

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Organska kemija za trajnostni razvoj
Course title:	Organic Chemistry for the Sustainable Development

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Ekotehnologije, 3. stopnja	/	1	1
Ecotechnologies, 3 rd cycle	/	1	1

Vrsta predmeta / Course type

Izbirni/ Elective

Univerzitetna koda predmeta / University course code:

EKO3-765

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15			15	105	5

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transferred to individual work.*

Nosilec predmeta / Lecturer:

Prof. dr. Stojan Stavber

**Jeziki /
Languages:**

Predavanja / Lectures: slovenščina, angleščina
Slovenian, English

Vaje / Tutorial: slovenščina, angleščina
Slovenian, English

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

Zaključena druga stopnja bolonjskega študija ali univerzitetni študijski program.
Priporočena usmeritev: organska kemija na dodiplomskem študiju.

Prerequisites:

Completed the second-level of the Bologna study or post-secondary study program.
Recommended specialization on organic chemistry at second-level studies.

Vsebina:

Predmet je namenjen poglobljanju in utrjevanju razumevanja organske kemije na specifičnem področju, ki je praviloma povezano s študentovim raziskovalnim področjem, povezanim s transformacijami organskih spojin pod zelenimi reakcijskimi pogoji in ustreznimi procesnimi tehnologijami. Poudarek je na naslednjih področjih:

1. Osnove zelene kemije (glavni mejniki, sodobni koncepti, razvojne smeri).
2. Oksidativne transformacije organskih spojin pod zelenimi reakcijskimi pogoji.
3. Aerobne oksidacije organskih spojin.

Content (Syllabus outline):

The course is directed towards deepening and consolidation of the understanding of organic chemistry in the specific area that is normally associated with the student's research topics related to transformations of organic molecules under green reaction conditions and corresponding process technologies. Emphasis is on the following topics:

1. Fundamentals of green chemistry (principal milestones, contemporary concepts, development directions).
2. Oxidative transformations of organic

<ol style="list-style-type: none"> 4. Oksidativno halogeniranje organskih spojin z uporabo zračnega kisika ali vodikovega peroksida kot oksidanta. 5. Sinteze organskih peroksidov z uporabo vodikovega peroksida. Bioaktivnost organskih peroksidov. 6. Selektivna uvedba fluorovega atoma v organske molekule pod zelenimi reakcijskimi pogoji. Potencialna bioaktivnost fluoriranih organskih spojin. 7. Alternativni reakcijski sistemi. 8. Zeleni reakcijski mediji: voda, ionske tekočine, fluorna topila, reakcije pod pogoji brez uporabe topil, imobilizirani reaktanti. 9. Alternativni načini aktivacije organskih reakcij: mikrovalovi, ultrazvok, svetloba, mehanokemijska aktivacija. 10. Oblikovanje organskih reakcij pod zelenimi reakcijskimi pogoji. 11. Metodologija ocenjevanja okoljske sprejemljivosti kemijskih procesov. 12. Uporaba principov zelene kemije v praksi. 13. Izbrane teme iz ožjega raziskovalnega področja študenta. <p><u>Obvezno:</u> podrobna analiza enega primera (po možnosti povezanega s projektom podiplomca) z vidika osnovnih principov zelene kemije (identifikacija ključnih ocenjevalnih kriterijev, ocena možnosti, izbor optimalnih rešitev).</p>	<ol style="list-style-type: none"> 3. Aerobic oxidations of organic compounds. 4. Oxidative halogenations of organic molecules using air oxygen or hydrogen peroxide as oxidants. 5. Synthesis of organic peroxides using hydrogen peroxide. Bioactivity of organic peroxides. 6. Selective introduction of the fluorine atom into organic molecules under green reaction conditions. Potential bioactivity of fluoroorganic compounds. 7. Alternative reaction systems. 8. Green reaction media: water, ionic liquids, fluorous solvents, solvent-free reactions, immobilization of reactants. 9. Alternative activation of organic reactions: microwaves, ultrasound, light, mechanochemical activation. 10. Design of organic reactions under green reaction conditions. 11. Methodology for evaluation of environmentally impact of chemical processes. 12. Application of the principles of green chemistry in practice. 13. Selected topic from the student's specific research area. <p><u>Obligatory:</u> detailed analysis of one example (possibly related with the postgraduate's project) from the viewpoints of the main principles of green chemistry (identification of the key evaluation criteria, evaluation of possibilities, choice of optimal solutions).</p>
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Temeljni literatura in viri / Readings:

- *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*. 6th Edition, MB Smith and J March, John Wiley & Sons, Inc., 2007
- *Modern Oxidation Methods*, Backvall, J.E. (Ed), Wiley, 200
- *Halogenated Heterocycles, Synthesis, Application and Environment*. Series: Topics in Heterocyclic Chemistry, Volume Editor J Iskra, Volume 27, Springer, 2012
- *Modern Fluoroorganic Chemistry. Synthesis, Reactivity, Applications*; Kirsh, P.; Wiley; 2004.
- *Modern Organofluorine Chemistry-Synthetic Aspects; Advanced in Organic Synthesis, Vol. 2.*; Rahman, A.-U.; Laali K.K. (Eds), Bentham, 2008.
- P. T. Anastas, J. C. Warner. *Green Chemistry: Theory and Practice*. Oxford University Press (2000), 152 p., ISBN 978-0198506980
- M. Lancaster. *Green Chemistry: An Introductory Text*. Royal Society of Chemistry (2nd Ed., 2010), 346 p., ISBN 978-1847558732
- A Lapkin, D. Constable. *Green Chemistry Metrics: Measuring and Monitoring Sustainable Processes*, Wiley-Blackwell, 2008.

