

## BIOTEHNOLOGIJA – TEORETIČNI PREDMETI

### UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Animalna biotehnologija
Course title:	Animal biotechnology

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3782
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	20	0	0	25	185	10

Nosilec predmeta/Lecturer:	Peter Dovč
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Izvajalci predavanj:	Peter Dovč, Gregor Gorjanc, Tanja Kunej, Mojca Narat
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
splošni pogoji za vpis na doktorski študij	general requirement for the enrollment to the doctoral programme

Vsebina:	Content (Syllabus outline):
Predmet obsega najpomembnejša področja animalne biotehnologije, njihov razvoj in aktualne raziskovalne probleme. Vsebina predmeta je razdeljena na pet poglavij: 1. Pregled razvoja animalne biotehnologije s poudarkom na razvoju metod transgeneze in	The subject addresses the most important areas of animal biotechnology, their development and present research problems. The content is organized in five chapters: 1. Review of development in animal biotechnology with special accent on

molekularnih markerjev za upravljanje z živalskimi genskimi viri. 2. Imunske tehnologije v animalni biotehnologiji. 3. Epigenetski mehanizmi, ki uravnavajo izražanje genov. 4. Razvoj živalskih modelov za biomedicinske študije. 5. Upravljanje velikih podatkovnih zbirk in genomska selekcija.	technology of transgenesis. 2. Immune technologies in animal biotechnology. 3. Epigenetic mechanisms regulating gene expression. 4. Development of animal models for biomedical research. 5. Management of big datasets and genomic selection.
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Temeljna literatura in viri/Readings:	
<ul style="list-style-type: none"> <li>• Paterson, A.H.: Molecular Dissection of complex traits. CRC Press, 1998, New York</li> <li>• Liu, B.H.: Statistical Genomics. CRC Press, 1998, New York</li> <li>• Hofman M., Anne J.: Biotechnology in Animal Husbandry. Kluwer Academic Publishers, 2001, Dordrecht</li> <li>• Babiuk, L., Phillips, J.P.: Animal Biotechnology, Pergamon press, 1989, Oxford</li> <li>• revijalni članki s področja, tekoča periodika, druga učna gradiva...«</li> </ul>	

Cilji in kompetence:	Objectives and competences:
Pridobiti pregled nad najpomembnejšimi področji raziskav v animalni biotehnologiji in seznanitev z osnovnimi metodološkimi pristopi. Študentje naj bi tako dobro poznali področje, da bi lahko kompetentno presojali različne raziskovalne pristope in bili sposobni prepoznati možnosti za tehnološki preboj.	Gaining the overview in the most important areas of research in animal biotechnology and getting acquainted with the basic methodological approaches. Students should be able to judge critically different research approaches and to develop the ability to recognize possibilities for technological break through.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Temelječ na znanju genetike, molekularne biologije, fiziologije in statistike naj bi se študent seznanil s stanjem v animalni biotehnologiji in se usposobil za sledenje razvoja tega znanstvenega področja.	Knowledge and understanding: Based on their knowledge in genetics, molecular biology, physiology and statistics should students get informed about the research challenges in animal biotechnology and develop skills to follow advancements in this field of research.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja (pet predavateljev, skupno 20 ur predavanj). Prirava seminarskega dela pri enem od predavateljev, konzultacije za pripravo seminarja. Samostojen študij	Lectures (five lecturers, cumulative 20 hours of lectures) Preparation of the seminar under the guidance of one of the lecturers, consultations during the preparation of the seminar. Individual study

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit	40,00 %	Exam
Seminar (pisni izdelek)	40,00 %	Seminar (written version)
Predstavitev in zagovor seminarja	20,00 %	Presentation and defence of the seminar

Reference nosilca/Lecturer's references:

Nosilec, P. DOVČ:

1. BENČINA, Mateja, CIZELJ, Ivanka, BERČIČ, Rebeka Lucijana, NARAT, Mojca, BENČINA, Dušan, DOVČ, Peter. Shared epitopes of avian immunoglobulin light chains. *Veterinary Immunology and Immunopathology*, ISSN 0165-2427. [Print ed.], 2014, in press.
2. JEVŠINEK SKOK, Daša, GODNIČ, Irena, ZORC, Minja, HORVAT, Simon, DOVČ, Peter, KOVAČ, Milena, KUNEJ, Tanja. Genome-wide in silico screening for microRNA genetic variability in livestock species. *Animal genetics*, ISSN 0268-9146, 2013, vol. 44, no. 6, str. 669-677.
3. SIMČIČ, Mojca, LENSTRA, J.A., BAUMUNG, R., DOVČ, Peter, ČEPON, Marko, KOMPAN, Drago. On the origin of the Slovenian Cika cattle. *Journal of animal breeding and genetics*, ISSN 0931-2668, 2013, vol. 130, no. 6, str. 487-495.
4. GODNIČ, Irena, ZORC, Minja, JEVŠINEK SKOK, Daša, CALIN, George Adrian, HORVAT, Simon, DOVČ, Peter, KOVAČ, Milena, KUNEJ, Tanja. Genome-wide and species-wide in silico screening for intragenic microRNAs in human, mouse and chicken. *PLoS one*, ISSN 1932-6203, 2013, vol. 8, no. 6, str. 1-14, e-65165.
5. CIRKVENČIČ, Nina, NARAT, Mojca, DOVČ, Peter, BENČINA, Dušan. Distribution of chicken cathepsins B and L, cystatin and ovalbumin in extra-embryonic fluids during embryogenesis. *British Poultry Science*, ISSN 0007-1668, 2012, vol. 53, no. 5, str. 623-630.
6. ZORC, Minja, JEVŠINEK SKOK, Daša, GODNIČ, Irena, CALIN, George Adrian, HORVAT, Simon, JIANG, Zhihua, DOVČ, Peter, KUNEJ, Tanja. Catalog of MicroRNA seed polymorphisms in vertebrates. *PLoS one*, ISSN 1932-6203, 2012, vol. 7, no. 1, str. 1-8, e30737.
7. OGOREVC, Jernej, DOVČ, Peter, KUNEJ, Tanja. Comparative genomics approach to identify candidate genetic loci for male fertility. *Reproduction in domestic animals*, ISSN 0936-6768, 2011, vol. 46, str. 229-239.
8. TERČIČ, Dušan, HOLCMAN, Antonija, DOVČ, Peter, MORRICE, D.R., BURT, David, HOCKING, Paul M., HORVAT, Simon. Identification of chromosomal regions associated with growth and carcass traits in an F3 full sib intercross line originating from a cross of chicken lines divergently selected on body weight. *Animal genetics*, ISSN 0268-9146, 2009, vol. 40, no. 5, str. 743-748.
9. IVANKOVIĆ, Ante, RAMLJAK, Jelena, DOVČ, Peter, KELAVA, Nikolina, KONJAČIĆ, Miljenko. Genetic structure of three Croatian horse breeds : implications for their conservation strategy. *Italian Journal of Animal Science*, ISSN 1594-4077, 2009, vol. 8, str. 677-689.
10. KAVAR, Tatjana, ČEH, Eva, DOVČ, Peter. A simplified PCR-based method for detection of gray coat color allele in horse. *Molecular and cellular probes*, ISSN 0890-8508, 2012, vol. 26, no. 6, str. 256-258.

Tanja Kunej, izvajalka:

1. FERDIN, Jana, NISHIDA, Naohiro, WU, X., NICOLOSO, Milena S., SHAH, Muhammad Yasin, DEVLIN, C., LING, H., SHIMIZU, Masayoshi, KUMAR, K., CORTEZ, Maria Angelica, FERRACIN, M., BI, Y., YANG, Decheng, CZERNIAK, Bogdan, ZHANG, Wei, SCHMITTGEN, T. D., VOORHOEVE, M. P., REGINATO, M. J., NEGRINI, M., DAVULURI, Ramana V., KUNEJ, Tanja, IVAN, M., CALIN, George Adrian. HINCUTs in cancer : hypoxia-induced noncoding ultraconserved transcripts. *Cell death and differentiation*, ISSN 1350-9047, 2013, vol. 20, no. 12, str. 1675-1687.
2. KUNEJ, Tanja, GODNIČ, Irena, FERDIN, Jana, HORVAT, Simon, DOVČ, Peter, CALIN, George A. Epigenetic regulation of microRNAs in cancer : an integrated review of literature. *Mutation Research*, ISSN 0027-5107.
3. NICOLOSO, Milena S., SUN, Hao, SPIZZO, Riccardo, KIM, Hyunsoo, WICKRAMASINGHE, Priyankara, SHIMIZU, Masayoshi, WOJCIK, Sylwia E., FERDIN, Jana, KUNEJ, Tanja, XIAO, Lianchun, MANOUKIAN, Siranoush, SECRETO, Giorgio, RAVAGNANI, Fernando, WANG, Xuemei, RADICE, Paolo, CROCE, Carlo M., DAVULURI, Ramana V., CALIN, George A. Single-nucleotide polymorphisms inside microRNA target sites influence tumor susceptibility. *Cancer research*, ISSN 0008-5472, 2010, vol. 70, no. 7, str. 2789-2798,
4. KUNEJ, Tanja, JEVŠINEK SKOK, Daša, HORVAT, Simon, DOVČ, Peter, JIANG, Zhihua. The glypican 3-hosted murine Mir717 gene : sequence conservation, seed region polymorphisms and putative targets. *International journal of biological sciences*, 2010, vol. 6, no.7, str. 769-772.
5. KUNEJ, Tanja, WU, Xiao-Lin, MICHAL, Jennifer J., MILOŠEVIČ BERLIČ, Tamara, JIANG, Zhihua, DOVČ, Peter. The porcine mitochondrial transcription factor a gene : molecular characterization, radiation hybrid mapping and genetic diversity among 12 pig breeds. *American journal of animal and veterinary sciences*, ISSN 1557-4555, 2009, vol. 4, no. 4, str. 129-135.

- JIANG, Zhihua, MICHAL, Jennifer J., CHEN, Jie, DANIELS, Tyler F., KUNEJ, Tanja, GARCIA, Matthew D., GASKINS, Charles Thorne, BUSBOOM, Jan Roger, ALEXANDER, Leeson J., WRIGHT, Raymond W., MACNEIL, Michael D. Discovery of novel genetic networks associated with 19 economically important traits in beef cattle. *International journal of biological sciences*, 2009, vol. 5, no. 6, str. 528-542.

Mojca Narat, izvajalka

- COLJA VENTURINI, Anja, BRESJANAC, Mara, VRANAC, Tanja, KOREN, Simon, NARAT, Mojca, POPOVIĆ, Mara, ČURIN-ŠERBEC, Vladka. Anti-idiotypic antibodies : a new approach in prion research. *BMC immunology*, ISSN 1471-2172, 2009, vol. 10, article 16, on line. <http://www.biomedcentral.com/1471-2172/10/16>, doi: [10.1186/1471-2172-10-16](https://doi.org/10.1186/1471-2172-10-16). [COBISS.SI-ID 2440072]
- DUŠANIĆ, Daliborka, BENČINA, Dušan, OVEN, Irena, CIZELJ, Ivanka, BENČINA, Mojca, NARAT, Mojca. Mycoplasma synoviae induces upregulation of apoptotic genes, secretion of nitric oxide and appearance of an apoptotic phenotype in infected chicken chondrocytes. *Veterinary research*, ISSN 1297-9716, 2012, vol. 43, no. 7, str. 1-14. <http://www.veterinaryresearch.org/content/pdf/1297-9716-43-7.pdf>, doi: [10.1186/1297-9716-43-7](https://doi.org/10.1186/1297-9716-43-7). [COBISS.SI-ID 3013768]
- CIZELJ, Ivanka, BERČIČ, Rebeka Lucijana, DUŠANIĆ, Daliborka, NARAT, Mojca, KOS, Janko, DOVČ, Peter, BENČINA, Dušan. Mycoplasma gallisepticum and Mycoplasma synoviae express a cysteine protease CysP, which can cleave chicken IgG into Fab and Fc. *Microbiology*, ISSN 1350-0872, 2011, vol. 157, no. 2, str. 362-372. <http://mic.sgmjournals.org/cgi/content/abstract/157/2/362?maxtoshow=&hits=10&RESULTFORMAT=&author1=Clyelj+&andor exactfulltext=and&searchid=1&FIRSTINDEX=0&sortspec=relevance&resourcetype=HWCIT>, doi: [10.1099/mic.0.045641-0](https://doi.org/10.1099/mic.0.045641-0). [COBISS.SI-ID 2835848]
- SLAVEC, Brigita, BERČIČ, Rebeka Lucijana, CIZELJ, Ivanka, NARAT, Mojca, ZORMAN-ROJS, Olga, DOVČ, Peter, BENČINA, Dušan. Variation of vlhA gene in Mycoplasma synoviae clones isolated from chickens. *Avian pathology*, ISSN 0307-9457, 2011, vol. 40, no. 5, str. 481-489, doi: [10.1080/03079457.2011.604840](https://doi.org/10.1080/03079457.2011.604840). [COBISS.SI-ID 2941832]
- BENČINA, Mateja, CIZELJ, Ivanka, BERČIČ, Rebeka Lucijana, NARAT, Mojca, BENČINA, Dušan, DOVČ, Peter. Shared epitopes of avian immunoglobulin light chains. *Veterinary Immunology and Immunopathology*, ISSN 0165-2427. [Print ed.], 2014, in press. <http://www.sciencedirect.com/science/article/pii/S016524271400004X>, doi: [10.1016/j.vetimm.2014.01.003](https://doi.org/10.1016/j.vetimm.2014.01.003). [COBISS.SI-ID 3341192]
- DUŠANIĆ, Daliborka, BERČIČ, Rebeka Lucijana, CIZELJ, Ivanka, SALMIČ, Simona, NARAT, Mojca, BENČINA, Dušan. Mycoplasma synoviae invades non-phagocytic chicken cells in vitro. *Veterinary Microbiology*, ISSN 0378-1135. [Print ed.], 2009, issues 1-2, vol. 138, str. 114-119. [http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6TD6-4VRX66J-2&\\_user=4776866&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&\\_view=c&\\_acct=C000033658&\\_version=1&\\_urlVersion=0&\\_userid=4776866&md5=1ba21383c610c8913d8f625752ab6509](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TD6-4VRX66J-2&_user=4776866&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000033658&_version=1&_urlVersion=0&_userid=4776866&md5=1ba21383c610c8913d8f625752ab6509), doi: [10.1016/j.vetmic.2009.02.014](https://doi.org/10.1016/j.vetmic.2009.02.014). [COBISS.SI-ID 2439560]

