

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Biomonitoring
Course title:	Biomonitoring

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: EKO3-869

Predavanja Lectures	Seminar Seminar	Druge oblike Other	Samostojno delo Individual 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 in sodelavci
Course leader and lecturers** Prof. dr. Milena Horvat

**Jeziki /
Languages:** **Predavanja / Lectures:** Slovenski ali angleški / Slovene or English
Seminar: Angleški / English

Prerequisites:

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

Zaključen študij druge stopnje naravoslovne ali tehniške smeri ali zaključen študij drugih smeri z dokazanim poznavanjem osnov področja predmeta (pisna dokazila, pogovor).

Completed second level studies in natural sciences or engineering or completed second level studies in other fields with proven knowledge of fundamentals in the field of this course (certificates, interview).

Vsebina:

Predmet obsega naslednje:

- Definicije, osnove bioindikacije/biomonitoringa v okolju in pri ljudeh (humanega biomonitoringa).
- Uporaba okoljske bioindikacije/biomonitoringa za ugotavljanje stanja okolja v kopenskih in vodnih ekosistemih kot posledica onesnaževanja vode, zraka in tal z različnimi onesnažili (žveplove spojine, dušikove spojine, fotooksidanti, težke kovine, radionuklidi, obstojne organske snovi...)
- Ravni in načini bioindikacije (kazalci, akumulatorji / monitorji)

Content (Syllabus outline):

The subject includes the following:

- Definitions, basics of bioindication / biomonitoring in the environment and in humans (human biomonitoring).
- Use of environmental bioindication / biomonitoring to determine the state of the environment in terrestrial and aquatic ecosystems as a result of pollution of water, air, soil with various pollutants (sulfur compounds, nitrogen compounds, photooxidants, heavy metals, radionuclides, persistent organic substances ...).
- Levels and methods of bioindication (indicators,

- Vrste bioindikatorjev: bioindikacija z epifitskimi lišaji, mahovi; višje rastline kot indikatorji onesnaženosti zraka ali tal; onesnaženje tal in bioindikacija (glive, mikroorganizmi); višje živali (ribe, srnjad, ptiči) kot indikatorji stanja okolja; primeri uporabe biomonitoringa v različnih mednarodnih programih, zakonodaji
- Humani biomonitoring (planiranje, izvedba, interpretacija, komunikacija)
- Biomarkerji izpostavljenosti, občutljivosti in vpliva
- Prikaz ključnih slovenskih, evropskih in svetovnih programov okoljskega in humanega biomonitoringa
- Povezava okoljske in humane bioindikacije

- accumulators / monitors).
- Types of bioindicators: Bioindication with epiphytic lichens, mosses; Higher plants as indicators of air or soil pollution, soil contamination and bioindication (fungi, microorganisms). Higher animals (fish, deer, birds) as indicators of the state of the environment.
- Humane biomonitoring (planning, execution, interpretation, comic)
- Biomarkers exposed to vulnerability, sensitivity and influence.
- Presentation of key Slovenian, European and global programs of environmental and human biomonitoring
- The link between environmental and humane bioindication.

Temeljna literatura in viri / Readings:

- National Research Council. 2006. Human Biomonitoring for Environmental Chemicals. Washington, DC: The National Academies Press. <https://doi.org/10.17226/11700>.
- Biomarkers and Human Biomonitoring, Vol. 1 and Vol.2 (ed. L. Knudsen) RCS Publishing 2014.
- Human biomonitoring: facts and figures. Copenhagen: WHO Regional Office for Europe, 2015.
- Markert, B.A., Breure A.M., Zechmeister, H.G. (Eds), 2003. Bioindicators & Biomonitoring, Principles, Concepts and Applications (Trace Metals and Other Contaminants in the Environment 6), 997 str., Elsevier,
- Mulgrew, A., Williams, P., 2000. Biomonitoring of air quality using plants.. Air Hygiene Report 10, Monitoring and Assessment Research Centre WHO Collaborating Centre for Air Quality Management and Air Pollution Control FEA Berlin & Monitoring and Assessment Research Centre WHO Collaborating Centre for Monitoring and Assessment, King's College London, 164 str., ISSN 0938-9822.

Cilji in kompetence:

Glavni cilj predmeta je doseči usposobljenost in čim večjo percepcijsko širino študentov pri razumevanju bioindikatorjev v okolju in pri ljudeh.

Študent bo ob zaključku sposoben:

- Razumeti stanja v kopenskih in vodnih ekosistemih v povezavi z antropogenimi vplivi s pomočjo rastlin, živali, gliv, mikroorganizmov kot indikatorskih organizmov.
- Obvladovati principe in pomen uporabe organizmov za sledenje stanja okolja v vodnih in kopenskih ekosistemih v primerjavi s fizikalno-kemičnimi meritvami.
- Razumeti različne načine (odzivne, akumulatorske, monitorje) in ravni (celica, organizem, populacija; zgradba, funkcija, produkcija) uporabe bioindikatorjev za sledenje

Objectives and competences:

The main objective of the course is to achieve the qualification and maximum perception of students in the understanding of bioindicators in the environment and in humans.

