UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJA HETEROCIKLIČNIH SPOJIN
Course Title:	CHEMISTRY OF HETEROCYCLIC COMPOUNDS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemija, 1. stopnja	**/**	**3.**	**6.**
USP Chemistry, 1st Cycle	**/**	**3rd**	**6th**

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: KESI9

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: doc. dr. Uroš Grošelj / Dr. Uroš Grošelj, Assistant Professor

Jeziki / Languages:

Predavanja / Lectures:	**slovenski / Slovenian**
Vaje / Tutorial:	**slovenski / Slovenian**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.	The course has to be assigned to the student.

Vsebina:	Content (Syllabus outline):
Struktura, nomenklatura in lastnosti heterociklov. Sistematika osnovnih sistemov (velikost, število, in povezava obročev, stopnja nasičenja). Heteroaromati: tavtomerija in valenčne izomerizacije. Nasičeni sistemi: napetost malih obročev, konformacijske značilnosti in analiza, anomerni efekt. **Sinteza heterociklov.** Ciklizacije (ciklosubstitucije, ciklokondenzacije, cikloadicije). Značilni gradniki za sintezo heterociklov. Baldwinova pravila. **Pretvorbe heterociklov.** Reakcije z elektrofili in nukleofili. Odpiranja in pretvorbe obročev. Metaliranje heterociklov. S paladijem katalizirane reakcije. Periciklične reakcije. **Pregled kemije osnovnih tipov heterociklov.**	**Structure, nomenclature, and properties of heterocyclic compounds:** Systematic survey on heterocycles (ring size, number of rings, connection of rings). Heteroaromatic systems: tautomerism and valence isomerisation. Saturated heterocycles: ring strain in small rings, conformational properties and analysis, anomeric effect. **Synthesis of heterocycles.** Cyclisations (cyclosubstitutions, cyclocondensations, cycloadditions). Typical building blocks in the synthesis of heterocycles. Baldwin rules. **Transformations of heterocylces.** Reactions with electrophiles and nucleophiles. Ring-opening and ring-transformations. Metallation of heterocycles. Palladium in heterocyclic

Piridini, kinolini in izokinolini. Diazini. Piroli in indoli. Furani in tiofeni. 1,2- in 1,3-diazoli. Heterocikli s tremi in več heteroatomi. Heterocikli z mostnim dušikovim atomom. **Pomen heterociklov v kemiji, biokemiji in farmaciji.**	chemistry. Pericyclic reactions. **Survey on the chemisty of fundamental heterocyclic systems.** Pyridines, quinolines, and isoquinolines. Pyrroles and indoles. Furans and thiophenes. 1,2- and 1,3-diazoles. Systems with three or more heteroatoms. Systems with a bridgehead nitrogen atom. **Importance of heterocycles in chemistry, biochemistry, and pharmacy.**

Temeljna literatura in viri / Readings:

- A. Joule, K. Mills: Heterocyclic Chemistry At A Glance, 2nd Edition, John Wiley & Sons, 2013, 230 strani.

Dodatna literatura:

- Comprehensive Heterocyclic Chemistry III, A. R. Katritzky, C. A. Ramsden, E. F. V. Scriven, R. J. K. Taylor eds., Elsevier Science, Oxford 2008. (izbrana poglavja).
- Pregledni članki, ki pokrivajo posamezne vsebine iz heterociklične kemije (praviloma v zadnjih 10 letih).

Cilji in kompetence:	**Objectives and Competences:**
Heterociklične spojine predstavljajo zelo pomemben del organske kemije, farmacije in biokemije, saj igrajo bistveno vlogo v osnovnih življenjskih procesih. **Cilj**: Študent se v okviru tega predmeta seznani s sintezami in pretvorbami heterocikličnih sistemov kot pomembnih gradnikov v organski kemiji, biokemiji in farmaciji. **Kompetence**: Poznavanje in uporaba heterocikličnih spojin kot intermediatov v organski sintezi.	Due to essential role of heterocyclic compounds in biological processes, these compounds represent an important topic in chemistry, biochemistry, and pharmacy. ***Objectives:*** The expected learning outcomes are knowledge and understanding of the synthesis and typical reactivity and transformations of heterocycles as well as their use as building blocks in organic chemistry, biochemistry, and pharmacy. ***Competences:*** Knowledge of heterocyclic compounds and their application as intermediates in organic synthesis.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent se nauči: - sinteze in pretvorbe osnovnih heterocikličnih sistemov s posebnim poudarkom na sistemih, ki so pomembni v organski sintezi in biokemiji - pretvorbe in premestitve heterocikličnih sistemov, ki so zlasti pomembne v organski sintezni kemiji - uporabnost hetrocikličnih N-oksidov v sintezni kemiji - elektrofilne in nukleofilne substitucije	<u>Knowledge and Comprehension</u> The student learns*:* -syntheses and transformations of basic heterocyclic systems with emphasis on systems relevant for organic synthesis and biochemistry - transformations and rearrangements of heterocyclic systems relevant in organic synthesis - application of heterocyclic N-oxides in synthetic chemistry - electrophilic and nucleophilic substitutions,

