

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: NOVODOBNA OKOLJSKA ONESNAŽILA
Course title: EMERGING ENVIRONMENTAL CONTAMINANTS

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Varstvo okolja in ekotehnologije, 2. stopnja	/	2.	/
Environmental Protection and Eco-technologies, 2 nd level	/	2 nd	/

Vrsta predmeta / Course type Izbirni predmet / Optional course

Univerzitetna koda predmeta / University course code: NOO

Predavanja Lectures	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
20	5	5	10	80	4

Nosilec predmeta / Lecturer: doc. dr. Anja Bubik

Jeziki / Predavanja / Lectures: Slovenščina / Slovenian
Languages: Vaje / Tutorial: Slovenščina / Slovenian

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

Pogojev ni.

Prerequisites:

No formal prerequisites.

Vsebina:

Predmet se osredotoča na kemikalije in materiale, ki se v sodobni družbi množično uporabljajo, zato pogosto prehajajo v okolje in vplivajo na ekosisteme ter človekovo zdravje. Obravnava razumevanje njihovega nastanka, lastnosti, poti v okolju, vplivov, regulativnih pristopov in metod ocene tveganja, podprtih z aktualnimi primeri iz prakse.

Poglavitne teme:

- Koncepti, trendi in izzivi sodobnih okoljskih onesnažil
- Regulativni okvir EU (REACH, CLP, SVHC, POP...) in upravljanje kemijske varnosti
- Nevarne lastnosti snovi (toksičnost, kancerogenost, mutagenost, teratogenost, reprotoksičnost,...)
- Usoda kemikalij v okolju (viri, transport, bioakumulacija, biomagnifikacija,...)
- Izpostavljenost ljudi kemikalijam v okolju (odmerki, metabolizem, ranljivost,...)

Content (Syllabus outline):

The course focuses on chemicals and materials that are widely used in modern society and therefore frequently enter the environment, affecting ecosystems and human health. It addresses their origin, properties, environmental pathways, impacts, regulatory approaches, and risk-assessment methods, supported by current real-world examples.

Main topics:

- Concepts, trends, and challenges of contemporary environmental contaminants
- EU regulatory framework (REACH, CLP, SVHC, POPs, ...) and chemical safety management
- Hazardous properties of chemicals (toxicity, carcinogenicity, mutagenicity, teratogenicity, reprotoxicity, ...)
- Environmental fate of chemicals (sources, transport, bioaccumulation, biomagnification, ...)
- Human exposure to environmental chemicals (doses, metabolism, vulnerability, ...)
- Chemical and Biological Contaminants

- Kemijska in biološka onesnažila
- Hormonski motilci
- Večne kemikalije (PFAS)
- Bisfenoli, ftalati in drugi aditivi
- Mikroplastika in nanoplastika
- Težke kovine
- Nastajajoča onesnažila (zdravila, pesticidi, kozmetika, ...)
- Digitalni odpadki
- Študije primerov

- Endocrine disruptors
- “Forever chemicals” (PFAS)
- Bisphenols, phthalates, and other additives
- Microplastics and nanoplastics
- Heavy metals
- Emerging contaminants (pharmaceuticals, pesticides, cosmetics, ...)
- Digital waste
- Case studies

Temeljna literatura in viri / Textbooks:

Obvezna / Required:

1. Izročki s predavanj
2. Aktualni znanstveni članki na izbrano tematiko

Priporočena / Recommended:

1. Sarma, H., Dominguez, D. C., & Lee, W.-Y. (Eds.). (2022). *Emerging contaminants in the environment: Challenges and sustainable practices* (1st ed.). Elsevier.
2. Zhang et al. (2024). *Emerging contaminants: A global overview of occurrence, fate, and impacts*. *The Innovation*, 5(3), Article 100509.
3. Daughton, C. G. (2005). “Emerging” chemicals as pollutants in the environment: A 21st century perspective. *Renewable Resources Journal*, 23(4), 6–23
4. Gore, A. C. (Ed.). (2007). *Endocrine-disrupting chemicals: From basic research to clinical practice* (1st ed.). Humana Press.