Gregor Gorjanc, izvajalec

- Genetic prediction of complex traits: integrating infinitesimal and marked genetic effects  
C Carré, F Gamboa, D Cros, JM Hickey, G Gorjanc, E Manfredi (2013)  
*Genetica* 141 (4-6), 239-246
- Genomic evaluations using similarity between haplotypes  
JM Hickey, BP Kinghorn, B Tier, SA Clark, JHJ Werf, G Gorjanc (2013)  
*Journal of Animal Breeding and Genetics* 130 (4), 259-269
- Genotype Imputation to Increase Sample Size in Pedigreed Populations  
JM Hickey, MA Cleveland, C Maltecca, G Gorjanc, B Gredler, A Kranis (2013)  
*Methods in Molecular Biology* 1019, 395-410
- Simulated Data for Genomic Selection and Genome-Wide Association Studies Using a Combination of Coalescent and Gene Drop Methods

JM Hickey, G Gorjanc (2012)  
G3: Genes| Genomes| Genetics 2 (4), 425-427

5. Inference of genotype probabilities and derived statistics for PrP locus in the Jezersko–Solcava sheep

G Gorjanc, M Kovač, D Kompan (2010)  
Livestock Science 129 (1), 232-236

6. Congenic and bioinformatics analyses resolved a major-effect Fob3b QTL on mouse Chr 15 into two closely linked loci

Z Prevoršek, G Gorjanc, B Paigen, S Horvat (2010)  
Mammalian Genome 21 (3-4), 172-185

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Biodiagnostiki in biosenzorji
Course title:	Biodiagnostics and biosensors

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3783
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	15	0	0	10	90	5

Nosilec predmeta/Lecturer:	Janko Kos
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Izvajalci predavanj:	Janko Kos
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij.	General conditions for enrolment into doctoral course.

Vsebina:	Content (Syllabus outline):
<ul style="list-style-type: none"> <li>• Biološke makromolekule v analitiki</li> <li>• DNA/RNA testi</li> <li>• Imunski testi</li> <li>• Biosenzorji</li> <li>• Avtomatizirani procesi v diagnostiki</li> <li>• Razvoj novih diagnostičnih sredstev v laboratorijskem in industrijskem merilu</li> <li>• Kontrola in zagotavljanje kakovosti diagnostičnih sredstev</li> </ul>	<ul style="list-style-type: none"> <li>• Biological macromolecules in analytical processes</li> <li>• DNA/RNA assays</li> <li>• Immunoassays</li> <li>• Biosensors</li> <li>• Automated processes in diagnostics</li> <li>• Development of new diagnostic assays on laboratory and industrial scale</li> <li>• Quality control and assurance of diagnostic assays</li> </ul>

Temeljna literatura in viri/Readings:
<ol style="list-style-type: none"> <li>1. -Barth FG, Humphrey JAC: Sensors and sensing in Biology and Engineering. Springer, 2003, ISBN 321183771X</li> <li>2. -Wild D: The Immunoassay Handbook. Nature Pub. Group, ©2001, ISBN 0333723066 1561592706</li> <li>3. -Roitt I, Male D, Brostoff J: Immunology. Mosby, 1998, ISBN 0723421781</li> <li>3. Najnovejši pregledni članki s področja /The latest review articles from the field.</li> </ol>

Cilji in kompetence:	Objectives and competences:
<p>Predmet seznanja študente z uporabo bioloških makromolekul v različnih laboratorijskih diagnostičnih metodah in sredstvih. Študent spozna lastnosti bioloških makromolekul, njihovo sposobnost vezave ligandov in dejavnike, ki določajo njihovo specifičnost. Podani so načini njihovega pridobivanja in priprava stabilnih oblik. Seznanjeni so z vrstami diagnostičnih testov in biosenzorjev. Predstavljeno je njihovo delovanje, metodika priprave testov v laboratorijskem in industrijskem merilu in načini kontrole in zagotavljanja njihove kakovosti.</p>	<p>The students will learn about the application of biological macromolecules in laboratory diagnostic methods and devices. They will be informed on properties of biological macromolecules, their ability to bind ligands and on factors defining their specificity. The methods for their isolation and the preparation of stable forms will be presented. Students will be acquainted with types of diagnostic assays and biosensors. Their functioning, technologies for laboratory and large scale production and methods for quality control and assurance will be presented</p>

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje:	Knowledge and understanding:

Poznavanje delovanja biodiagnostikov in biosenzorjev omogoča uporabo teh testov za samozdravljenje, v kliničnih ter industrijskih biotehnoloških laboratorijih in s tem optimizacijo zdravljenja in biotehnoloških postopkov. i.	Understanding of biodiagnostics and biosensors enables the application for self treatment, in clinical and industrial biotechnological laboratories optimising the treatment and biotechnological processes..
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Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, seminarji, vodena diskusija, problemsko osnovano učenje, skupinsko delo.	Lectures, seminars, tutorial discussions, problem based learning, group learning.

Načini ocenjevanja:	Delež/Weight	Assessment:
1. opravljena seminarska naloga	40,00 %	1. Seminar
2. ustni izpit	60,00 %	2. oral exam

Reference nosilca/Lecturer's references:
<p><b>8. References:</b></p> <ol style="list-style-type: none"> <li>JØRGENSEN, Iben, KOS, Janko, KRAŠOVEC, Marta, TROELSEN, Lone, KLARLUND, Mette, JENSEN, Trine W., HANSEN, Michael S., JACOBSEN, Søren. Serum cysteine proteases and their inhibitors in rheumatoid arthritis: relation to disease activity and radiographic progression. Clin. rheumatol., 2010, vol. , no. ,</li> <li>KOLWIJCK, Eva, OBERMAJER, Nataša, KOS, Janko, SPAN, Paul, THOMAS, Chris M.G., MASSUGER, Leon F.A.G, SWEEP, Fred. The balance between extracellular cathepsins and cystatin C is of importance for ovarian cancer. Eur. j. clin. investig. (Print), 2010, issue 7, vol. 40, str. 591-599.</li> <li>COLIN, Carole, VOUTSINOS-PORCHE, Brigitte, NANNI, Isabelle, FINA, Frédéric, METELLUS, Philippe, INTAGLIATA, Dominique, BAEZA, Nathalie, BOUVIER, Corinne, DELFINO, Christine, LOUNDOU, Anderson, CHINOT, Olivier, LAH TURNŠEK, Tamara, KOS, Janko, MARTIN, Pierre-Marie, OUAFIK, L'Houcine, FIGARELLA-BRANGER, Dominique. High expression of cathepsin B and plasminogen activator inhibitor type-1 are strong predictors of survival in glioblastomas. Acta Neuropathol, 2009, vol. 118, str. 745-754</li> <li>KRALJ, Slavko, ROJNIK, Matija, KOS, Janko, MAKOVEC, Darko. Targeting EGFR-overexpressed A431 cells with EGF-labeled silica-coated magnetic nanoparticles. Journal of nanoparticle research, ISSN 1388-0764, 2013, vol. 15, no. 5, str.1666-1-1666-11, doi: 10.1007/s11051-013-1666-6.</li> <li>VIŽIN, Tjaša, CHRISTENSEN, Ib Jarle, NIELSEN, Hans Jørgen, KOS, Janko. Cathepsin X in serum from patients with colorectal cancer: relation to prognosis. Radiology and oncology, ISSN 1318-2099, 2012, vol. 46, no. 3, str. 207-212</li> </ol>

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Bioproceno inženirstvo bioloških makromolekul, virusov in celic
Course title:	Bioprocess engineering of biologic macromolecules, viruses and cells

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3784
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	10	20	0	0	85	5

Nosilec predmeta/Lecturer:	Aleš Podgornik
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Izvajalci predavanj:	Igor Plazl, Aleš Podgornik, Polona Žnidaršič Plazl
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Vpis na doktorski študij; zaključen drugostopenjski ali star univerzitetni študij biotehnologije, kemijskega inženirstva, biokemije, kemije, farmacije, mikrobiologije, živilske tehnologije in sorodnih programov	Enrollment to the doctoral study; completed <b>Bologna</b> 2nd Cycle <b>Study</b> Program or university study in biotechnology, chemical engineering, biochemistry, chemistry, pharmacy, microbiology, food technology or related studies

Vsebina:	Content (Syllabus outline):
Predstavljeni bodo sodobni inženirski trendi pridobivanja in izolacije bioloških makromolekul (kot so encimi, monoklonska protitelesa, plazmidna DNA), virusov (bakteriofagov in humanih virusov) in celic (matične celice) ter	State of the art engineering approaches for production and isolation of biologic macromolecules (like enzymes, monoclonal antibodies and plasmid DNA), viruses (bacteriophages and human viruses) and cells



<p>biokatalitskih procesov, ki so in bodo pomembni na podočju varnosti, prehrane in zdravja. Podrobno bodo predstavljene sodobne tehnike pridobivanja bioloških makromolekul, virusov in celic, ter biokatalitskih procesov z encimi in celicami s poudarkom na mikoreaktorjih in kontinuirnih procesih. Glavni poudarek predmeta bo na različnih tehnikah izolacije obravnavanih bioproduktov na osnovi obarjanja, kristalizacije, ekstrakcije, različnih membranskih separacij in kromatografije, ter sodobni trendi kot so kontinuirna ekstrakcija in kromatografija. Študentje bodo seznanjeni z osnovami načrtovanja eksperimentov s poudarkom na QbD (Quality by Design), regulatornimi aspekti pridobivanja farmacevtskih učinkovin npr. PAT (Process Analytical Technology) in s tem povezano specifično analitiko. Poseben sklop bodo tehnologije za enkratno uporabo (angl. single use ali disposable) ter integrirani procesi in razlogi za njihovo uporabo. Predstavljeni bodo tudi konkretni primeri procesov.</p> <p>Ker je predmet izrazito aplikativno naravn, bodo znaten del predmeta predstavljale laboratorije vaje v obliki delavnice, ki bodo soorganizirane s centrom odličnosti COBIK in farmacevtskimi podjetji iz Slovenije in tujine. Namen je, da bo vsak študent praktično izvedel procese izolacije bioloških makromolekul, virusov ter celic z različnimi tehnikami in se tako seznanil s ključnimi praktičnimi izzivi.</p>	<p>(stem cells) together with biocatalytic processes being important for safety, food and health are elaborate.</p> <p>Furthermore, various techniques, including microreactors and continuous processes, for production of biologic macromolecules, viruses and cells as well as biocatalytic processes are discussed. This includes precipitation, extraction, various membrane separations and chromatography. Basics of experimental design are presented especially QbD (Quality by Design), regulatory aspects of pharmaceutical production (PAT -Process Analytical Technology) and related analytics.</p> <p>Additional topics are single use or disposable technology and integrated processes. Several case studies of existing processes will be presented to elucidate advantages of proposed approaches.</p> <p>Due to applied oriented nature of the course an important part consists of practical laboratory training organized together with the centre of excellence COBIK and pharmaceutical companies from Slovenia and abroad. Each student will have a chance to practice isolation of biologic macromolecules, viruses and cells using different techniques facing in this way practical challenges encountered in industry.</p>
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<p>Temeljna literatura in viri/Readings:</p> <p>Izbrana poglavja iz Carta G., Jungbauer A. Protein Chromatography: Process Development and Scale-Up, Wiley-VCH, Weinheim, 2010</p> <p>Izbrana poglavja iz Subramanian G. (Eds.). Biopharmaceutical production technology. Weinheim: Wiley-VCH, 2012</p> <p>Izbrana poglavja iz Hessel, V., Renken, A., Schouten, J.C., Yoshida, J.-I. (2009) editors, Micro Process Engineering: A Comprehensive Handbook, Vol. 1-3, Wiley-VCH Verlag GmbH &amp; Co. KGaA, Weinheim, Germany</p> <p>Izbrana poglavja iz Buchholz K., Kasche V., Bornscheuer U.T. (2012) Biocatalysts and Enzyme Technology, 2nd Edition</p> <p>Znanstveni članki iz tekoče znanstvene perodike.</p>
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Cilji in kompetence:	Objectives and competences:
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<ul style="list-style-type: none"> <li>• Razumevanje teoretičnih principov tehnologij uporabljenih pri pridobivanju in izolacijah bioloških makromolekul, virusov in celic</li> <li>• Razumevanje koncepta kontinuirnih procesov in mikroreaktorjev</li> <li>• Razumevanje načrtovanja in vodenja biokatalitskih procesov</li> <li>• Razumevanje regulatornih konceptov</li> <li>• Razumevanje tehnologij za enkratno uporabo ter integriranih procesov</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding theoretical principles of techniques used for production of biologic molecules, viruses and cells</li> <li>• Understanding concepts of microreactors and continuous processes</li> <li>• Understanding design and performance of biocatalytic processes</li> <li>• Understanding of regulatory concepts</li> <li>• Understanding of single use technology and integrated processes</li> </ul>
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<b>Predvideni študijski rezultati:</b>	<b>Intended learning outcomes:</b>
<ul style="list-style-type: none"> <li>• Sposobnost vključevanja pridobljenega znanja v projektu</li> <li>• Izkazano doseganje izobraževalnih ciljev</li> </ul>	<ul style="list-style-type: none"> <li>• Implementation of acquired knowledge in projects</li> <li>• Demonstrated achievement of educational goals</li> </ul>

