UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Mikrobni biosenzorji: celice in celične komponente, populacije ter združbe
Course title:	Microbial biosensors: cells and cellular component, populations and communities

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Senzorske tehnologije, 3. stopnja	/	1	1
Sensor Technologies, 3rd cycle	/	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	ST3-544

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 transfered to individual work.*

Nosilec predmeta / Lecturer:	Doc. dr. Aleš Lapanje

Jeziki / Languages:	**Predavanja / Lectures:**	Slovenski ali angleški / Slovene or English
	Vaje / Tutorial:	Slovenski ali angleški / Slovene or English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Zaključen študij druge stopnje ustrezne (naravoslovne ali tehniške) smeri ali zaključen študij drugih smeri z dokazanim poznavanjem osnov področja predmeta (pisna dokazila, pogovor).	Completed second cycle studies in natural sciences or engineering or completed second cycle studies in other fields with proven knowledge of fundamentals in the field of this course (certificates, interview).

Vsebina:	**Content (Syllabus outline):**
• Tipi mikrobnih biosenzorjev. • Prednosti in slabosti mikrobnih biosenzorjev. • Principi delovanja biosenzorjev, temelječih na posameznih komponentah mikrobnih celic (DNA, RNA, proteini). • Principi delovanja celičnih mikrobnih biosenzorjev in opredelitev senzorja, transducerja in efektorja na mikrobni ravni. • Problemi in rešitve vključevanja mikrobnih biosenzorjev v aparature – izzivi biomehatronike. • Nove tehnologije mikrobnih biosenzorjev – uporaba MFC (Microbial Fuel Cell) komponent.	• Types of microbial biosensors. • Advantages and disadvantages of properties and use of microbial biosensors. • Principles of functioning of the components of biosensors which are based on cellular parts (DNA, RNA, proteins). • Principles of functioning of biosensor devices based on microbial cells and their components by determination of sensing components, transducers and effectors. • Solutions of common problems in devices based on the microbial biosensors – challenges for mechatronic approaches.

• Opredelitev mikrobnih združb kot biosenzorjev, tehnike njihove uporabe ter analize – prikaz hitrih genomskih in metagenomskih analitičnih pristopov in integracija komputacijske biologije. • Razvoj novih tehnik pridobivanja receptorjev iz nekulturabilnih mikroorganizmov. • Mikroorganizmi kot analit: detekcija mikroorganizmov in ugotavljanja njihove številčnosti v vzorcih.	• Novel emerging technologies – use of MFC (Microbial fuel cells) and their components. • Defining microbial communities as the sensing components of biosensors, techniques of use of analysis of microbial communities – rapid genomic and metagenomic screening and implementation of tools of computation biology. • Development of new techniques for extracting new receptors from nonculturable microbial cells. • Microorganisms as an analytes: detection of microorganisms and their quantification.

Temeljni literatura in viri / Readings:

Knjige / Books:

- Principles of Bacterial Detection: Biosensors, Recognition Receptors and Microsystems. Zourob, Mohammed; Elwary, Sauna; Turner, Anthony P. F. (Eds.), 2008, Springer.
- Metagenomics: Current Innovations and Future Trends. Diana Marco (Eds.), 2011, Caister Academic Press.
- Chemical Sensors and Biosensors: Microbial Biosensors for Environmental Applications. René Lalauze, Gérald Thouand, Marie José Duran, 2013, John Wiley & Sons.

Revije / Periodicals:

- Biosensors and Bioelectronics, Elsevier.
- Analytical Chemistry, ACS.
- Biotechnology and applied biochemistry, Wiley.
- Microbiome, BMC.

Cilji in kompetence:	**Objectives and competences:**
Cilji: Študent: • razume verzatilnost in smiselnost uporabe mikroorganizmov, od molekularnega do družbenega nivoja, uporabljenih v senzorskih tehnologijah, • je sposoben kritično ovrednotiti meritve s pomočjo mikrobnih biosenzorjev (npr. mutabilnost, adaptacija, toksičnost...), • razume koncept biološke dostopnosti ter zna določiti kvaliteto izmerjenih podatkov iz okoljskih meritev, • razume specifičnost integracije mikrobnih biosenzorjev in njihovih posameznih komponent s končnimi aparaturami, • zna uporabiti pristope za odkrivanje novih senzorskih komponent iz nekulturabilnih mikroorganizmov. Kompetence:	Objectives: • to understand versatility and reasonable use of microoorganisms and their components in sensor technologies from molecular up to the community level of organisation, • is able to critically evaluate measurements based on microorganisms (e.g. mutability, adaptation, toxicity etc.), • to understand concept of bioavailability and is able to determine quality of measured data particularly from environmental measurements, • to understand peculiarity of integration of microbial biosensors and their components with aparatures, • utilise methods for obtaining new sensing components from unculturable microroganisms. Competency: • integration of microbial biosensors within complex devices and their evaluation based on specificity, dinamic range and sensitivity,