Cilji in kompetence:

Predmetno specifični cilji in kompetence:

- študente seznaniti s tem, katera so novodobna okoljska onesnažila ter zakaj predstavljajo izziv okolju
- študente seznaniti z najpogostejšimi viri in lastnostmi onesnažil
- študentom predstaviti ključne nevarne lastnosti kemikalij in njihov pomen za širše okolje
- študentom predstaviti procese prenosa, transformacije in usode kemikalij v različnih okoljskih medijih
- študentom pojasniti potencialne vplive sodobnih onesnažil na ekosisteme in zdravje ljudi
- študente seznaniti z zakonodajnimi in regulativnimi okviri na področju kemijske varnosti ter njihovim pomenom za upravljanje tveganj
- študente usposobiti za osnovno laboratorijsko in terensko delo za prepoznavanje prisotnosti ter vplivov teh kemikalij v okolju.

Splošne kompetence:

Objectives and competences:

Specific competences:

- introduce students to emerging/modern environmental pollutants and explain why they pose challenges to the environment
- familiarise students with the most common sources and properties of these pollutants
- present to students the key hazardous properties of chemicals and their relevance for the broader environment
- present the processes of transport, transformation, and fate of chemicals in different environmental media
- explain the potential impacts of emerging pollutants on ecosystems and human health
- introduce students to the legislative and regulatory frameworks in the field of chemical safety and their importance for risk management
- train students in basic laboratory and field techniques for identifying the presence and effects of these chemicals in the environment

General competencies:

- sposobnost razumevanja pomena trajnostnega in odgovornega ravnanja s kemikalijami
- sposobnost analize, sinteze in uporabe znanstvenih informacij ter podatkovnih virov
- sposobnost kritičnega mišljenja pri obravnavi okoljskih izzivov
- sposobnost samostojnega in skupinskega reševanja kompleksnih strokovnih nalog
- sposobnost učinkovite komunikacije strokovnih vsebin v pisni in ustni obliki

- ability to understand the importance of sustainable and responsible handling of chemicals
- ability to analyse, synthesise, and apply scientific information and data sources
- ability to think critically when addressing environmental challenges
- ability to solve complex professional tasks independently and in teams
- ability to communicate technical content effectively in written and oral form

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent bo ob zaključku predmeta sposoben:

- naštetih glavna okoljska onesnažila v sodobni družbi
- prepoznati glavne vire novodobnih onesnažil ter razumeti njihove fizikalno-kemijske lastnosti in nevarnosti
- opisati razlike med posameznimi kategorijami nevarnosti in njihove posledice širše okolje
- razložiti procese prenosa, transformacije in usode teh kemikalij v različnih okoljskih medijih
- opisati potencialne vplive sodobnih onesnažil na ekosisteme in zdravje ljudi
- slediti ključnim zakonodajnim in regulativnim zahtevam na področju kemijske varnosti ter razumeti njihov pomen pri upravljanju tveganj
- pridobiti praktične izkušnje pri laboratorijskem in terenskem delu, zlasti pri prepoznavanju prisotnosti in vplivov teh kemikalij v okolju.

Prenosljive/ključne spretnosti in drugi atributi:

- sposobnost kritičnega vrednotenja znanstvenih informacij in podatkovnih virov
- učinkovito pisno in ustno komuniciranje strokovnih vsebin
- samostojno in skupinsko reševanje kompleksnih okoljskih problemov
- uporaba digitalnih orodij za iskanje, analizo in interpretacijo okoljskih podatkov
- odgovoren, etičen in trajnostno naravnani pristop k obravnavi kemikalij v okolju

Intended learning outcomes:

Knowledge and understanding:

At the end of the subject, student will be able:

- to list the major environmental/emerging pollutants present in modern society
- to identify the main sources of emerging contaminants and understand their physicochemical properties and associated hazards
- to describe the differences between individual hazard categories and their implications for the broader environment
- to explain the processes of transport, transformation, and fate of these chemicals in different environmental media
- to describe the potential impacts of emerging pollutants on ecosystems and human health
- to follow key legislative and regulatory requirements in the field of chemical safety and understand their relevance for risk management
- to demonstrate practical experience in laboratory and field work, particularly in identifying the presence and effects of these chemicals in the environment