The student will be able to:

- Understand the conditions in terrestrial and aquatic ecosystems in connection with anthropogenic influences with the help of plants, animals, fungi, microorganisms as indicator organisms.
- To master the principles and significance of the use of organisms for monitoring the state of the environment in aquatic and terrestrial ecosystems compared to physical and chemical measurements.
- Understand different ways (response, battery,

vnoša najpogostejših zračnih onesnažil v naravne in antropogene kopenske ekosisteme glede na vrsto onesnaženja.

- Razumeti pomen humanega biomonitoringa v kontekstu ocene zunanje in notranje izpostavljenosti ljudi in pri okoljski oceni učinkov na zdravje.

monitors) and levels (cell, organism, population, structure, function, production) of using bioindicators to track the most frequent air pollutants entering natural and anthropogenic terrestrial ecosystems, depending on the type of pollution.

- Understand the importance of human biomonitoring in the context of external and exposure assessment in humans and environmental health impact assessment.

Predvideni študijski rezultati (izidi):

Znanje in razumevanje:

- Osnovni principi bioindikacije/biomonitoringa
- Metode uporabe bioindikacije/biomonitoringa

Študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili:

- Pregled najbolj pogostih metod biomonitoringa glede na vrsto ekosistema, način onesnaževanja in tip onesnažila
- Sposobnost uporabe biomonitoringa za specifični primer
- Povezava okoljskega biomonitoringa z različnimi tehnologijami in drugimi fizikalno-kemijskimi metodami.

Prenesljive/ključne spretnosti in drugi atributi:

- Uporaba domače in tuje literature
- Pridobivanje sposobnosti celovitega razumevanja okoljskega in humanega biomonitoringa v kontekstu varstva okolja
- Vključevanje znanja v gradnjo hipotez za reševanje problemov, ciljano k temi doktorata

Intended learning outcomes:

Knowledge and Understanding:

- Basic principles of bioindication / biomonitoring
- Methods of using bioindication / biomonitoring

Students successfully completing this course will acquire:

- Overview of the most frequent biomonitoring methods according to the type of ecosystem, pollution type and type of pollutant
- Ability to use biomonitoring for a specific case study
- Linking environmental biomonitoring with different technologies and other physicochemical methods.

Transferable / Key Skills and other attributes:

- Use of national and international literature
- Acquiring the capability of a comprehensive understanding of environmental and human biomonitoring in the context of environmental protection
- Incorporation of knowledge into the construction of hypotheses for problem solving, thematically linked to postgraduate thesis

Metode poučevanja in učenja:

Sistematična predavanja

- razgovor
- reševanje problemov
- eksperimentalno delo

Terensko delo

- praktični primeri.

Learning and teaching methods:

Systematic lectures

- conversation
- problem solving
- experimental work

Fieldwork

- practical examples.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminarska naloga	25 %	Seminar work
Ustni izpit.	50 %	Oral exam.
Zagovor seminarske naloge, pri katerem dokaže osvojitve vseh študijskih izidov z vsaj po enim konkretnim primerom.	25 %	Defense of the seminar work where the student demonstrates the achievement of all learning outcomes with at least one specific case for each outcome.

Reference nosilca / Lecturer's references:

HORVAT, Milena. Environmental biomonitoring as a tool in risk and impact assessment associated with post-conflict restoration and rehabilitation. V: MACHLIS, Gary E. (ur.). Warfare ecology : a new synthesis for peace and security : [proceedings of the NATO advanced research workshop on Warfare ecology: synthesis, priorities and policy implications for peace and security, Vieques, Puerto Rico, 10-12 December 2009], (NATO science for peace and security series, ISSN 1874-6519, C, Environmental security). Dordrecht: Springer. cop. 2011, str. 189-197

HORVAT, Milena, SNOJ TRATNIK, Janja, MIKLAVČIČ VIŠNJEVEC, Ana. Mercury : biomarkers of exposure and human biomonitoring. V: KNUDSEN, Lisbet E. (ur.), MERLO, Domenico Franco (ur.). Biomarkers and human biomonitoring. Volume 1, Ongoing programs and exposures, (Issues in toxicology). Cambridge: Royal Society of Chemistry. 2011, str. 381-417.

HORVAT, Milena, ŠLEJKOVEC, Zdenka, FALNOGA, Ingrid. Arsenic : biomarkers of exposure and human biomonitoring. V: KNUDSEN, Lisbet E. (ur.), MERLO, Domenico Franco (ur.). Biomarkers and human biomonitoring. Volume 1, Ongoing programs and exposures, (Issues in toxicology). Cambridge: Royal Society of Chemistry. 2011, str. 418-445.

SARIGIANNIS, Dimosthenis, HORVAT, Milena, MAZEJ, Darja, SNOJ TRATNIK, Janja, KOČMAN, David, et al., EGOROV, Andrey I. (urednik). Human biomonitoring : facts and figures. Copenhagen: WHO = World Health Organization, 2015. XIII, 88 str., ilustr. [COBISS.SI-ID 28620839]

DEN HOND, Elly, HORVAT, Milena, MAZEJ, Darja, SNOJ TRATNIK, Janja, et al. First steps toward harmonized human biomonitoring in Europe : demonstration project to perform human biomonitoring on a European scale. Environmental health perspectives, ISSN 0091-6765, 2015, vol. 123, no. 3, str. 255-263, doi: 10.1289/ehp.1408616. [COBISS.SI-ID 28197671]