<b>Metode poučevanja in učenja:</b>	<b>Learning and teaching methods:</b>
<ul style="list-style-type: none"> <li>• predavanja</li> <li>• seminarji (v obliki rednih seminarskih predstavitev z diskusijami)</li> <li>• praktične laboratorijske vaje v sodelovanju s strokovnjaki iz farmacevtskih podjetij ter znanstvenih institucij iz Slovenije in tujine</li> </ul>	<ul style="list-style-type: none"> <li>• lectures</li> <li>• seminars (regular presentations with discussions)</li> <li>• practical laboratory course in cooperation with experts from pharmaceutical industry and academic institutions from Slovenia and abroad</li> </ul>

<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
Preverjanje znanja poteka v obliki projektne naloge na realnih primerih iz raziskovalne prakse, v kateri študentje pripravijo rešitve za izbrani predlog raziskovalnega projekta. Projektne naloge oddajo v pisni obliki in jih zagovarjajo v ustni obliki, v diskusiji z nosilcem predmeta in sodelujočimi profesorji ter ostalimi študenti.	50,00 %	During the course students prepare individual projects of real cases from research practice, where students prepare solutions for determined research project proposal. They prepare final project work and defend it in the classroom in discussion with professors and other students.
Študent pripravi tudi seminar iz tematike doktorata v povezavi z eno od vsebin predmeta. Pri tem sodelujeta mentor in nosilec predmeta oz. drugi izvajalci predmeta. Zagovor opravlja študent pred mentorjem in nosilcem in/ali drugim izvajalcem.	50,00 %	Student prepares a doctoral seminar on the topic related to one of the course. In this cooperate mentor and lecturer or/and other professors. Student defend the seminar in front of mentor and lecturer and/or other professors.

<b>Reference nosilca/Lecturer's references:</b>
1. Aleš Podgornik, Vida Smrekar, Peter Krajnc, Aleš Štrancar, "Estimation of methacrylate monolith binding capacity from pressure drop data", <i>J. Chromatogr., A</i> , vol. 1272, str. 50-55, 11. Jan. 2013, doi: <a href="https://doi.org/10.1016/j.chroma.2012.11.057">10.1016/j.chroma.2012.11.057</a> . [COBISS.SI-ID 16493846]

2. Vida Smrekar, Franc Smrekar, Aleš Štrancar, Aleš Podgornik, "Single step plasmid DNA purification using methacrylate monolith bearing combination of ion-exchange and hydrophobic groups", *J. chromatogr., A*, vol. 1276, str. 58-64, 2013, doi: [10.1016/j.chroma.2012.12.029](https://doi.org/10.1016/j.chroma.2012.12.029). [COBISS.SI-ID 4199288]
3. Urh Černigoj, Urška Vidic, Miloš Barut, Aleš Podgornik, Matjaž Peterka, Aleš Štrancar, "A multimodal histamine ligand for chromatographic purification of plasmid DNA", *J. chromatogr., A*, vol. 1281, str. 87-93, 2013, doi: [10.1016/j.chroma.2013.01.058](https://doi.org/10.1016/j.chroma.2013.01.058). [COBISS.SI-ID 4263544]
4. Claire S. Burden, Jing Jin, Aleš Podgornik, Daniel G. Bracewell, "A monolith purification process for virus-like particles from yeast homogenate", *Journal of chromatography. B, Analytical technologies in the biomedical and life sciences*, vol. 880, str. 82-89, 2012, doi: [10.1016/j.jchromb.2011.10.044](https://doi.org/10.1016/j.jchromb.2011.10.044). [COBISS.SI-ID 4112760]
5. Nika Lendero Krajnc, Franc Smrekar, Aleš Štrancar, Aleš Podgornik, "Adsorption behavior of large plasmids on the anion-exchange methacrylate monolithic columns", *J. chromatogr., A*, vol. 1218, iss. 17, str. 2413-2424, 2011, doi: [10.1016/j.chroma.2010.12.058](https://doi.org/10.1016/j.chroma.2010.12.058). [COBISS.SI-ID 3940984]
6. Franc Smrekar, Mateja Ciringer, Aleš Štrancar, Aleš Podgornik, "Characterisation of methacrylate monoliths for bacteriophage purification", *J. chromatogr., A*, vol. 1218, iss. 17, str. 2438-2444, 2011, doi: [10.1016/j.chroma.2010.12.083](https://doi.org/10.1016/j.chroma.2010.12.083). [COBISS.SI-ID 3940728]
7. Franc Smrekar, Mateja Ciringer, Janez Jančar, Peter Raspor, Aleš Štrancar, Aleš Podgornik, "Optimization of lytic phage manufacturing in bioreactor using monolithic supports", *J. sep. sci.*, vol. 34, issue 16/17, str. 2152-2158, 2011. [COBISS.SI-ID 3942008]
8. Franc Smrekar, Aleš Podgornik, Mateja Ciringer, Sandra Kontrec, Peter Raspor, Aleš Štrancar, Matjaž Peterka, "Preparation of pharmaceutical-grade plasmid DNA using methacrylate monolithic columns", *Vaccine*, str. 2039-2045. [COBISS.SI-ID 3772280]
9. NOVAK, Uroš, ŽNIDARŠIČ PLAZL, Polona. Integrated lipase-catalyzed isoamyl acetate synthesis in a miniaturized system with enzyme and ionic liquid recycle. Green processing and synthesis, ISSN 2191-9542. [Print ed.], 2013, vol. 2, no. 6, str. 561-568, ilustr. <http://www.degruyter.com/view/j/gps.2013.2.issue-6/gps-2013-0082/gps-2013-0082.xml?format=INT>, doi: [10.1515/gps-2013-0082](https://doi.org/10.1515/gps-2013-0082). [COBISS.SI-ID 1656111]
10. NOVAK, Uroš, POHAR, Andrej, PLAZL, Igor, ŽNIDARŠIČ PLAZL, Polona. Ionic liquid-based aqueous two-phase extraction within a microchannel system. *Sep. purif. technol.*, 2012, vol. 97, no. 1, str. 172-178, doi: [10.1016/j.seppur.2012.01.033](https://doi.org/10.1016/j.seppur.2012.01.033). [COBISS.SI-ID 35736325]
11. TIŠMA, Marina, ŽNIDARŠIČ PLAZL, Polona, VASIČ-RAČKI, Đurđa, ZELIĆ, Bruno. Optimization of laccase production by *Trametes versicolor* cultivated on industrial waste. *Appl. biochem. biotechnol.*, 2012, vol. 166, no. 1, 36-46, doi: [10.1007/s12010-011-9401-1](https://doi.org/10.1007/s12010-011-9401-1)
12. MARQUES, M. P. C., FERNANDES, P., CABRAL, Joaquim M. S., ŽNIDARŠIČ PLAZL, Polona, PLAZL, Igor. Continuous steroid biotransformations in microchannel reactors. *New biotechnology*, 2012, vol. 29, no. 2, 227-234, doi: [10.1016/j.nbt.2011.10.001](https://doi.org/10.1016/j.nbt.2011.10.001).
13. CVJETKO, M., VORKAPIČ-FURAČ, Jasna, ŽNIDARŠIČ PLAZL, Polona. Isoamyl acetate synthesis in imidazolium-based ionic liquids using packed bed enzyme microreactor. *Process biochem.*, 2012, vol. 47, no. 9, 1344-1350, doi: [10.1016/j.procbio.2012.04.028](https://doi.org/10.1016/j.procbio.2012.04.028)
14. STOJKOVIČ, Gorazd, ŽNIDARŠIČ PLAZL, Polona. Immobilization of yeast cells within microchannels of different materials. *Acta chimica slovenica*, ISSN 1318-0207. [Tiskana izd.], 2010, vol. 57, no. 1, str. 144-149. <http://acta.chem-soc.si/57/57-1-144.pdf>. [COBISS.SI-ID 33807877],
15. LIU, Mingqiang, NOVAK, Uroš, PLAZL, Igor, FRANKO, Mladen. Optimization of a thermal lens microscope for detection in a microfluidic chip. *International journal of thermophysics*, ISSN 0195-928X, 12 str., doi: [10.1007/s10765-013-1515-y](https://doi.org/10.1007/s10765-013-1515-y). [COBISS.SI-ID 2895867]
16. SKUBIC, Blaž, LAKNER, Mitja, PLAZL, Igor. Sintering behavior of expanded perlite thermal insulation board : modeling and experiments. *Industrial & engineering chemistry research*, ISSN 0888-5885. [Print ed.], 9. jul. 2013, vol. 52, no. 30, str. 10244-10249, ilustr. <http://pubs.acs.org/doi/ipdf/10.1021/ie400196z>, doi: [10.1021/ie400196z](https://doi.org/10.1021/ie400196z). [COBISS.SI-ID 1604399]
17. ŽNIDARŠIČ PLAZL, Polona, PLAZL, Igor. Development of a continuous steroid biotransformation process and product extraction within microchannel system. *Catal. today.*, 2010, vol. 157, no. 1/4, 315-320, doi: [10.1016/j.cattod.2010.01.042](https://doi.org/10.1016/j.cattod.2010.01.042).
18. MARQUES, M. P. C., FERNANDES, P., CABRAL, Joaquim M. S., ŽNIDARŠIČ PLAZL, Polona, PLAZL, Igor. On the feasibility of in-situ steroid biotransformation and product recovery in microchannels. *Chem. eng. j.*, 2010, vol. 160, 708-714, doi: [10.1016/j.cej.2010.03.056](https://doi.org/10.1016/j.cej.2010.03.056).

19. ŽNIDARŠIČ PLAZL, Polona, PLAZL, Igor. Modelling and experimental studies on lipase-catalyzed isoamyl acetate synthesis in a microreactor. *Process biochemistry*, ISSN 1359-5113, 2009, vol. 44, no. 10, str. 1115-1121, doi: 10.1016/j.procbio.2009.06.003. [COBISS.SI-ID 3054541]
20. TIŠMA, Marina, ZELIĆ, Bruno, VASIĆ-RAČKI, Đurđa, ŽNIDARŠIČ PLAZL, Polona, PLAZL, Igor. Modelling of laccase-catalyzed L-DOPA oxidation in a microreactor. *Chem. eng. j.*, 2009, vol. 149, no. 1/3, 383-388, doi: 10.1016/j.cej.2009.01.025.