- reaktivnost petčlenskih in šestčlenskih heterociklov, podobnosti in razlike - selektivne reaktivnosti, transformacije funkcionalnih skupin	- reactivity of five- and six-membered heterocycles, similarity and differences, - selective reactivity, transformations of functional groups
Uporaba Poznavanje heterociklične kemije je eden od temeljev organske kemije, zlasti v sintezni organski kemiji, kjer služijo heterocikli mnogokrat kot reaktivni intermediati. To znanje služi poleg tega še vrsti drugih področij, predvsem biokemiji in farmacevtski industriji, kemiji kompleksov z anorganskimi ioni, itd.	Application The knowledge of heterocyclic chemistry belongs to fundamentals of organic chemistry, especially in synthetic organic chemistry, where heterocyclic compounds are frequently used as reactive intermediates. This knowledge is also essential in other related fields, such as biochemistry, pharmaceutical chemistry, and coordination chemistry etc.
Refleksija Predmet je osnova za delo na ostalih področjih kemije predvsem nekaterih predmetov izbirnega sklopa organske kemije in biokemije. Posebnega pomena je tovrstno znanje za delo v kemijski in farmacevtski industriji	Analysis Knowledge of heterocyclic chemistry is required for practical work in other areas of chemistry. It is also useful if not a prerequisite for elective courses from various specialized topics in organic chemistry. This knowledge is of vital importance for those working in chemical and pharmaceutical industry.
Prenosljive spretnosti Znanje heterociklične kemije zagotavlja zaradi prisotnosti heteroatomov v organskem skeletu najširše strukturne in reakcijske možnosti na celotnem področju kemije.	Skill-transference Ability Due to presence of heteroatoms in organic structure, the knowledge of heterocyclic chemistry gives wide structural and reaction possibilities within the whole area of chemistry.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja; seminarji, individualni in skupinski projekti, laboratorijske vaje, individualni in skupinski sintezni projekti.	Lectures,seminars, seminar projects, and laboratory trainings

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit	**70 %**	Written exam
Seminarska naloga	**30 %**	Seminar project
Ocene: pozitivno 6-10; negativno 1-5.		Grades: positive 6-10, negative 1-5

Reference nosilca / Lecturer's references:

1. E. Pušavec Kirar, M. Drev, J. Mirnik, U. Grošelj, A. Golobič, G. Dahmann, F. Požgan, B. Štefane, J. Svete, Synthesis of 3D-Rich Heterocycles: Hexahydropyrazolo[1,5-a]pyridin-2(1H)-ones and Octahydro-2H-2a,2a1-diazacyclopenta[cd]inden-2-ones, J. Org. Chem. 2016, 81, 8920–8933. DOI: 10.1021/acs.joc.6b01608. [COBISS.SI-ID 1537115331]
2. U. Grošelj, E. Pušavec, A. Golobič, G. Dahmann, B. Stanovnik, J. Svete, Synthesis of 1,5-

disubstituted-4-oxo-4,5-dihydro-1H-pyrazolo[4,3-c]pyridine-7-carboxamides, Tetrahedron 2015, 71, 109–123. DOI: 10.1016/j.tet.2014.11.034. [COBISS.SI-ID 1536061891]
3. U. Grošelj, A. Beck, W. B. Schweizer, D. Seebach, Preparation and Structures of 2-Substituted 5-Benzyl-3-methylimidazolidin-4-one-Derived Iminium Salts, Reactive Intermediates in Organocatalytic Transformations Involving α,β-Unsaturated Aldehydes, Helv. Chim. Acta 2014, 97, 751–796. DOI: 10.1002/hlca.201400110. [COBISS.SI-ID 1536179139]
4. U. Grošelj, M. Žorž, A. Golobič, B. Stanovnik, J. Svete, α-Amino acid derived enaminones and their application in the synthesis of N-protected methyl 5-substituted-4-hydroxypyrrole-3-carboxylates and other heterocycles, Tetrahedron 2013, 69, 11092–11108. DOI: 10.1016/j.tet.2013.11.008. [COBISS.SI-ID 1650735]
5. U. Grošelj, A. Podlogar, A. Novak, G. Dahmann, A. Golobič, B. Stanovnik, J. Svete, Synthesis of tetrahydropyrazolo[1,5-c]pyrimidine-2,7(1H,3H)-diones, Synthesis 2013, 45, 639–650. DOI: 10.1055/s-0032-1318107. [COBISS.SI-ID 36543749]