UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Sintezna biologija in biosenzorika
Course title:	Synthetic Biology and Biosensing

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 level	/	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	ST3-541

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
10	**10**			**30**	**250**	**10**

**Navedena porazdelitev ur velja, če je vpisanih vsaj 10 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 10 students are enrolled. Otherwise the contact hours are linearly reduced and transfered to individual work.*

Nosilec predmeta / Lecturer:	Prof. dr. Tamara Lah Turnšek Prof. dr. Henning Ulrich

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 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:	**Content (Syllabus outline):**
• Uvod: koncept biosenzorjev: biološki mehanizmi, zaznavni in prevodni sistemi (več predavateljev). • Sintezna biologija: uvajanje in priprave novih umetnih bioloških poti, organizmov ali novo preurejanje iz obstoječih naravnih bioloških sistemov za biotehnološke namene in v diagnostiki ter zdravljenju. • Uporaba DNA in RNA inženiringa za namene ustvarjanja osnovnih bioloških komponent. • Inženiring bioloških snovi osnovanih na regulatornih zankah RNA. • RNA molekule za programiranje genskega	• Introduction: Concept of biosensors: Biological mechanisms, detection and translation systems (more authors). • Synthetic biology: Introducing the concept and construction of novel artificial biological pathways, organisms, or the redesign of existing natural biological systems for purposes of biotechnology, diagnostics and therapy. • Application of DNA and RNA engineering principles to design the fundamental biological components. • Engineering of biological substances, based on RNA regulatory loops.

izražanja in odziv majhnih molekul za uporabo kot biosenzorji. • RNA in DNA aptameri v biosenzoriki: principi in uporaba v primerjavi s klasičnimi testi uporabe (protitelesa). • Novi pristopi v zaznavanju metabolitov in proteinov v živih celicah z RNA aptameri. • Aptameri za zaznavanje matičnih in rakavih celic in patogenih organizmov. • On-chip proteinske mreže za multipleksna SPRI merjenja v raziskavah in klinični uporabi. • Alosterični ribozimi in deoksi ribozimi kot biosenzorji. • Biosenzorji na osnovi RNA in DNA v varovanju okolja in varne hrane. • Biosensorji v raziskavah raka: tehnologije biomarkerjev.	• RNA molecules for programming gene expression in response to small molecules. Applications for biosensorics. • RNA and DNA aptamers for biosensorics: Principles and applications vs. classical (antibody-based) assays. • New approaches for sensing metabolites and proteins in live cells using RNA aptamers. • Aptamers for detection of stem, cancer cells and pathogenic organisms. • On-chip protein microarray for multiplexed SPRI biosensing measurements in research and clinical application. • Allosteric ribozymes and deoxy-ribozymes as biosensors. • RNA- and DNA-derived biosensors in environmental protection and food safety. • Biosensors in cancer research: Biomarkers technologies.

Temeljni literatura in viri / Readings:

- Arugula MA, Zhang Y, Simonian A. Biosensors as 21st Century technology for detecting Genetically Modified Organisms in food and feed. Anal Chem. 2013 Oct 2. [Epub ahead of print
- Bacchus W, Aubel D, Fussenegger M. Biomedically relevant circuit-design strategies in mammalian synthetic biology. Mol Syst Biol. 2013 Sep 24;9:691.
- Bacchus W, Fussenegger M. Engineering of synthetic intercellular communication systems. Metab Eng. 2013 Mar;16:33-41. doi: 10.1016/j.ymben.2012.12.001.
- Benenson Y. Synthetic biology with RNA: progress report. Curr Opin Chem Biol. 2012 Aug;16(3-4):278-84.
- Breaker RR. Engineered allosteric ribozymes as biosensor components. Curr Opin Biotechnol. 2002 Feb;13(1):31-9. Review.
- Chen Y, Nakamoto K, Niwa O, Corn RM. On-chip synthesis of RNA aptamer microarrays for multiplexed protein biosensing with SPR imaging measurements. Langmuir. 2012 Jun 5;28(22):8281-5.
- Liu J, Cao Z, Lu Y. Functional nucleic acid sensors. Chem Rev. 2009 May;109(5):1948-98.
- McKeague M, Giamberardino A, DeRosa MC. Advances in Aptamer-Based Biosensors for Food Safety. In: "Environmental Biosensors", book edited by Vernon Somerset, ISBN 978-953-307-486-3, InTech, 2011
- Paige JS, Nguyen-Duc T, Song W, Jaffrey SR. Fluorescence imaging of cellular metabolites with RNA. Science. 2012 Mar 9;335(6073):1194.
- Robert S. Marks, Christopher R. Lowe, David C. Cullen, Howard H. Weetall, Isao Karube. Handbook of Biosensors and Biochips. Wiley 2007, ISBN: 978-0-470-01905-4.
- Šmuc T, Ahn IY, Ulrich H. Nucleic acid aptamers as high affinity ligands in biotechnology and biosensorics. J Pharm Biomed Anal. 2013 Jul-Aug;81-82:210-7
- Strehlitz B, Reinemann C, Linkorn S, Stoltenburg R. Aptamers for pharmaceuticals and their application in environmental analytics. Bioanal Rev. 2012 Mar;4(1):1-30.
- Ulrich H, Wrenger C. Disease-specific biomarker discovery by aptamers. Cytometry A. 2009 Sep;75(9):727-33
- Win MN, Liang JC, Smolke CD. Frameworks for programming biological function through RNA parts and devices. Chem Biol. 2009 Mar 27;16(3):298-310.