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Bioreakcijsko inženirstvo
Course title:	Bioreaction Engineering

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3785
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	20	0	0	0	95	5

Nosilec predmeta/Lecturer:	Igor Plazl
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Izvajalci predavanj:	Igor Plazl
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
splošni pogoji za vpis na doktorski študij	Enrollment to the doctoral study

Vsebina:	Content (Syllabus outline):
<ul style="list-style-type: none"> <li>• biokemijska inženirska analiza in modeliranje;</li> <li>• bioprocesna kinetika: rast mikroorganizmov (Monod, rast na več substratih, inhibicija,...), kinetika encimskih reakcij (Michaelis-Menten,...);</li> <li>• snovne in energijske bilance: reakcijski in separacijski bioprocesi; entalpijske spremembe;</li> <li>• osnove dinamike tekočin: idealni in neidealni tokovni modeli, napoved 3D hitrostnih profilov eno- in večfaznih sistemov;</li> </ul>	<ul style="list-style-type: none"> <li>• modelling and analysis of biochemical engineering processes;</li> <li>• bioprocess kinetics: growth of microorganisms (Monod, growth on multiple substrates, inhibition, ...), enzyme kinetics (Michaelis-Menten,...);</li> <li>• mass and energy balances: reaction and separation bioprocesses; enthalpy changes;</li> <li>• basic fluid dynamics: ideal and nonideal flow models, 3D velocity profile prediction of single and multiphase flow;</li> </ul>

<ul style="list-style-type: none"> <li>osnove numerične analize: reševanje navadnih diferencialnih enačb: analitična metoda, Eulerjeva metoda, Rungejeva trapezna metoda, Runge-Kutta-klasična metoda četrtega reda, sistem navadnih diferencialnih enačb, numerično integriranje; numerično reševanje parcialnih diferencialnih enačb: eksplicitna in implicitna metoda končnih razlik, analitična in numerična rešitev Laplaceove enačbe;</li> <li>zapis in reševanje ohranitvenih enačb;</li> <li>razvoj 2D in 3D matematičnih modelov, ki vključujejo tok tekočin in reakcijsko-difuzijske člene;</li> <li>uporaba računalniških orodij (npr.: Mathematica, Comsol, Matlab);</li> <li>izbrani primeri modeliranja bioprosesov (encimska reakcija z raztopljenim katalizatorjem v eno- ali dvofaznem sistemu; biotransformacija v mikroreaktorju s pritrjenimi encimi ali celicami; šaržni in kontinuirni proces biotransformacije progesterona z imobilizirano biomaso; modeliranje biološke čistilne naprave,...).</li> </ul>	<ul style="list-style-type: none"> <li>numerical analysis basics: ordinary differential equations (exact solutions, Euler's method, Euler trapeze method, Runge-Kutta methods, systems of ordinary differential equations, numerical integration; numerical solution of partial differential equations: explicit and implicit finite difference methods, analytical and numerical solution of Laplace's equation;</li> <li>conservation equations;</li> <li>development of 2D and 3D mathematical models considering velocity profile and reaction diffusion dynamics terms;</li> <li>applications of computational tools (<i>Mathematica</i>, <i>COMSOL</i>, <i>Matlab</i>);</li> <li>bioprocess modelling of selected cases (modelling and experimental studies on enzyme-catalyzed reaction in a microreactor; biotransformation in a microreactor with surface immobilized enzymes or cells; batch and continuous steroid biotransformation process with immobilized biomass; modelling of a pilot wastewater treatment plant,...).</li> </ul>
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#### Temeljna literatura in viri/Readings:

- I. Plazl, M. Lakner, *Uvod v modeliranje procesov*, Založba FKKT, Univerza v Ljubljani, Ljubljana, 2004, 230 str.
- J. Nielsen, J. Villadsen, *Bioreaction Engineering Principles*, Plenum Press, New York, 1994.
- M-L. Shuler, F. Kargi, *Bioprocess Engineering: Basic Concepts*, Prentice-Hall, Upper Saddle River, NJ, 2002.

Tekoča znanstvena periodika / Current scientific periodicals.

<b>Cilji in kompetence:</b>	<b>Objectives and competences:</b>
pridobitev ali poglobitev znanja za samostojno delo na področju raziskav bioprosesov in njihovega teoretičnega opisa, ter načrtovanje in optimizacija bioprosesnih sistemov, s poudarkom na okolju in človeku sprejemljivejših tehnologijah.	<ul style="list-style-type: none"> <li>to develop skills for independent research work in the field of bio-processes, their theoretical description, design and optimization, with emphasis on environmentally acceptable biotechnologies</li> </ul>

<b>Predvideni študijski rezultati:</b>	<b>Intended learning outcomes:</b>
kandidata usposobiti za izvedbo omenjenih raziskav, rezultati katerih bodo predstavljali pomembne prispevke temeljni ali aplikativni znanosti na področju biotehniških znanosti.	ability for solving various engineering tasks and problems of bioprocess technologies.

<b>Metode poučevanja in učenja:</b>	<b>Learning and teaching methods:</b>
Predavanja, seminarji, delo na projektih.	Lectures, seminars, project workshops.

<b>Načini ocenjevanja:</b>	<b>Delež/Weight</b>	<b>Assessment:</b>
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ustni izpit	60,00 %	Project with public presentation
seminar	40,00 %	oral examination.

Reference nosilca/Lecturer's references:

1. LUBEJ, Martin, PLAZL, Igor. Theoretical and experimental study of iron catalyst preparation by chemical vapor deposition of ferrocene in air. *The chemical engineering journal*, ISSN 1385-8947. [Print ed.], str. 1-34, 2013; ilustr. <http://www.sciencedirect.com/science/article/pii/S1385894713016197>, doi: 10.1016/j.cej. 2013.12.038. [COBISS.SI-ID 1664303]
2. UNGERBÖCK, B., POHAR, Andrej, MAYR, T., PLAZL, Igor. Online oxygen measurements inside a microreactor with modeling of transport phenomena. *Microfluidics and nanofluidics*, ISSN 1613-4982, 2013, vol. 14, no. 3/4, str. 565-574, doi: 10.1007/s10404-012-1074-8. [COBISS.SI-ID 36271621]
3. POHAR, Andrej, LAKNER, Mitja, PLAZL, Igor. Parallel flow of immiscible liquids in a microreactor : modeling and experimental study. *Microfluidics and nanofluidics*, ISSN 1613-4982, 2012, vol. 12, no. 1/4, str. 307-316, doi: 10.1007/s10404-011-0873-7. [COBISS.SI-ID 35319813]
4. LEVSTEK, Meta, PLAZL, Igor. Influence of carrier type on nitrification in the moving-bed biofilm process. *Water sci. technol.*, 2009, 59, 875-882.
5. ŽNIDARŠIČ PLAZL, Polona, PLAZL, Igor. Modelling and experimental studies on lipase-catalyzed isoamyl acetate synthesis in a microreactor. *Process biochemistry*, ISSN 1359-5113, 2009, vol. 44, no. 10, str. 1115-1121, doi: 10.1016/j.procbio.2009.06.003. [COBISS.SI-ID 30545413]
6. POHAR, Andrej, PLAZL, Igor, ŽNIDARŠIČ PLAZL, Polona. Lipase-catalyzed synthesis of isoamyl acetate in an ionic liquid/n-heptane two-phase system at the microreactor scale. *Lab on a chip*, ISSN 1473-0197, 2009, vol. 9, no. 23, str. 3385-3390, doi: 10.1039/b915151f. [COBISS.SI-ID 30820357]

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Glivna predobdelava lignoceluloznih substratov
Course title:	Fungal pre-treatment of lignocelulosic substates

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3786
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	5	15	0	5	90	5

Nosilec predmeta/Lecturer:	Miha Humar
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Izvajalci predavanj:	Miha Humar
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij	General conditions for enrollment in doctoral study

Vsebina:	Content (Syllabus outline):
Pretvorba lignoceluloznih surovin v energente in nove materiale ima zaradi razširjenosti prednost pred ostalimi obnovljivimi viri. Ogljikove hidrate v lignoceluloznih surovinah je moč uporabiti v različnih bioprocesih za proizvodnjo biogoriv, kemikalij, materialov in živalske krme. Kemijska in sestava in zgradba lignoceluloznih substratov pogosto omejuje neposredno uporabo v bioreaktorjih, zato	The conversion of lignocellulosic substrates into energy and new materials has several advantages due to its renewable origin. Carbohydrates in lignocellulosic materials can be used in a variety of bioprocesses for the production of biofuels, chemicals, materials and animal feed.... However, chemical composition and structure of lignocellulosic substrates is often limited factor for direct use in



<p>moramo lignoceleulozne substrate pred tem ustrezno obdelati. Za učinkovito pretvorbo je potrebno dobro poznavanje lignoceluloznih substratov. Razumeti je potrebno interakcije le teh z glivami in poznati tehnike za karakterizacijo lignoceluloznih materialov. V okviru tega predmeta bomo študentom predstavili najpomembnejše vire lignoceluloznih substratov, njihove možne uporabe in možnosti predobdelave z glivami oziroma njihovimi encimi. Slušateljem bomo tako predstavili delovanje gliv bele in rjave trohnobe in najpomembnejše značilnosti njihovih encimov.</p>	<p>bioreactors, so lignocellulosic substrates have to be properly treated before use. Effective conversion requires good understanding of lignocellulosic substrates. Additionally, interactions of lignocellulosic materials with fungi and techniques for their characterization is a must as well. In the context of this course the most important sources of lignocellulosic substrates, their potential uses and possibilities of pre-treatment with fungi or their enzymes will be presented to students. Attendees will understand mode of action of the white and brown rot fungi and the most important characteristics of their enzymes.</p>
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<p>Temeljna literatura in viri/Readings:</p>	
<p>Poonam Singh nee' Nigam, Ashok Pandey; 2009. Biotechnology for Agro-Industrial Residues Utilisation, Netherlands, Springer, ISBN: 978-1-4020-9941-0 (Izbrana poglavja)</p>	
<p>Anuj K. Chandel and Silvio Silv�rio da Silva, 2013. Biochemistry, Genetics and Molecular Biology »Sustainable Degradation of Lignocellulosic Biomass - Techniques, Applications and Commercialization" INTECH, ISBN 978-953-51-1119-1 (Izbrana poglavja)</p>	
<p>�studentom bo na razpolago tudi gradivo s predavanj in vaj v elektronski obliki. Gradivo bo objavljeno pred začetkom predavanj na spletni strani. Za izdelavo seminarskih nalog in dodatno razumevanje vsebin bodo študentje uporabili tudi svetovni splet (internet).</p>	

<p>Cilji in kompetence:</p>	<p>Objectives and competences:</p>
<p>Cilji predmeta so: Spoznati variabilnost sestave lignoceluloznih substratov, raznolikost delovanja ksilofagnih gliv, lignoliti�nih encimov in mo�nosti njihove uporabe v procesih predobdelave.</p> <p>Kompetence: �studentje si bodo pridobili znanja o biolo�kih procesih razgradnje lignoceluloznih substratov in vedenje, kako te procese uporabiti za biotehnolo�ko obdelavo lignoceluloznih substratov.</p>	<p>The objectives of the course are: to understand the variability of the composition of lignocellulosic substrates, diversity of the wood inhabiting fungi, lignolytic enzymes and their possible use in the pre-treatment processes.</p> <p>Competencies: Students will acquire knowledge of biological processes of degradation of the lignocellulosic substrates of mode of action of the selected fungi and understanding on the how these processes used for the biotechnological pre-treatment of the lignocellulosic substrates.</p>

<p>Predvideni �tudijski rezultati:</p>	<p>Intended learning outcomes:</p>
<p><i>Znanje in razumevanje:</i> �student pozna najpomembnejše vire lignoceluloznih substratov, njihovo zgradbo in prednosti ter omejitve njihove glivne predobdelave.</p>	<p><i>Knowledge and understanding:</i> Students are familiar to the sources and composition of the most important lignocellulosic substrates and advantages and limitations of their fungal pre-treatment.</p>

<p><i>Refleksija:</i> predmet predstavlja strokovni temelj v skladu z naravo študija in je zelo dobra podlaga za nadaljnje proučevanje biotehnoške obdelave lignoceluloznih substratov.</p> <p><i>Prenosljive spretnosti:</i> študent pridobljeno znanje uporablja pri drugih (bio)tehnoloških predmetih. Zna uporabiti domačo in tujo literaturo ter računalniške baze podatkov. Poleg tega obvlada osnove znanstveno raziskovalnega dela (postavitev hipoteze na osnovi svojega znanja in literaturnih podatkov, načrt eksperimenta, razprava in ovrednotenje rezultatov).</p>	<p><i>Reflections:</i> the course is the professional fundament in accordance with the nature of the study. It represents a firm basis for further studies of biotechnological pre-treatment of lignocellulosic substrates.</p> <p><i>Transferable skills:</i> a student can use the knowledge at other technological courses. He/she knows to use scientific literature and computer data bases. Besides, he/she is acquainted with methods of scientific research work (can make a hypothesis, experimental plan, discussion, critical evaluation of the results).</p>
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Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja (10 ur), Seminarji (5 ur), Laboratorijske vaje (10 ur), Ostalo (5 ur)	Lectures (10 hours) Seminars (5 hours) Lab. work (10 hours) Other (5 hours)

Načini ocenjevanja:	Delež/Weight	Assessment:
- Pisni in ustni izpit	60,00 %	- written and oral exam
- Seminar	40,00 %	- seminar