Transferable/key skills and other attributes:

- ability to critically evaluate scientific information and data sources
- effective written and oral communication of technical content
- independent and collaborative problem-solving of complex environmental issues
- use of digital tools for searching, analysing, and interpreting environmental data
- responsible, ethical, and sustainable approach to handling chemicals in the environment

Metode poučevanja in učenja:

Learning and teaching methods:

Oblike dela:

- predavanja
- seminarske vaje (vključevanje strokovnjakov iz prakse oz. gostujočih predavateljev iz tujine)
- laboratorijske vaje
- terenske vaje
- samostojno delo študentov

Metode dela:

- razlaga
- branje in analiza znanstvenih člankov
- razprava v manjših skupinah
- problemsko učenje (preučevanje študij primerov)
- praktično delo v laboratoriju in na terenu

Forms of teaching:

- in-class lectures
- seminar lessons (including contributions from industry experts or visiting lecturers from abroad)
- laboratory work
- fieldwork
- individual work of students

Teaching methods:

- explanation
- reading and analysis of scientific articles
- small-group discussion
- problem-based learning (case study analysis)
- practical work in the laboratory and in the field

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
<p>Pogoj za pristop k izpitu: Opravljene seminarske, laboratorijske in terenske vaje</p> <p>Končna ocena pri predmetu je sestavljena iz ocene pisnega izpita in ocene poročila vaj: - poročilo iz laboratorijskih in terenskih vaj - izpit</p> <p>Ocenjevalna lestvica:</p> <ul style="list-style-type: none"> ▪ zadostno 6: 60–67 % ▪ dobro 7: 68–75 % ▪ prav dobro 8: 76–83 % ▪ prav dobro 9: 84–90 % ▪ odlično 10: 91–100 % 	<p>30 %</p> <p>70 %</p>	<p>A prerequisite for access to the exam: completed seminar, laboratory, and field work</p> <p>Final evaluation consists of the written exam and the evaluation of the exercise report: - report from laboratory and field exercises - written exam</p> <p>Grading scale:</p> <ul style="list-style-type: none"> ▪ Sufficient D (6): 60–67% ▪ Good C (7): 68–75% ▪ Very good B (8): 76–83% ▪ Very good B+ (9): 84–90% ▪ Excellent A (10): 91–100%

Materialni pogoji za izvedbo predmeta :

- predavalnica z multimedijско opremo.
- študijski laboratorij z ustreznim kemijskim inventarjem in dostopom do analitskih instrumentov.

Material conditions for subject realization:

- Classroom with the multimedia equipment.
- Teaching laboratory with appropriate chemical equipment and access to analytical instruments.

Obveznosti študentov:

100 % prisotnost na seminarskih, laboratorijskih in terenskih vajah. Za vse vaje skupaj morajo študenti pripraviti eno poročilo. Namen poročila je, da študenti oblikujejo sintezo vseh pridobljenih praktičnih znanj, razumejo potencialne nevarnosti obravnavanih onesnažil, ter raziščejo načine za analizo njihove prisotnosti in določanje koncentracij v različnih okoljskih medijih.

Pozitivno opravljen izpit.

Student's commitments:

100% attendance at seminars, laboratory and field work. Students must prepare one joint report. The purpose of the report is for students to develop a synthesis of all acquired practical skills, understand the potential hazards of the pollutants under study, and explore methods for analysing their presence and determining their concentrations in different environmental media.

Successfully passed exam.

Reference nosilca predmeta:

Pedagoško delo:

