and solving the problems - reporting and presentation of the results (oral and written) - critical analysis and synthesis |

Metode poučevanja in učenja:

Predavanja, seminarji in vaje

Learning and Teaching Methods:

Lectures, seminars, seminar projects, and laboratory trainings

Načini ocenjevanja:

Seminarska naloga, ustni izpit.
 Ocene: 6-10 (pozitivno), 1-5 (negativno)

Delež (v %) /

Weight (in %) **Assessment:**

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|--|-------------|---|
| | 30 % | Seminar work, oral exam Grades: 6-10 (positive), 1-5 (negative) |
| | 70 % | |

Reference nosilca / Lecturer's references:

- BAŠKOVČ, Jernej, DAHMANN, Georg, GOLOBIČ, Amalija, GROŠELJ, Uroš, KOČAR, Drago, STANOVNIK, Branko, SVETE, Jurij. Diversity-oriented synthesis of 1-substituted 4-aryl-6-oxo-1,6-dihydropyridine-3-carboxamides. *ACS combinatorial science*, ISSN 2156-8952, 2012, vol. 14, no. 9,

str. 513-519, doi: [10.1021/co3000709](https://doi.org/10.1021/co3000709). [COBISS.SI-ID [36122373](#)]

- MALAVAŠIČ, Črt, BRULC, Blaž, ČEBAŠEK, Petra, DAHMANN, Georg, HEINE, Niklas, BEVK, David, GROŠELJ, Uroš, MEDEN, Anton, STANOVNIK, Branko, SVETE, Jurij. Combinatorial solution-phase synthesis of (2S,4S)-4-acylamino-5-oxopyrrolidine-2-carboxamides. *Journal of combinatorial chemistry*, ISSN 1520-4766, 2007, vol. 9, no. 2, str. 219-229. [COBISS.SI-ID [28465925](#)]

- GROŠELJ, Uroš, MEDEN, Anton, STANOVNIK, Branko, SVETE, Jurij. Synthesis of spiro[bicyclo[2.2.1]heptane-2,2'-furan]-3-amines via stereoselective cycloadditions of trimethylenemethane to (1S,3EZ,4R)-3-arylimino-1,7,7-trimethylbicyclo[2.2.1]heptan-2-ones. *Tetrahedron: asymmetry*, ISSN 0957-4166. [Print ed.], 2007, vol. 18, no. 19, str. 2365-2376. [COBISS.SI-ID [29014789](#)]

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