Reference nosilca/Lecturer's references:
<p>THALER, Nejc, LESAR, Boštjan, HUMAR, Miha. Performance of copper-ethanolamine-impregnated scots pine wood during exposure to terrestrial microorganisms. <i>Bioresources</i>, ISSN 1930-2126, 2013, vol. 8, iss. 3, str. 3299-3308.</p> <p>HRASTNIK, David, BUDIJA, Franc, HUMAR, Miha, PETRIČ, Marko. Influence of liquefied and ccb containing liquefied wood on growth of wood decay fungi. <i>Maderas. Ciencia y tecnología</i>, ISSN 0717-3644, 2013, vol. 15, no. 1, str. 105-118.</p> <p>THALER, Nejc, LESAR, Boštjan, KARIŽ, Mirko, HUMAR, Miha. Bioincising of Norway spruce wood using wood inhabiting fungi. <i>International biodeterioration &amp; biodegradation</i>, ISSN 0964-8305. [Print ed.], 2012, vol. 68, no. 1, str. 51-55.</p> <p>PIŠKUR, Barbara, BAJC, Marko, ROBEK, Robert, HUMAR, Miha, SINJUR, Iztok, KADUNC, Aleš, OVEN, Primož, REP, Gregor, AL SAYEGH-PETKOVŠEK, Samar, KRAIGHER, Hojka, JURC, Dušan, POHLEVEN, Franc. Influence of <i>Pleurotus ostreatus</i> inoculation on wood degradation and fungal colonization. <i>Bioresource technology</i>, ISSN 0960-8524. [Print ed.], vol. 102, iss. 22, str. 10611-10617</p> <p>THALER, Nejc, LESAR, Boštjan, HUMAR, Miha. Correlation between brown rot decay and Pilodyn measurements. <i>Holz als Roh- und Werkstoff</i>, ISSN 0018-3768. [Print ed.], 2012, vol. 70, no. 6, str. 893-895</p> <p>LESAR, Boštjan, HUMAR, Miha. Re-evaluation of fungicidal properties of boric acid. <i>Holz als Roh- und Werkstoff</i>, ISSN 0018-3768. [Print ed.], 2009, vol. 67, no. 4, str. 483-484.</p>

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Interakcije med patogeni in gostitelji
Course title:	Host-pathogen interactions

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3788
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	15	0	0	5	95	5

Nosilec predmeta/Lecturer:	Mojca Narat
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Izvajalci predavanj:	Peter Dovč, Mojca Narat
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij	General prerequisites for enrolment into doctoral studies.

Vsebina:	Content (Syllabus outline):
Proučevanje interakcij med različnimi gostitelji in različnimi patogeni poteka (H-P) na nivoju organizmov, celic gostitelja in mikroba ter na nivoju celične signalizacije in izražanje genov. Za to so v uporabi različne metode, s katerimi proučujemo dogajanja v gostitelju kot tudi v mikrobi. Namen študij je odkrivanje mehanizmov delovanja in/ali možna aplikacija. V okviru predmeta bodo predstavljeni različni	The study of interactions between different hosts and a variety of pathogens is carried out (H-P) at the level of organisms, host or pathogen cells and on the level of cell signaling and gene expression. Different methods and approaches are used to study the events that are very complex. The aim of studies of human or animal pathogens and specific hosts or of H-P interactions in animal models is to

<p>primeri odnosa med gostiteljem in patogenom: vsakič bo predstavljena osnovna problematika in namen, nato pa pristop k proučevanju le te, vključno z metodami in analizo podatkov. Mikoplazme, kot primer mikrobov brez celične stene in interakcije z gostiteljem, ter vpliv gostiteljevega odziva na mikoplazme. Ali okužba z mikoplazmo inducira avtoimunska bolezen? Učinek sočasnih okužb. Proučevanje naravne imunosti oz aktivacije imunskega odziva preko TLR . Okužbe mlečne žleze in tumorogeneza. Uporaba živalskih modelov (mišk) v proučevanju H-P interakcij. Okužba prebavnega trakta s <i>Helicobacter pylori</i> – vzrok za nastanek raka na črevesju? H-P interakcije pri rastlinah.</p>	<p>understand basic molecular mechanisms and/or possible applications. The course will present examples of H-P interactions: authors will present the background and the aim of the study they performed along with methods and results. Students are expected to have read the study (paper) first and participate actively in the discussion in course.</p> <p>Topics: Mycoplasmas: microbes without cell wall. Can they induce autoimmune disease? How do they influence on simultaneous infections with viruses? Infections of the mammary gland and tumorogenesis. Animal models in H-P interactions research. Infection with <i>Helicobacter pylori</i> and tumorogenesis. H-P interactions in plants.</p>
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<p>Temeljna literatura in viri/Readings:</p> <p>Vsebina bo temeljila na člankih, ki so jih objavili predavatelji in bodo slušateljem posredovani vsako leto v naprej.</p>
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<p>Cilji in kompetence:</p> <p>Cilj je razviti</p> <ul style="list-style-type: none"> <li>• spoznati kompleksnost interakcij med patogeni in gostitelji</li> <li>• spoznati pristope za proučevanje</li> <li>• spoznati možnosti in delo na tem področju v slovenskem in mednarodnem prostoru</li> <li>• razviti sposobnosti razumevanja in analiziranja znanstvenih člankov in razviti sposobnost znanstvene diskusije na temo H-P interakcije</li> </ul>	<p>Objectives and competences:</p> <ul style="list-style-type: none"> <li>• to recognize the complexity of H-P interactions</li> <li>• to recognize the approaches and methods</li> <li>• to get the insight into the H-P research projects in SLO and international</li> <li>• to develop the capability of understanding and analyzing of scientific papers as well as develop the capability of scientific discussion</li> </ul>
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<p>Predvideni študijski rezultati:</p> <p>Znanje in razumevanje:</p> <p>Poznavanje aktualnih problematik H-P in možnosti (sistemov, načinov, pristopov, metod) za študij le teh in za razvoj biotehnoških aplikacij. Razumevanje pomena raziskovanja na področju H-P interakcij.</p> <p>Sposobnost samostojnega študija problema z branjem znanstvene literature.</p>	<p>Intended learning outcomes:</p> <p>Knowledge and understanding:</p> <p>Knowledge of up-to date problems of host-pathogen interactions (H-P) and possibilities (methods, approach) for research. They will understand the importance of the research of H-P interactions.</p> <p>They should gain the ability to understand the problem and find the application/solution based on biotechnology approach.</p> <p>Students should gain the ability of self-dependent studying scientific papers.</p>
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<p>Metode poučevanja in učenja:</p> <p>Osnova so znanstveni članki (predavatelji so soavtorji), ki jih bodo kandidati prebrali/preštudirali v naprej. Posamezno</p>	<p>Learning and teaching methods:</p> <p>Scientific papers will be delivered in advance. Lecturer, which is a co-author of the paper, will present the background of the research. In the</p>
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predavanje bo namenjeno širši predstavitvi tematike, ki je obravnavana v posameznem članku. Sledil bo seminar, namenje diskusiji, kjer se predvideva aktivno sodelovanje študentov.	seminar students will take an active part. Additional explanation of methods/ results will be provided by lecturer.
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Načini ocenjevanja:	Delež/Weight	Assessment:
Izpit	80,00 %	Exam
Seminar	20,00 %	Seminar

Reference nosilca/Lecturer's references:

**Mojca Narat:**

1. DUŠANIĆ, Daliborka, BENČINA, Dušan, OVEN, Irena, CIZELJ, Ivanka, BENČINA, Mojca, NARAT, Mojca. Mycoplasma synoviae induces upregulation of apoptotic genes, secretion of nitric oxide and appearance of an apoptotic phenotype in infected chicken chondrocytes. *Veterinary research*, ISSN 1297-9716, 2012, vol. 43, no. 7, str. 1-14. <http://www.veterinaryresearch.org/content/pdf/1297-9716-43-7.pdf>, doi: [10.1186/1297-9716-43-7](https://doi.org/10.1186/1297-9716-43-7). [COBISS.SI-ID [3013768](https://www.cobiss.si/urn:nbn:si:coibis:3013768)]
2. DUŠANIĆ, Daliborka, BERČIČ, Rebeka Lucijana, CIZELJ, Ivanka, SALMIČ, Simona, NARAT, Mojca, BENČINA, Dušan. Mycoplasma synoviae invades non-phagocytic chicken cells in vitro. *Veterinary Microbiology*, ISSN 0378-1135. [Print ed.], 2009, issues 1-2, vol. 138, str. 114-119. <http://www.sciencedirect.com/science?ob=ArticleURL&udi=B6TD6-4VRX66J-2&user=4776866&rdoc=1&fmt=&orig=search&sort=d&view=c&acct=C000033658&version=1&urlVersion=0&userid=4776866&md5=1ba21383c610c8913d8f625752ab6509>, doi: [10.1016/j.vetmic.2009.02.014](https://doi.org/10.1016/j.vetmic.2009.02.014). [COBISS.SI-ID [2439560](https://www.cobiss.si/urn:nbn:si:coibis:2439560)]
3. LAVRIČ, Miha, MAUGHAN, Michele N., BLISS, Travis W., DOHMS, John E., BENČINA, Dušan, KEELER, Calvin L., NARAT, Mojca. Gene expression modulation in chicken macrophages exposed to Mycoplasma synoviae or Escherichia coli. *Veterinary Microbiology*, ISSN 0378-1135. [Print ed.], 2008, letn. 126, št. 1/3, str. 111-121. [COBISS.SI-ID [2193032](https://www.cobiss.si/urn:nbn:si:coibis:2193032)]
4. BOLHA, Luka, BENČINA, Dušan, CIZELJ, Ivanka, OVEN, Irena, SLAVEC, Brigita, ZORMAN-ROJS, Olga, NARAT, Mojca. Effect of Mycoplasma synoviae and lentogenic Newcastle disease virus coinfection on cytokine and chemokine gene expression in chicken embryos. *Poultry science*, ISSN 0032-5791, 2013, vol. 92, no. 12, str. 3134-3143. <http://ps.fass.org/content/92/12/3134>, doi: [10.3382/ps.2013-03332](https://doi.org/10.3382/ps.2013-03332). [COBISS.SI-ID [3303304](https://www.cobiss.si/urn:nbn:si:coibis:3303304)]
5. OVEN, Irena, RESMAN RUS, Katarina, DUŠANIĆ, Daliborka, KEELER, Calvin L., NARAT, Mojca. Diacylated lipopeptide from Mycoplasma synoviae mediates TLR15 induced innate immune responses. *Veterinary research*, ISSN 1297-9716, 2013, iss. 3, vol. 44. <http://www.veterinaryresearch.org/content/44/1/99>, doi: [10.1186/1297-9716-44-99](https://doi.org/10.1186/1297-9716-44-99). [COBISS.SI-ID [30945497](https://www.cobiss.si/urn:nbn:si:coibis:30945497)]
6. BERČIČ, Rebeka Lucijana, CIZELJ, Ivanka, DUŠANIĆ, Daliborka, NARAT, Mojca, ZORMAN-ROJS, Olga, DOVČ, Peter, BENČINA, Dušan. Neuraminidase of Mycoplasma synoviae desialylates heavy chain of the chicken immunoglobulin G and glycoprotein of chicken tracheal mucos. *Avian pathology*, ISSN 0307-9457, 2011, vol. 40, no. 3, str. 299-308, doi: [10.1080/03079457.2011.565311](https://doi.org/10.1080/03079457.2011.565311). [COBISS.SI-ID [2859912](https://www.cobiss.si/urn:nbn:si:coibis:2859912)]

**Peter Dovč:**

1. OGOREVC, Jernej, KUNEJ, Tanja, RAZPET, Andrej, DOVČ, Peter. Database of cattle candidate genes and genetic markers for milk production and mastitis. *Animal genetics*, ISSN 0268-9146, 2009, vol. 40, str. 832-851, doi: [10.1111/j.1365-2052.2009.01921.x](https://doi.org/10.1111/j.1365-2052.2009.01921.x). [COBISS.SI-ID [2462344](https://www.cobiss.si/urn:nbn:si:coibis:2462344)]
2. PRPAR MIHEVC, Sonja, MARTIGNANI, Eugenio, DOVČ, Peter, BARATTA, Mario. Identification of goat mammary stem/progenitor cells. *Biology of reproduction*, ISSN 0006-3363, vol. 86, no. 4, str. 1-7. <http://www.biolreprod.org/content/early/2012/01/09/biolreprod.111.095489.full.pdf+html>, doi: [10.1095/biolreprod.111.095489](https://doi.org/10.1095/biolreprod.111.095489). [COBISS.SI-ID [3095176](https://www.cobiss.si/urn:nbn:si:coibis:3095176)]
3. ŠTAMPFEL, Martin, SKUTELLA, Thomas, CVJETIČANIN, Branko, MEZNARIČ, Marija, DOVČ, Peter, NOVAKOVIĆ, Srdjan, CERKOVNIK, Petra, VRTAČNIK-BOKAL, Eda, VIRANT-KLUN, Irma. Isolation, characterization and differentiation of cells expressing pluripotent/multipotent markers from adult

human ovaries. *Cell and tissue research*, ISSN 0302-766X, Nov. 2013, vol. 354, no. 2, str. 593-607, ilustr., doi: [10.1007/s00441-013-1677-8](https://doi.org/10.1007/s00441-013-1677-8). [COBISS.SI-ID [30679001](#)]