- Sodelovanje pri izvedbi programa Varstvo okolja in ekotehnologije 1.stopnja:
 - Nosilka predmeta *Človek in okolje* (2014—)
 - Asistentka pri predmetih *Človek in okolje* (2008—2023), *Kemija in okolje* (2010—2023), *Ekotoksikologija* (2009—2025), *Molekularna ekologija v naravovarstvu* (2020—), *Čiščenje odpadni vod* (2021—2025), *Kemija onesnaževal* (2021—)
 - Sodelovanje pri izvedbi laboratorijskih vaj pri predmetu *Ocena tveganja in varstvo pri delu*
- Soavtorica priročnikov in navodil za izvajanje laboratorijskih vaj za predmetu *Kemija in okolje* (2014, 2015, 2019, 2022 ponatis)
- Soavtorica navodil za vaje iz *Ekotoksikologije* za študente 2. in 3. letnika (2011).
- Avtorica 5 spletnih tečajev s področja mikroplastike in okolja (2022)
- Soavtorica 2 inovativnih učnih gradiv in delavnic v okviru projekta STE(A)M
- Mentorica in somentorica diplomskih/magistrskih del
- Mentorica Praktičnega usposabljanja študentov s področja *Kemija in okolje* ter *Okolje in zdravje*
- Predsednica Komisije za študentske zadeve (2017—)
- Predsednica Komisije za študijske zadeve (2023—)

Znanstveno-raziskovalno delo:

- Članica raziskovalne skupine *Inštitut za ekotehnologije in trajnostni razvoj* (2015 -)
- Članica programa *Ekotoksikologija, toksikološka genomika in karcinogeneza* (2009 – 2012)
- Vodenje projektnih aktivnosti v okviru projektov Erasmus+ KA2: *MicPlaPROB* (2021—2022), *GreenGate* (2021—2023), *GreenGate II* (2024—2026), *Ecu4PlastiCircular* (2023—2027)
- Sodelovanje v mednarodnih, nacionalnih, regionalnih projektih:
 - PLASTIX – *Plastics Revolution for European Regions* (Interreg Europe) (2023—2027)
 - STE(A)M – *Promocija študija za poklice prihodnosti s kakovostnimi aktivnostmi in vsebinami za mlade izven javnih univerzitetnih središč* (2022—2024)
 - *Tveganja zaradi okoljskih in naravnih nesreč na območjih Slovenske vojske* (2023—2025)
 - *Dvojna narava matičnih celic v raku in njihova uporaba v zdravljenju* (2011—2014)
- Vabljen predavanja na tujih univerzah
- Aktivno sodelovanje na znanstvenih konferencah s področja mikroplastike, plastike, potencialno nevarnih kemikalij, fitoplanktona in njihovih metabolo aktivnih snovi ter zelenih in digitalnih veščin v izobraževanju

Strokovno delo in izbrane strokovne publikacije:

- Zunanja sodelavka Zveze potrošnikova Slovenije in avtorica strokovnih člankov s področja potencialno nevarnih kemikalij:

Lecturer's references:

Pedagogic activities:

- Participation in the implementation of the undergraduate study programme *Environmental Protection and Ecotechnology*:
- Course holder and lecturer of *People and environment* (2014—)
- Assistant in the courses *People and environment* (2008—2023), *Chemistry and the Environment* (2010—2023), *Ecotoxicology* (2009—2025), *Molecular Ecology in Nature Conservation* (2020—), *Wastewater Treatment* (2021—2025), *Chemistry of Pollutants* (2021—)
- Participation in laboratory classes for the course *Ecological Risk and Work Safety*
- Co-author of manuals and instructions for laboratory exercises for the course *Chemistry and the Environment* (2014, 2015, 2019, 2022 reprint)
- Co-author of laboratory instructions for *Ecotoxicology* for 2nd- and 3rd-year students (2011)
- Author of five online courses in the field of microplastics and the environment (2022)
- Co-author of two innovative teaching materials and workshops within the STE(A)M project
- Supervisor and co-supervisor of bachelor's and master's theses
- Supervisor of student practical training in the fields *Chemistry and the Environment* and *Environment and Health*
- Chair of the Student Affairs Committee (2017—)
- Chair of the Academic Affairs Committee (2023—)

Scientific and research work:

- Member of the research group *Institute for Ecotechnology and Sustainable Development* (2015—)
- Member of the research programme *Ecotoxicology, Toxicogenomics and Carcinogenesis* (2009—2012)
- Management of project activities within Erasmus+ KA2 projects: *MicPlaPROB* (2021—2022), *GreenGate* (2021—2023), *GreenGate II* (2024—2026), *Ecu4PlastiCircular* (2023—2027)
- **Participation in international, national, and regional projects:**
 - PLASTIX – *Plastics Revolution for European Regions* (Interreg Europe) (2023—2027)
 - STE(A)M – *Promotion of Future-Oriented Careers through High-Quality Activities and Content for Youth Outside Public University Centres* (2022—2024)
 - *Risks from Environmental and Natural Disasters in Areas of the Slovenian Armed Forces* (2023—2025)
 - *Dual Nature of Stem Cells in Cancer and Their Use in Therapy* (2011—2014)
- Invited lectures at foreign universities
- Active participation in scientific conferences in the fields of microplastics, plastics, potentially hazardous chemicals, phytoplankton and their metabolically active substances, and green and digital skills in education