- Zimbres FM, Tárnok A, Ulrich H, Wrenger C. Aptamers: Novel Molecules as Diagnostic Markers in Bacterial and Viral Infections? Biomed Res Int. 2013;2013:731516.

Cilji in kompetence:

- Razumeti biologijo RNA in DNA ter sodobne tehnologije biosenzorjev na njeni osnovi.
- Sposobnost načrtovati in vrednotiti pristope za razvoj biosenzorjev.
- Razumeti, kako lahko umetni tokokrog (v sintezni biologiji) uporabimo za biosenzorje.
- Razumeti interdisciplinarni pristop.

Kompetence:

- Znati samostojno uporabljati interedisciplinarne pristope pri razvoju in pripravi biosenzorjev na osnovi nukleinskih kislin.

Objectives and competences:

- Comprehension of RNA and DNA biology and state-of-the art techniques for biosensors.
- Ability to design and evaluate approaches for biosensor development.
- How artificial circuits (synthetic biology) can be used for biosensor approaches.
- Understanding of the importance of interdisciplinary approaches.

Competence

- Independent use of tolls to develop the interdisciplinary approach in preparation of nuclear acids base biosensors.

Predvideni študijski rezultati:

Znanje in razumevanje:

- Interdisciplinarnih pristopov.
- Osvojeno znanje predavanj.
- Ustvarjanje neodvisnega mišljenja v raziskavah.

Intended learning outcomes:

Knowledge and understanding of:

- Interdisciplinary approaches.
- Knowledge on taught subjects.
- Formation of independent researcher´s skills.

Metode poučevanja in učenja:

- Predavanja profesorjev.
- Interaktivno obravnavanje novih objav iz izbranih področij raziskav s profesorjem.
- Seminar študentov.
- Praktična projektna naloga s področja razvoja biosenzorja.

Learning and teaching methods:

- Lectures by the professor.
- Discussion groups where student read selected papers and discuss their content with the professor.
- Students' seminars.
- Practical project in the biosensors field.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ustni izpit.	50 %	Oral examination.
Seminarska / projektna naloga.	50 %	Seminar / Project for biosensor-development.

Reference nosilca / Lecturer's references:

- TORSVIK, Anja, PRIMON, Monika, LAH TURNŠEK, Tamara, MOTALN, Helena. Spontaneous malignant transformation of human mesenchymal stem cells reflects cross-contamination: putting the research field on track - letter. Cancer res. (Baltimore), 2010, 70, 15, 6393-6396.
- MOTALN, Helena, SCHICHOR, Christian, LAH TURNŠEK, Tamara. Human mesenchymal stem cells and their use in cell-based therapies. Cancer (Print), 2010, vol. 116, no. 11,. 2519-2530.
- SCHICHOR Christian , ALBRECHT Valerie , KORTE , Benjamin, BUCHNER, Alexander , BUCHNER Rainer, MYSLIWIETZ Josef, PARON Igor, MOTALN, Helena, LAH TURNŠEK, Tamara, JÜRCHOTT Kathrin , SELBIG Joachim, TONN Joerg-Christian. Mesenchymal stem cells and glioma cells form a structural as well as a functional syncytium in vitro. Exp. neurol., 2012, vol. 234, issue 1,. 208-219.
- MOTALN, Helena, GRUDEN, Kristina, HREN, Matjaž, SCHICHOR, Christian, PRIMON, Monika, ROTTER, Ana, LAH TURNŠEK, Tamara. Human mesenchymal stem cells exploit the immune response mediating

chemokines to impact the phenotype of glioblastoma. Cell transplant. 2012, vol. 21, no. 7, str. 1529-1545.

- TORKAR, Ana, BREGANT, S., DEVEL, Laurent, NOVINEC, Marko, LENARČIČ, Brigita, LAH TURNŠEK, Tamara, DIVE, Vincent. A novel photoaffinity-based probe for selective detection of cathepsin L active form. ChemBioChem. 2012, vol. 13, issue 17, 2616-2621.