4. VIRANT-KLUN, Irma, ROŽMAN, Primož, CVJETIČANIN, Branko, VRTAČNIK-BOKAL, Eda, NOVAKOVIĆ, Srdjan, RÜLICHE, Thomas, DOVČ, Peter, MEDEN-VRTOVEC, Helena. Parthenogenetic embryo-like structures in the human ovarian surface epithelium cell culture in postmenopausal women with no naturally present follicles and oocytes. *Stem cells and development*, ISSN 1547-3287, 2009, vol. 18, no. 1, str. 137-149. [COBISS.SI-ID [714875](#)]
5. The Bovine Genome Sequencing and Analysis Consortium, ELSIK, Christine G., DOVČ, Peter, RAZPET, Andrej, et al. The genome sequence of taurine cattle : a window to ruminant biology and evolution. *Science*, ISSN 0036-8075, 2009, vol. 324, no. 5926, str. 522-528. [COBISS.SI-ID [2460552](#)]
6. KUNEJ, Tanja, GODNIČ, Irena, FERDIN, Jana, HORVAT, Simon, DOVČ, Peter, CALIN, George A. Epigenetic regulation of microRNAs in cancer : an integrated review of literature. *Mutation Research*, ISSN 0027-5107. [Print ed.], 2011, vol. 717, no. 1/2, str. 77-84.  
<http://www.sciencedirect.com/science/article/pii/S0027510711000601>, doi: [10.1016/j.mrfmmm.2011.03.008](https://doi.org/10.1016/j.mrfmmm.2011.03.008). [COBISS.SI-ID [2837128](#)]

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Mikrobna biotehnologija
Course title:	Microbial Biotechnology

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3789
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	30	0	0	20	180	10

Nosilec predmeta/Lecturer:	Hrvoje Petković
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Izvajalci predavanj:	Mojca Benčina, Hrvoje Petković
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij.	General conditions for enrolment in doctoral studies apply.

Vsebina:	Content (Syllabus outline):
<p>Pregled in osvežitev znanja na področju tradicionalnih metod in pristopov, kar vključuje različne aspekte mikrobne biotehnologije:</p> <p>-klasični pristopi izolacije mikroorganizmov iz okolja, izboljševanja industrijskih sevov in razvoja bioprosesov za industrijsko proizvodnjo različnih bioproizvodov, proizvodnja primarnih in sekundarnih metabolitov, produktov</p>	<p>In the scope of the course an overview of traditional methods and various approaches of microbial biotechnology will be presented such as:</p> <p>-classical approaches if isolation of microorganisms from natural environments, industrial strain and process development for industrial production of various bioproducts, production of primary and</p>

proteinske narave, uporaba mikroorganizmov in encimov v živilski, kemijski in farmacevtski industriji.

-uporaba mikroorganizmov in razvoj bioprosesov v živilski industriji, agrikulturi in okljevstvu.

Nadalje se vsebina predmeta navezuje na novejšo, v industriji široko uporabljane pristope metabolnega in biosinteznega in proteinskega inženirstva z uporabo rekombinantne DNA, razvoj izpopolnjenih bioprosesov za produkcijo generičnih proizvodov, in uvajanja novih bioproizvodov, npr. majhnih molekul z novim načinom delovanja, protiteles in drugih biofarmacevtskih produktov proteinske narave.

Komparativni pregled najbolj pomembnih industrijskih mikroorganizmov in novih konceptov mikrobne biotehnologije, ki se nanašajo na izbor industrijskih gostiteljskih mikroorganizmov (ang. chassis), primernih za proizvodnjo širokega spektra bioproizvodov, tako tradicionalnih (generičnih) kot tudi novih bioproizvodov.

Predstavitev novejši gostiteljskih sevov, kot so npr. miksobakterije, cianobakterije, alge in arheje, ki se danes še ne uporabljajo pogosto v industrijskem merilu, vendar so zaradi potencialnih prednosti, npr. vir novih učinkovin in encimov, izboljšane ekonomske bioprosesa in okoljevarstvenih razlogov danes predmet intenzivnih raziskav.

Komparativni pregled najnovejših metod in pristopov, ki so še v razvoju, vendar že prihajajo v industrijsko okolje, kot so to npr.:

-metagenomika, podatkovno rudarjenje genomov, (ang. genome mining) ob hitrem razvoju uporabi zmogljivih bioinformatičnih orodij  
-napredne metode sekvenciranja in sinteze DNA in napredne metode manipulacije mikroorganizmov  
- uporaba »omskih« pristopov v razumevanju in razvoju industrijskih sevov in bioprosesov

secondary metabolites, proteins and enzymes for food chemical and pharmaceutical industry.

-application of microorganisms in the development of bioproses in food, agriculture and environmental industry.

Further, the content of the subject is interconnected with new and widely applied approaches of metabolic and biosynthetic engineering, where recombinant DNA methodology is applied, development of the advanced bioproses for production of generic products and introduction of novel bio-products, eg. small molecules with novel mode of action, antibodies and biopharmaceuticals.

Comparative overview of the most important industrial microorganisms and recent concepts in microbial biotechnology, relating to the most advanced industrial hosts (chassis), suitable for the production of wide spectrum of bio-products, both, traditional (generic) as well as new bio-products.

In the scope of the course, a number of novel hosts in current R&D will be presented, such as myxobacteria, cyanobacteria, algae, archaea, not yet used often in industrial environments, but show great potential for production of various bio-products of potentially high economic advantage and environmental value, currently being under intensive R&D development.

In the scope of the subject »Microbial biotechnology«, comparative overview of the most recently developed methods and approaches, only recently reaching industrial environment will be discussed such as:

-metagenomics and genome mining approaches, further fortified by the development of powerful bioinformatics approaches  
- new powerful and affordable DNA sequencing, DNA synthesis and advanced gene manipulation methods



<p>- razvoj pristopov t.i. sintezne biologije, konstrukcija »ne-naravnih« biosinteznih poti in produktov, uporaba obnovljivih virov energije, razvoj novih biomaterialov (biopolimerov), biofarmacevtskih produktov, vključno s tistimi, ki niso mikrobnega izvora.</p> <p>Predmet se bo vsebinsko dotaknil tudi dimenzij regulative, varnosti, etike, intelektualne lastnine in nasplošno družbeno-ekonomskih dimenzij, ki jih prinaša hiter razvoj biotehnologije.</p>	<p>- application of recently developed »omics« approaches for better understanding and development of industrial microorganisms and bioprocesses.</p> <p>-further, development and application of »synthetic biology« approaches, construction of novel »non-natural« biosynthetic pathways and bio-products, the use of renewable sources of energy, development of advanced biomaterials (biopolymers) and biopharmaceutical products from heterologous sources.</p> <p>Finally, the subject »Microbial biotechnology« will also deal with issues such as regulatory affairs, safety, ethics, intellectual property and other important issues of modern society, due to the rapid development of biotechnology.</p>
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Temeljna literatura in viri/Readings:

- Microbial Biotechnology: Principles and applications, 2013, 3rd ed. (Ed.: Yuan Kun Lee). World Scientific Publishing, Co. Pte. Ltd. ISBN13: 978-9814366816 (Hardcover),
- Microbial Biotechnology: Fundamentals of Applied Microbiology (Hardcover),2007, Eds.: Alexander N. Glazer Hiroshi Nikaido, 2nd ed. ISBN 9780-521-84210-5 (Hardcover).

Druga učna gradiva: Drugi viri obsegajo novejša revialne in originalne znanstvene publikacije in izbrana patentna literatura

<p>Cilji in kompetence:</p> <p>Študenti se bodo srečali in osvojili znanja, ki dajejo široko platformo razumevanja modernih pristopov v mikrobni biotehnologiji, ki slonijo na tradicionalnih pristopih biotehnologije.</p> <p>Koncept predmeta komparativno združuje spekter komplementarni znanja, od področja mikrobiologije pa do biotehnološkega inženirstva, kar omogoča celovito razumevanje delovanja bioprosesov in njihovo obvladovanje v raziskovanem, razvojnem delu in prenosu v industrijsko delu.</p> <p>Študenti se bodo srečali z novimi koncepti v mikrobni biotehnologiji, ki slonijo na modernih metodah, in zato bistveno spreminjajo pogled na razvoj in raziskave in industrijsko proizvodnjo na področju sodobne mikrobne biotehnologije.</p>	<p>Objectives and competences:</p> <p>Students will receive a new information and understanding related to wider platform of modern approaches in microbial biotechnology, originally based on the traditional concepts in biotechnology.</p> <p>The course is unifying complementary knowledge, from wider areas of microbiology to biotechnological engineering, thus ensuring comprehensive understanding on how bioprocesses are developed during research and development efforts and transferred to the industrial environment.</p> <p>Students will meet a new concepts in modern microbial biotechnology, based on recently developed methods, which will clearly have great impact in the near future development in the area of microbial biotechnology.</p>
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Predvideni študijski rezultati:

Intended learning outcomes:

<p>Znanja in razumevanje novih konceptov mikrobne biotehnologije, ki se naslanjajo predvsem na uporabo večnamenskih industrijskih gensko manipuliranih gostiteljskih mikroorganizmov (ang. Chassis), ki slonijo na modernih metodah biosinteznega in metabolnega inženirstva, sintezne biologije, omskih pristopov, od katerih so nekatere še v razvoju, vendar že bistveno spreminjajo pogled na raziskovalno razvojne aktivnosti v mikrobni biotehnologiji.</p> <p>Vsebinsko se bo predmet povezoval med teorijo in prakso metod dela z industrijskimi mikroorganizmi v laboratoriju in prenosu v industrijsko okolje in ima jasne vsebinske povezave do drugih vej biotehnologije, kot so npr. farmacevtska, medicinska, živilska, in okoljevarstvena biotehnologij. Zato bo predmet prinašala uporabna znanja in razumevanje tudi za študente, ki ne delujejo neposredno na področju mikrobne biotehnologije.</p>	<p>Student will gain knowledge and understanding of new concepts in microbial biotechnology, based on the use of multipurpose host organisms (chassis), where modern methods such as biosynthetic and metabolic engineering, synthetic biology and omics approaches are applied, some of which are still being developed, but will clearly have near future impact in R&amp;D activities in strain and industrial process development.</p> <p>Content of the course will interconnect between theoretical knowledge and practical methodologies, applied in the work with industrial microorganisms at the laboratory scale and their transfer to the industrial environment. The course has obvious connections to the other areas of biotechnology such as pharmaceutical, medical food and environmental biotechnology, thus bringing valuable knowledge to students not closely familiar with are of microbial biotechnology.</p>
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<p>Metode poučevanja in učenja: Predavanja, osebne konzultacije in individualno delo v sklopu priprave seminarske naloge</p>	<p>Learning and teaching methods: Lecture, personal consultations and individual work on seminar-projects.</p>
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Načini ocenjevanja:	Delež/Weight	Assessment:
Seminar	70,00 %	Seminar
Ustni Izpit	30,00 %	Oral exam

<p>Reference nosilca/Lecturer's references:</p> <p><b>Prof. dr. Hrvoje Petković:</b></p> <ol style="list-style-type: none"> <li>Gordan Sladič, Matilda Urukalo, Matjaž Kirn, Urška Lešnik, Vasilka Magdevska, Neda Benički, Mitja Pelko, Aleš Gasparič, Peter Raspor, Tomaž Polak, Štefan Fujs, Paul A. Hoskisson and Hrvoje Petković (2014). Identification of Lipstatin Producing Ability in <i>Streptomyces virginiae</i> CBS 314.55 Using a Dereplication Approach. Food technology Biotechnology., In press.</li> <li>KENDREW, Steven Gary, PETKOVIĆ, Hrvoje, GAISSER, Sabine, READY, Sarah J., GREGORY, Matthew Alan, COATES, Nigel, NUR-E-ALAM, Mohammad, WARNECK, Tony, SUTHAR, Dipen, FOSTER, Teresa A., MCDONALD, Leonard, SCHLINGMAN, Gerhard, KOEHN, Frank E., SKOTNICKI, Jerauld S., CARTER, Guy T., MOSS, Steven J., ZHANG, Ming-Qiang, MARTIN, Christine J., SHERIDAN, Rose M., WILKINSON, Barrie. Recombinant strains for the enhanced production of bioengineered rapalogs. Metabolic engineering, ISSN 1096-7176, 2013, vol. 15, str. 167-173, [COBISS.SI-ID 4189560]</li> <li>KIRM, Benjamin, MAGDEVSKA, Vasilka, TOME, Miha, HORVAT, Marinka, KARNIČAR, Katarina, PETEK, Marko, VIDMAR, Robert, BAEBLER, Špela, JAMNIK, Polona, FUJS, Štefan, HORVAT, Jaka, FONOVIĆ, Marko, TURK, Boris, GRUDEN, Kristina, PETKOVIĆ, Hrvoje, KOSEC, Gregor. SACE_5599, a putative regulatory protein, is involved in morphological differentiation and erythromycin</li> </ol>
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production in *Saccharopolyspora erythraea*. *Microbial cell factories*, ISSN 1475-2859, 2013, vol. 12, str. 126-1-126-15. [COBISS.SI-ID 3005775]

4. LUKEŽIČ, Tadeja, LEŠNIK, Urška, PODGORŠEK, Ajda, HORVAT, Jaka, POLAK, Tomaž, ŠALA, Martin, JENKO, Branko, RASPOR, Peter, HERRON, Paul R., HUNTER, Iain S., PETKOVIĆ, Hrvoje.