Professional work and selected professional publications:

<p><u>BUBIK, Anja</u> (2026). Med učinkovitostjo, varnostjo in okoljsko odgovornostjo: silikoni v kozmetiki.</p> <p><u>BUBIK, Anja</u> (2025). Večne kemikalije, ki zastrupljajo naš svet: PFAS.</p> <p><u>BUBIK, Anja</u> (2025). Skriti formaldehid v kozmetičnih izdelkih : čeprav je prepovedan, je še vedno prisoten.</p> <p><u>BUBIK, Anja</u> (2025). Med dvema ognjema : zaviralci gorenja med varnostjo in tveganjem.</p> <p><u>BUBIK, Anja</u> (2025). V naše okolje prinašajo številna tveganja: obstojni in vseprisotni bisfenoli.</p> <p><u>BUBIK, Anja</u> (2024). So bleščice vredne svojega blišča? Oblačila s sijajem.</p> <ul style="list-style-type: none"> • Avtorica in urednica knjige G-book: <i>educational support for safe and responsible cosmetic product use</i> • Soavtorica strokovne monografije <i>EDU4Plastic: handbook with innovative training methods for trainers: WP2 training methodology design.</i> (2025) • Soavtorica video vsebin s področja mikroplastike <p>Priznanja in nagrade: /</p>	<ul style="list-style-type: none"> • External expert of the Slovenian Consumers' Association on potentially hazardous chemicals: <p><u>BUBIK, Anja</u> (2026). <i>Between effectiveness, safety and environmental responsibility: silicones in cosmetics.</i></p> <p><u>BUBIK, Anja</u> (2025). <i>Forever chemicals poisoning our world: PFAS.</i></p> <p><u>BUBIK, Anja</u> (2025). <i>Hidden formaldehyde in cosmetic products: although banned, it is still present.</i></p> <p><u>BUBIK, Anja</u> (2025). <i>Caught between two fires: flame retardants between safety and risk.</i></p> <p><u>BUBIK, Anja</u> (2025). <i>Persistent and ubiquitous bisphenols: bringing numerous risks to our environment.</i></p> <p><u>BUBIK, Anja</u> (2024). <i>Are glittery clothes worth the sparkle?</i></p> <ul style="list-style-type: none"> • Author and editor of the book <i>G-book: Educational Support for Safe and Responsible Cosmetic Product Use</i> • Co-author of the professional monograph <i>EDU4Plastic: Handbook with Innovative Training Methods for Trainers: WP2 Training Methodology Design</i> (2025) • Co-author of video materials in the field of microplastics <p>Awards: /</p>
<p>Izbrani znanstveni članki / Selected scientific papers:</p> <p>Izvirni znanstveni članek (1.01)/ Original scientific article (1.01):</p> <p><u>BUBIK, Anja</u>, FRANGEŽ, Robert, ŽUŽEK, Monika C., GUTIÉRREZ-AGUIRRE, Ion, LAH TURNŠEK, Tamara, SEDMAK, Bojan. Cyanobacterial cyclic peptides can disrupt cytoskeleton organization in human astrocytes : a contribution to the understanding of the systemic toxicity of cyanotoxins. <i>Toxins : Elektronski vir.</i> 2024, vol. 16, iss. 9, [art. no.] 374, str. 1-18. ISSN 2072-6651. https://www.mdpi.com/2072-6651/16/9/374, DOI: 10.3390/toxins16090374. [COBISS.SI-ID 205320707]</p> <p>SEDMAK, Bojan, CARMELI, Shmuel, POMPE NOVAK, Maruša, TUŠEK-ŽNIDARIČ, Magda, GRACH-POGREBINSKY, Olga, ELERŠEK, Tina, ŽUŽEK, Monika C., <u>BUBIK, Anja</u>, FRANGEŽ, Robert. Cyanobacterial cytoskeleton immunostaining: the detection of cyanobacterial cell lysis induced by planktopeptin BL1125. <i>Journal of plankton research.