• integracija mikrobnih biosenzor v kompleksne naprave ter ovrednotenje delovanja mikrobnega biosenzorja z vidika specifičnosti, dinamičnega območja in občutljivosti, • interpretacija in uporaba pridobljenih podatkov iz mikrobnih senzorjev, • uporablja metode iskanja novih mikrobnih senzorskih komponent.	• interpretation and utilisation of obtained data from microbial biosensors, • utilise methods for obtaining novel sensing components from microorganisms.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: • študent bo z uspešno zaključenim predmetom razumel, kje so do sedaj omejitve uporabe mikrobnih senzorjev, pri čemer bo na podlagi svojega osnovnega znanja podal potencialne poti novih pristopov izogibanju omejitev, • študent bo znal interdisciplinarno povezovati znanje molekularne biologije, biokemije, fizike, kemije in mikrobne biotehnologije z namenom priprave mikrobnih senzorjev, • študent bo znal ločiti med interpretacijo kemijskih in mikrobnih meritev ter bo lahko pri svojem delu izbral metode meritve glede na relevantnost rezultatov pri konkretnem primeru, • na podlagi prikaza konkretne problematike bo študent znal določiti katero metodo in kdaj jo je potrebno uporabiti pri iskanju in uporabi mikrobnih senzorskih komponent.	Knowledge and understanding: • student with successfully finished course will gain the understanding of the current limitations of microbial biosensors. Moreover, based on her or his knowledge they are going to determine potential research approaches for bypassing current limitations, • students will expand his problem solving approaches by the interdisciplinary use of molecular biology, physics, chemistry, microbial biotechnology and similar, • students are going to know to interpret results from chemical and microbial based measurements, respectively. They will gain knowledge to use appropriate method for relevant measurements, • based on the demonstration of the real problems, students will know to determine which and when the appropriate method can be used for searching and use of microbial based sensing components.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• interaktivno oblikovanje podajanja osnov za nadaljnje delo na nivoju višjih kognitivnih procesov, • vlečenje paralel s teoretičnim znanjem na podlagi konkretnih znanih primerov iz (i) znanstvenih objav, (ii) konkretnega raziskovalnega dela in (iii) s področja raziskovalnega dela, ki ga raziskuje študent, • s pomočjo modularne aparature, ki omogoča manipuliranje mikrobnih biosenzorjev, generiranje in testiranje raziskovalnih idej, kjer se pričakuje horizontalni način razmišljanja (off track), • interaktivno delo s študentom na raziskovalnih problemih, ki jih ima študent pri svojem raziskovalnem delu (definiranje problema,	Interactive work with a student. • interactive description of basic concepts for further research as well as mental work based on higher cognitive processes, • use of theoretical basics in finding solutions for the real problems from the (i) scientific publications, (ii) real research work and (iii) research work of the PhD research project of the student, • using modular device for development of concepts and testing research hypotheses with high expectance of off track thinking methods, • interactive consultation based on the research problems of the specific students research work (defining the problem, finding solutions and

podajanje rešitev tega problema in iskanje paralelnih rešitev v končnem dizajnu in re-dizajnu poskusov in pristopov), • pri skupini študentov z različnim predznanjem je pristop multidisciplinaren pri posameznem konkretnem primeru, ki jih vsak od študentov predstavi in se rešuje skupinsko iz različnih zornih kotov.	parallelisation of final solutions as well as redesigning of the experiments and approaches), • group of students with various backgrounds, the teaching method will be especially multidisciplinary based on the research problems of each students and solutions provided by the team of students (solutions of the case problems).

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga.	20 %	Seminar work.
Ustni izpit.	5 %	Oral exam.
Zagovor projekta – reševanje primera.	75 %	Project defence – solving a case.

Reference nosilca / Lecturer's references:

- KOVAČ VIRŠEK, Manca, HUBAD, Barbara, LAPANJE Aleš, Aquatic Toxicology, 2013, vol. 144, str. 208 – 217.
- HUBAD, Barbara, LAPANJE, Aleš. Inadequate hospital ventilation system increases the risk of nosocomial Mycobacterium tuberculosis. J. hosp. infect., 2012, vol. 80, no. 1, str. 88-91.
- FAVET, Jocelyne, LAPANJE, Aleš, GIONGO, Adriana, KENNEDY, Suzanne. Microbial hitchhikers on intercontinental dust : catching a lift in Chad. ISME j. (Print), 2013, vol. 7, issue 4, str. 850-867.
- ZRIMEC, Jan, KOPINČ, Rok, RIJAVEC, Tomaž, ZRIMEC, Tatjana, LAPANJE, Aleš. Band smearing of PCR amplified bacterial 16S rRNA genes: dependence on initial PCR target diversity. J. microbiol. methods. [Print ed.], Nov. 2013, vol. 95, no. 2, str. 186-194.