- DJ Adams, PJ Dyson, SJ Tavener. *Chemistry in Alternative Reaction Media*. John Wiley & Sons, Inc., Weinheim, 2004.
- UM Lindstrom. *Organic Reactions in Water: Principles, Strategies and Applications*. Wiley- Blackwell Publishing, 2007.
- R Ballini. *Eco-Friendly Synthesis of Fine Chemicals*; Series: RSC Green Chemistry Series, Royal Society of Chemistry, 2009.
- Izbrana literatura iz mednarodne znanstvene periodike. / Selected literature from international scientific periodicals.

Cilji in kompetence:

Cilji

Cilj predmeta je poglobljanje znanja iz organske kemije na področju, na katerem poteka raziskovalno delo študenta in je povezano s transformacijami organskih molekul pod zelenimi reakcijskimi pogoji in odgovarjajočimi procesnimi tehnikami. Tako bo lahko poglobil svoje znanje na raziskovalnem področju zelene organske kemije in s tem vnesel dodatno dimenzijo v reševanje problematike raziskovanega področja.

Splošne kompetence:

- Obvladanje raziskovalnih metod, postopkov in procesov
- Razvoj kritične in samokritične presoje
- Sposobnost uporabe znanja v praksi
- Razvoj komunikacijskih sposobnosti in spretnosti, posebej komunikacije v mednarodnem okolju
- Kooperativnost in delo v skupini (in v mednarodnem okolju)
- Reševanje varnostnih problemov in problemov okolja

Predmetnospecifične kompetence

- Seznanitev s splošnimi znanji na področju zelene kemije
- Specifično znanje, povezano z raziskovalno tematiko

Objectives and competences:

Objectives

The main objective of this course is to deepen the knowledge of organic chemistry in the area of student's research programme connected with transformations of organic compounds under green reaction conditions and related process techniques. Thus, a student can deepen the knowledge in his research and at the same time enter a new dimension in solving problems in areas of his study of green organic chemistry.

General Competences:

- The student will master research methods, procedures and processes
- The student will develop critical thinking
- The student will develop communications skills to present research achievement in the international environment
- Cooperation and teamwork (also in international environment)
- Safety and environmental problem solving abilities

Course Specific Competences:

- Acquaintance with the basic knowledge in the area of green chemistry
- Specific knowledge related to the research project

Predvideni študijski rezultati:

Znanje in razumevanje:

Specifično globlje znanje na izbranem raziskovalnem področju zelene organske kemije. Razumevanje povezave med teoretičnim znanjem in reševanjem praktičnih problemov. Sposobnost abstrahiranja bistva iz množice informacij in urejanje le-teh v smiselno celoto. Teoretično in praktično znanje na področju

Intended learning outcomes:

Knowledge and understanding:

Deeper knowledge in the selected research field of green organic chemistry. Understanding the links between theoretical knowledge and solving practical problems. The ability to abstract the essence from mass of information and to distil it down into a meaningful whole.

modernih kromatografskih separacijskih metod in spektroskopskih metod za identifikacijo organskih spojin.

Theoretical and practical knowledge dealing with modern chromatographic method for separation and spectroscopic method for identification of organic compounds.

Metode poučevanja in učenja:

Predavanja, seminarji.
Individualno delo s študenti.
Eksperimentalno raziskovalno delo v laboratoriju v okviru doktorske disertacije oziroma krajše eksperimentalno delo na ožjem projektu.

Learning and teaching methods:

Lectures and seminars.
Individual work with students.
Experimental research work on PhD thesis or short experimental work on a special project.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminar	50 %	Seminar
Ustni izpit	50 %	Oral exam

Reference nosilca / Lecturer's references:

- AJVAZI, Njomza, STAVBER, Stojan. Direct halogenation of alcohols with halosilanes under catalyst- and organic solvent-free reaction conditions. *Tetrahedron letters*, ISSN 0040-4039. [Print ed.], 2016, vol. 57, no. 22, str. 2430-2433, doi: [10.1016/j.tetlet.2016.04.083](https://doi.org/10.1016/j.tetlet.2016.04.083).
- PREBIL, Rok, STAVBER, Stojan. The α -chlorination of aryl methyl ketones under aerobic oxidative conditions. *Advanced Synthesis & Catalysis*, ISSN 1615-4150. [Print ed.], 2014, vol. 356, no. 6, str. 1266-1274, doi: [10.1002/adsc.201301012](https://doi.org/10.1002/adsc.201301012).
- PREBIL, Rok, STAVBER, Gaj, STAVBER, Stojan. Aerobic oxidation of alcohols by using a completely metal-free catalytic system. *European journal of organic chemistry*, ISSN 1434-193X, 2014, vol. 2014, no. 2, str. 395-402, doi: [10.1002/ejoc.201301271](https://doi.org/10.1002/ejoc.201301271).
- PREBIL, Rok, STAVBER, Stojan. Aerobic oxidative [alpha]-iodination of carbonyl compounds using molecular iodine activated by a nitrate-based catalytic system. *Tetrahedron letters*, ISSN 0040-4039. [Print ed.], 2014, vol. 55, issue 41, str. 5643-5647, doi: [10.1016/j.tetlet.2014.08.055](https://doi.org/10.1016/j.tetlet.2014.08.055).
- 5. STAVBER, Gaj, STAVBER, Stojan. Towards greener fluorine organic chemistry : direct electrophilic fluorination of carbonyl compounds in water and under solvent-free reaction conditions. *Advanced Synthesis & Catalysis*, ISSN 1615-4150. [Print ed.], 2010, vol. 352, no. 16, str. 2838-3846, doi: [10.1002/adsc.201000477](https://doi.org/10.1002/adsc.201000477).