Identification of the chelocardin biosynthetic gene cluster from *Amycolatopsis sulphurea* : a platform for producing novel tetracycline antibiotics. *Microbiology*, ISSN 1350-0872, 2013, vol. 159, no. 12, str. 2524-2532, [COBISS.SI-ID 27043111]

5. BLAŽIČ, Marko, STARCEVIC, Antonio, LISFI, Mohamed, BARANASIC, Damir, GORANOVIČ, Dušan, FUJS, Štefan, KUŠČER, Enej, KOSEC, Gregor, PETKOVIĆ, Hrvoje, CULLUM, John, HRANUELI, Daslav, ZUCKO, Jurica. Annotation of modular PKS and NRPS gene clusters in the genome of *Streptomyces tsukubaensis* NRRL18488. *Applied and environmental microbiology*, ISSN 0099-2240, 2012, vol. 78, no. 23, str. 8183-8190, [COBISS.SI-ID 4142456]

6. GORANOVIČ, Dušan, BLAŽIČ, Marko, MAGDEVSKA, Vasilka, HORVAT, Jaka, KUŠČER, Enej, POLAK, Tomaž, SANTOS-ABERTURAS, Javier, MARTÍNEZ-CASTRO, Miriam, BARREIRO, Carlos, MRAK, Peter, KOPITAR, Gregor, KOSEC, Gregor, FUJS, Štefan, MARTÍN, Juan F., PETKOVIĆ, Hrvoje. FK506 biosynthesis is regulated by two positive regulatory elements in *Streptomyces tsukubaensis*. *BMC microbiology*, ISSN 1471-2180, 2012, vol. 12, [article no.] 238, str. 1-15, [COBISS.SI-ID 4146808]

7. KOSEC, Gregor, GORANOVIČ, Dušan, MRAK, Peter, FUJS, Štefan, KUŠČER, Enej, HORVAT, Jaka, KOPITAR, Gregor, PETKOVIĆ, Hrvoje. Novel chemobiosynthetic approach for exclusive production of FK506. *Metabolic engineering*, ISSN 1096-7176, 2012, vol. 14, str. 39-46, doi: 10.1016/j.ymben.2011.11.003. [COBISS.SI-ID 3988600]

8. GORANOVIČ, Dušan, KOSEC, Gregor, MRAK, Peter, FUJS, Štefan, HORVAT, Jaka, KUŠČER, Enej, KOPITAR, Gregor, PETKOVIĆ, Hrvoje. Origin of the Allyl group in FK506 biosynthesis. *The Journal of biological chemistry*, ISSN 0021-9258, 2010, vol. 285, no. 19, str. 14292-14300, [COBISS.SI-ID 3754104]

9. MAGDEVSKA, Vasilka, GABER, Rok, GORANOVIČ, Dušan, KUŠČER, Enej, BOAKES, Steve, DURAN ALONSO, Maria Beatriz, SANTAMARÍA, Ramon, RASPOR, Peter, LEADLAY, Peter Francis, FUJS, Štefan, PETKOVIĆ, Hrvoje. Robust reporter system based on chalcone synthase *rppA* gene from *Saccharopolyspora erythraea*. *Journal of microbiological methods*, ISSN 0167-7012. [Print ed.], 2010, vol. 83, str. 111-119, [COBISS.SI-ID 3811960]

10. LEŠNIK, Urška, GORMAND, Amelie, MAGDEVSKA, Vasilka, FUJS, Štefan, RASPOR, Peter, HUNTER, Iain S., PETKOVIĆ, Hrvoje. Regulatory elements in tetracycline-encoding gene clusters : the *otcG* gene positively regulates the production of oxytetracycline in *Streptomyces rimosus*. *Food technology and biotechnology*, ISSN 1330-9862, 2009, vol. 47, no. 3, str. 323-330. [COBISS.SI-ID 3608696].

#### **prof. dr. Mojca Benčina**

1. DUŠAK, Peter, BENČINA, Mojca, TURK, Martina, BAVČAR, Dejan, KOŠMERL, Tatjana, BEROVIČ, Marin, MAKOVEC, Darko. Application of magneto-responsive *Oenococcus oeni* for the malolactic fermentation in wine. *Biochemical engineering journal*, ISSN 1369-703X. [Print ed.], 15 June 2016, vol. 110, str. 134-142, doi: 10.1016/j.bej.2016.02.016. [COBISS.SI-ID 4977768]

2. BINDER, Ulrike, BENČINA, Mojca, FIZIL, Ádám, BATA, Gyula, CHILLAR, Anil K., MARX, Florentine. Protein kinase A signaling and calcium ions are major players in PAF mediated toxicity against *Aspergillus niger*. *FEBS letters*, ISSN 0014-5793. [Print ed.], May 2015, vol. 589, iss. 11, str. 1266-1271. doi: 10.1016/j.febslet.2015.03.037. [COBISS.SI-ID 5696026]

3. VALKONEN, Mari, PENTTILÄ, Merja, **BENČINA, Mojca**. Intracellular pH responses in the industrially important fungus *Trichoderma reesei*. *Fungal genetics and biology*, ISSN 1087-1845, Sep. 2014, vol. 70, str. 86-93, doi: 10.1016/j.fgb.2014.07.004. [COBISS.SI-ID 5533978]

4. VALKONEN, Mari, MOJZITA, Dominik, PENTTILÄ, Merja, **BENČINA, Mojca**. Non-invasive high-throughput single-cell analysis of the intracellular pH of yeast by ratiometric flow cytometry.

Applied and environmental microbiology, ISSN 0099-2240, 2013, vol. 79, no. 23, str. 7179-7187, doi: 10.1128/AEM.02515-13. [COBISS.SI-ID 5323802]

5. GABER, Rok, MAJERLE, Andreja, JERALA, Roman, **BENČINA, Mojca**. Noninvasive high-throughput single-cell analysis of HIV protease activity using ratiometric flow cytometry. Sensors, ISSN 1424-8220, Dec. 2013, vol. 13, iss. 12, str. 16330-16346, doi: 10.3390/s131216330. [COBISS.SI-ID 5383706]

6. BAGAR, Tanja, **BENČINA, Mojca**. Antiarrhythmic drug amiodarone displays antifungal activity, induces irregular calcium response and intracellular acidification of "Aspergillus niger" - Amiodarone targets calcium and pH homeostasis of "A. niger". Fungal genetics and biology, ISSN 1096-0937, 2012, vol. 49, iss. 10, str. 779-791, doi: 10.1016/j.fgb.2012.07.007. [COBISS.SI-ID 5038618]

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Načrtovanje raziskovalnega dela, poročanje in priprava projektov
Course title:	Planning of research activities, reporting and project proposals

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3791
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	55	0	0	0	65	5

Nosilec predmeta/Lecturer:	Borut Bohanec
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Izvajalci predavanj:	Borut Bohanec in vabljeni predavatelji
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Slovenščina, Angleščina
	Vaje/Tutorial:	Slovenščina, Angleščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij	General conditions for enrollment in doctoral studies

Vsebina:	Content (Syllabus outline):
Izbira raziskovalnega področja glede na usposobljenost raziskovalca in raziskovalne skupine. Temeljni ali aplikativni projekti: kriterij znanstvene novosti, kriterij uporabnosti. Agencije pristojne za financiranje znanstveno raziskovalnega dela v SLO, EU in drugod. Projekti bilateralnega sodelovanja. Postopki prijave projektov, iskanje partnerjev, odločitev	The choice of research areas according to the capacity of researchers and research groups . Basic or applied projects: the criterion of scientific novelty and usefulness. Agencies responsible for funding of scientific research in Slovenia, EU and elsewhere . Projects of bilateral cooperation . Procedures of filing projects , partner search , the decision of the

<p>o nosilcu ali regionalnem nosilcu. Kritični elementi prijave: hipoteza, stanje znanosti, obseg dela, usposobljenost, reference prijavitelja.</p> <p>Enostopenjska ali dvostopenjska projektna dokumentacija. Poodobritveni postopki – pogajanja s finanserji in usklajevanje s sodelavci. Izvajanje odobrene naloge- roki, mejniki, zaključni rezultati. Poročanje in finančno vodenje projekta glede na tip projekta in njegov nacionalni ali mednarodni značaj. Specializirana podjetja za finančno vodenje projektov. Pisanje znanstvenih objav s povdankom na preveritvi originalnosti hipoteze, izbiri relevantne metode dela glede na obstoječe možnosti, kontaktiranje s sodelavci, pristop k pisanju članka, pristop k izbiri najustreznejše revije.</p> <p>Prijava patentov: odločitev o potrebi in možnosti za patentiranje, cilj– lokalni ali mednarodni patent, konzultiranje patentne pisarne, proučitev možnosti za odkup patenta.</p>	<p>coordinator or regional institution. Critical elements of the application : hypothesis , the state of science , scope of work , qualifications , references of the applicant .</p> <p>Single-stage or two-stage project documentation . Follow-up procedures - negotiations with funding agencies and coordination with colleagues. Implementation of the approved tasks - dates , mile stones, the final results . Reporting and financial management of the project according to the project type and its national or international character . Companies specializing in the financial management of projects. Writing scientific publications with an emphasis on originality verification of hypotheses , selecting the relevant methods according to the existing options , contact with colleagues, approach to writing an article , approach to the selection of the most appropriate journals .</p> <p>Patent applications : the decision on the need and potential for patenting, goal - local or international patents , consulting patent attorneys, exploring options for the purchase of patent.</p>
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<p>Temeljna literatura in viri/Readings:</p>	
<p><b>5. Temeljni študijski viri</b></p> <p>RA Day (2006): How to write and publish a scientific paper. ISBN 0-313-33027-1</p> <p>AJ Friedland &amp; CL Folt (2009): Writing successful science proposals ISBN 978-0-300-11939</p> <p>PG Chapin (2004) Research projects and research proposals ISBN 0-521-83015- X</p> <p>B. Strel (2007) Kako zaščititi izum. Plant GV ISBN 978-961-6529-39-6</p> <p>Druga učna gradiva (dosegljiva na VIS , available on VIS)</p>	

<p>Cilji in kompetence:</p>	<p>Objectives and competences:</p>
<p><b>Izobraževalni cilji:</b></p> <p>Temeljni izobraževalni cilj je seznaniti slušatelje z načini in možnostmi prijave znanstveno raziskovalnih in aplikativnih projektov, njihovo vodenje in poročanje.</p> <p>Predmet tudi vključuje osnove pravil znanstvenega publiciranja in podajanja patentne prijave.</p> <p>Predvidene kompetence so obvladanje zahtev planiranja in prijave projekta, pristop k izvedbi projekta in izboljššan način poročanja o rezultatih vključno s pisanjem znanstvenih člankov. Slušatelj tudi dobi osnovna znanja,</p>	<p><b>Objectives of the course:</b></p> <p>The basic educational goal is to acquaint students with options to apply for the potential basic or applied projects, their management and reporting.</p> <p>Subject also includes the basics of the rules of scientific publishing and delivery of patent applications.</p> <p>Provided the mastery of skills required for planning the project proposals, planning of project execution and improving way of reporting the results including writing of scientific articles. The student also gets basic</p>

kdaj in kako je primerno rezultate dela zaščititi s patentno prijavo.	knowledge how and when it is appropriate to protect new findings by a patent application.
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Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Osvojeno znanje bo omogočilo slušatelju primeren pristop do ustreznega znanstvenega poročanja, ga vodilo k prijavi domačih in mednarodnih projektov ob poznavanju pasti na poti do uspeha, ga usposablja za finančno vodenje projektov in ga seznanja z možnostjo intelektualne zaščite novih odkritij.	Knowledge and Understanding: Attained knowledge will guide the student to use suitable approach to proper scientific reporting, and led him to the application of domestic and international projects. Knowledge is additionally focused on appropriate ways to the financial management of running projects and it provides the possibility of intellectual protection of new discoveries.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja so organizirana v 6ih sklopih, pri katerih slušatelji sodelujejo z neposrednimi vprašanji in sugeriranji dodatnih vsebin, v drugem pa gre za individualno pripravo in branjenje teze projekta, ki pa je skupinsko obravnavan.	Lectures are composed of 6 thematic subjects in which students contribute with direct questions and suggestions of additional contents, the second focused on individual preparation and defence the thesis projects, which are discussed collectively.