</i> 2009, vol. 31, no. 11, str. 1321-1330. ISSN 0142-7873. http://dx.doi.org/10.1093/plankt/fbp076, DOI: 10.1093/plankt/fbp076. [COBISS.SI-ID 2070607]</p> <p><u>BUBIK, Anja</u>, SEDMAK, Bojan, NOVINEC, Marko, LENARČIČ, Brigita, LAH TURNŠEK, Tamara. Cytotoxic and peptidase inhibitory activities of selected non-hepatotoxic cyclic peptides from cyanobacteria. <i>Biological chemistry.</i> 2008, issue 10, vol. 389, str. 1339-1346. ISSN 1431-6730. DOI: 10.1515/BC.2008.153. [COBISS.SI-ID 21960743]</p> <p>Pregledni znanstveni članek (1.02)/Review article (1.02):</p> <p><u>BUBIK, Anja</u>, ELERŠEK, Tina. Pristopi za boljše prepoznavanje cianobakterij kot grožnje za zdravje ljudi in okolja = Approaches to better identification of cyanobacteria as a threat to human and environmental health. <i>Ujma : revija za vprašanja varstva pred naravnimi in drugimi nesrečami.</i> 2020/2021, št. 34/35, str. 292-298, graf. prikazi, tabele. ISSN 0353-085X. https://www.gov.si/assets/organi-v-sestavu/URSZR/Publikacija/Ujma/2020/2021/Pristopi-za-boljse-prepoznavanje-cianobakterij-kot-groznje-za-zdravje-ljudi-in-okolja.pdf. [COBISS.SI-ID 92575491]</p> <p>Objavljeni znanstveni prispevek na konferenci (vabljen predavanje (1.06)/Published scientific conference contribution (invited lecture) (1.06):</p> <p><u>BUBIK, Anja</u>, SEDMAK, Bojan. Biološki učinki cianobakterijskih peptidov - raziskava na humanih možganskih celicah v kulturi = Biological effects of cyanobacterial peptides - research on human brain cells in culture. In: ZUPANČIČ JUSTIN, Maja (ed.). <i>Celinska vodna telesa : monitoring in metode obvladovanja cvetenja cianobakterij = Freshwater bodies : monitoring and methods for cyanobacterial bloom control ; Zaščita okolja in zdravja ljudi = Protecting the environment and human health : zbornik konference = proceedings of the conference.</i> Ljubljana: Arhel, 2017. Str. 64-66. ISBN 978-961-94149-0-3. http://lifestopcyanbloom.arhel.si/wp-content/uploads/Zaključna-konferenca-LIFE-Stop-CyanoBloom-2016.pdf. [COBISS.SI-ID 4166991]</p> <p>Objavljeni znanstveni prispevek na konferenci (1.08)/ Published scientific conference contribution (1.08):</p> <p><u>BUBIK, Anja</u>, ŠKOLNIK ŠKRABE, Katrin. Chemical variability of personal care and cosmetic products. In: <i>International Scientific and Professional Conference Politehnika 2023 : Belgrade, 15th December 2023 : conference proceedings.</i> Belgrade: The Academy of Applied Technical Studies, 2023. Str. 112-117, ilustr. ISBN 978-86-7498-110-8. [COBISS.SI-ID 203187715]</p> <p><u>BUBIK, Anja</u>. Freshwater phytoplankton blooms in relation to anthropogenic influences – students opinion. In: ŠTRKALJ, Anita (ed.), GLAVAŠ, Zoran (ed.). <i>Proceedings book.</i> 2nd International Conference the holistic approach to environment, May 28th, 2021, virtual conference. Sisak: Association for Promotion of Holistic Approach to Environment, 2021. Str. 51-57, ilustr. Proceedings book (International Conference "The Holistic Approach to Environment"). ISSN 2623-677X. [COBISS.SI-ID 95154947]</p>	