Načini ocenjevanja:	Delež/Weight	Assessment:
Ocenjuje se izdelava in predstavitev projektne naloge. Pogoji za vnos ocene je vsaj 80% prisotnost na predavanjih.	100,00 %	Thesis projects are estimate. At least 80% attendance at lectures is required.

Reference nosilca/Lecturer's references:
<p><b>Borut Bohanec</b></p> <p>RUDOLF PILIH, Katarina, PETKOVŠEK, Marko, JAKŠE, Jernej, ŠTAJNER, Nataša, MUROVEC, Jana, BOHANEK, Borut. Proposal of a new hybrid breeding method based on genotyping, inter-pollination, phenotyping and paternity testing of selected elite F1 hybrids. <i>Frontiers in plant science</i>. 2019, art. 1111, vol. 10, str. 1-12. ISSN 1664-462X</p> <p>STAJIČ, Ester, KIEŁKOWSKA, Agnieszka, MUROVEC, Jana, BOHANEK, Borut. Deep sequencing analysis of CRISPR/Cas9 induced mutations by two delivery methods in target model genes and the CENH3 region of red cabbage (<i>Brassica oleracea</i> var. <i>capitata</i> f. <i>rubra</i>). <i>Plant cell, tissue and organ culture</i>. [Print ed.]. 2019, vol. 139, iss. 2, str. 227-235.</p> <p>MUROVEC, Jana, GUČEK, Katja, BOHANEK, Borut, AVBELJ, Monika, JERALA, Roman. DNA-free genome editing of <i>Brassica oleracea</i> and <i>B. rapa</i> protoplasts using CRISPR-Cas9 ribonucleoprotein complexes. <i>Frontiers in plant science</i>. 2018, art. 1594, vol. 9, str. 1-9. ISSN 1664-462X.</p> <p>BANJANAC, Tijana, DRAGIĆEVIĆ, Milan, ŠILER, Branislav, GAŠIĆ, Uroš, BOHANEK, Borut, NESTOROVIĆ ŽIVKOVIĆ, Jasmina, TRIFUNOVIĆ, Snežana, MIŠIĆ, Danijela. Chemodiversity of two closely related tetraploid <i>Centaurium</i> species and their hexaploid hybrid: Metabolomic search for high-resolution taxonomic classifiers. <i>Phytochemistry</i>.</p>

WEBER, Tim, JAKŠE, Jernej, SLADONJA, Barbara, HRUŠEVAR, Dario, LANDEKA, Nediljko, BRANA, Slavko, BOHANEK, Borut, MILOVIĆ, Milenko, VLADOVIĆ, Dalibor, MITIĆ, Božena, POLJUHA, Danijela. Molecular study of selected taxonomically critical taxa of the genus *Iris* L. from the broader Alpine-Dinaric area. *Plants*. 2020, vol. 9, no. 9, 1229, str. 1-16.

MLINAREC, Jelena, SKUHALA, Ana, JURKOVIĆ, Adela, MALENICA, Nenad, MCCANN, Jamie, WEISS-SCHNEEWEISS, Hanna, BOHANEK, Borut, BESENDORFER, Višnja. The repetitive DNA composition in the natural pesticide producer *Tanacetum cinerariifolium*: interindividual variation of subtelomeric tandem repeats. *Frontiers in plant science*. 2019, art. 613, vol. 10, str. 1-14.



## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Naravna zdravila iz gliv, rastlin in živali
Course title:	Natural medicines from fungi, plants and animals

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3792
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	30	0	0	5	80	5

Nosilec predmeta/Lecturer:	Kristina Sepčič
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Izvajalci predavanj:	doc. dr. Andrej Gregori, Samo Kreft, Kristina Sepčič, Borut Štrukelj
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Končan univerzitetni ali drugostopenjski bolonjski študij iz širšega področja naravoslovja, matematike in računalništva oziroma ožjega področja Vede o živi naravi (klasifikacija po Klasius-u).	Completed university studies or bologna masters in natural sciences, mathematics and computer studies or the narrower field of life sciences (Klasius classification).

Vsebina:	Content (Syllabus outline):
Predstavljene bodo naslednje vsebine: 1. Zdravilne učinkovine rastlinskega izvora in rastlinski izvlečki s poudarkom pa klinično potrjenih primerih uporabe zdravilnih rastlin,	The following contents will be presented and discussed:

<p>njihova izolacija, molekularni način delovanja in uporaba v terapevtske namene;</p> <p>2. Pomen gob v kitajski tradicionalni medicini in po svetu, vrste medicinskih gob, biotehnološki postopki gojenja, ekstrakcija aktivnih komponent iz gliv (encimi, polisaharidi, lektini, antioksidanti, terpenoidi, proteoglikani in proteinski derivati), uporaba prehranskih dopolnil za preventivne in kurativne namene ter lajšanje simptomov antitumorske terapije, ter priprava preparatov v obliki tinktur, praškov ali kapsul;</p> <p>3. Sinteza, pomen, pridobivanje in biološka aktivnost naravnih produktov živalskega izvora, s posebnim poudarkom na spojinah iz morskih živali. Uporaba naravnih produktov morskega izvora in živalskih toksinov v biomedicini, biotehnologiji, farmakologiji in industriji.</p>	<ol style="list-style-type: none"> <li>1. Medicinal substances from plants as well as plant crude extracts will be presented in terms of their structure/activity relationship, therapeutic use and clinical importance;</li> <li>2. The importance of mushrooms in Chinese traditional medicine and worldwide, species of medicinal mushrooms, biotechnological methods of their cultivation, extraction of active components from fungi (enzymes, polysaccharides, lectins, antioxidants, terpenoids, proteoglycans and protein derivatives), the use of nutrition supplements for preventive and curative purposes and relieve the symptoms of antitumour therapies, and preparation of fungal products in the form of tinctures, powders or capsules;</li> <li>3. The synthesis, biological significance, purification and biological activity of natural products from animal sources. Particular emphasis will be given to natural products deriving from marine animals. The use of marine natural products and animal toxins in biomedicine, biotechnology, pharmacology and industry.</li> </ol>
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Temeljna literatura in viri/Readings:

Učbenik: *Sodobna fitoterapija*, urednika: Samo Kreft, Nina Glavač Hočevar, SFD, 2013, ISBN: 978-961-92900-5-7/ Monograph: *Modern Phytotherapy*, SFD 2013, Samo Kreft, Nina Glavač Hočevar, eds; ISBN: 978-961-92900-5-7

Pregledni članki in novejši znanstveni članki s področja/Review papers and recent scientific papers

<p>Cilji in kompetence:</p> <p>Študent se bo poglobil v ožjo raziskovalno problematiko, ki jo bo nadgrajeval v svoji doktorski disertaciji. Predmet ni namenjen ekstenzivnemu širjenju teoretičnega znanja, pač pa je cilj predstavitev določenih problemov in obvladovanje specifičnih metod in tehnik, ki lahko pripomorejo k rešitvi problemom. Namenjen je tudi poznavanju pregleda predhodnih raziskav s področja bodoče doktorske disertacije študenta.</p>	<p>Objectives and competences:</p> <p>Students will get deeper insight into research problems which he or she will upgrade in her/his doctoral thesis. The contents are not intended to extensively broaden the theoretical knowledge but should introduce specific problems, indicate methods and techniques with which the problem can be addressed. Students should get familiar with previous research in the field of their doctoral thesis.</p>
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<p>Predvideni študijski rezultati:</p> <p>Znanje in razumevanje: Zgoraj opisan pristop se mora odraziti v pravilnem načrtovanju raziskav in poskusov, ki vodijo k preizkusu hipotez zastavljenih v temi doktorske disertacije.</p>	<p>Intended learning outcomes:</p> <p>Knowledge and understanding: Such an approach should result in the proper planning of research experiments which can test the hypotheses raised in the doctoral thesis.</p>
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Metode poučevanja in učenja:	Learning and teaching methods:
Neposredna predavanja naštetih nosilcev (vsak 2.5 uri), priprava in vodenje Journal clubov; priprava problemskih nalog, diskusije in konzultacije glede njihovega reševanja. Pregled in poprava rešitev problemskih nalog.	Frontal ex-cathedra teaching (2.5 hr per lecturer); preparation and supervision of Journal clubs; preparation of problem tasks, discussion and consultation. Assessment and correction of problem solutions.

Načini ocenjevanja:	Delež/Weight	Assessment:
Oddaja rešene problemske naloge,	50,00 %	Presentation of problem solution,
sodelovanje na journal club-ih.	50,00 %	participation at journal clubs.

Reference nosilca/Lecturer's references:
<p><b>Kristina Sepčič:</b></p> <ol style="list-style-type: none"> <li>1. TADESSE Margey, SVENSON Johan, SEPČIČ Kristina, TREMBLEAU L, ENGQVIST M, ANDERSEN JH, JASPARS Marcel, STENSIVAG Klara, HAUG Tor. <u>Isolation and Synthesis of Pulmonarins A and B, Acetylcholinesterase Inhibitors from the Colonial Ascidian Synoicum pulmonaria.</u> <i>J Nat Prod.</i> 2014 Feb 18. [DOI: 10.1021/np401002s]</li> <li>2. TURK, Tom, AMBROŽIČ, Jerneja, BATISTA, Urška, STRUGAR, Gašper, KOSMINA, Rok, ČIVOVIČ, Sandra, JANUSSEN, Dorte, KAUFERSTEIN, Silke, MEBS, Dietrich, SEPČIČ, Kristina. Biological activities of ethanolic extracts from deep-sea Antarctic marine sponges. <i>Marine drugs</i>, ISSN 1660-3397, 2013, vol. 11, no. 4, str. 1126-1139. <a href="http://www.mdpi.com/1660-3397/11/4/1126">http://www.mdpi.com/1660-3397/11/4/1126</a>, doi: <a href="https://doi.org/10.3390/md11041126">10.3390/md11041126</a>. [COBISS.SI-ID 2762319]</li> <li>3. ZOVKO, Ana, VAUKNER, Maja, SEPČIČ, Kristina, POHLEVEN, Franc, JAKLIČ, Domen, GUNDE-CIMERMAN, Nina, TURK, Tom, et al. Antifungal and antibacterial activity of 3-alkylpyridinium polymeric analogs of marine toxins. <i>International biodeterioration &amp; biodegradation</i>, ISSN 0964-8305. [Print ed.], 2012, vol. 68, str. 71-77. <a href="http://dx.doi.org/10.1016/j.ibiod.2011.10.014">http://dx.doi.org/10.1016/j.ibiod.2011.10.014</a>, doi: <a href="https://doi.org/10.1016/j.ibiod.2011.10.014">10.1016/j.ibiod.2011.10.014</a>. [COBISS.SI-ID 2500943]</li> <li>4. SEPČIČ, Kristina, ZALAR, Polona, GUNDE-CIMERMAN, Nina. Low water activity induces the production of bioactive metabolites in halophilic and halotolerant fungi. <i>Marine drugs</i>, ISSN 1660-3397, 2011, vol. 9, issue 1, str. 43-58, doi: <a href="https://doi.org/10.3390/md9010043">10.3390/md9010043</a>. [COBISS.SI-ID 2320719]</li> <li>5. HOUSSEN, Wael E., SEPČIČ, Kristina, TURK, Tom, ZOVKO, Ana, et al. Chemical synthesis and biological activities of 3-alkyl pyridinium polymeric analogues of marine toxins. <i>Journal of chemical biology</i>, 2010, issue 3, vol. 3, str. 113-125. <a href="http://dx.doi.org/10.1007/s12154-010-0036-4">http://dx.doi.org/10.1007/s12154-010-0036-4</a>, doi: <a href="https://doi.org/10.1007/s12154-010-0036-4">10.1007/s12154-010-0036-4</a>. [COBISS.SI-ID 2185807]</li> <li>6. SEPČIČ, Kristina, KAUFERSTEIN, Silke, MEBS, D., TURK, Tom. Biological activities of aqueous and organic extracts from tropical marine sponges. <i>Marine drugs</i>, ISSN 1660-3397, 2010, vol. 8, str. 1550-1566. [COBISS.SI-ID 2214223]</li> </ol> <p><b>Gregori Andrej:</b></p> <ol style="list-style-type: none"> <li>1. GREGORI, Andrej. Medicinal mushrooms native to Slovenia = Zdravilne gobe rastoče v Sloveniji. <i>Acta biologica slovenica : ABS</i>, ISSN 1408-3671. [Tiskana izd.], 2013, vol. 56, št. 2, str. 9-22. [COBISS.SI-ID 3104335]</li> <li>2. GREGORI, Andrej, POHLEVEN, Franc. Cultivation of three medicinal mushroom species on olive oil press cakes containing substrates. <i>Acta agriculturae Slovenica</i>, ISSN 1581-9175. [Tiskana izd.], 2014, letn. 103, št. 1, str. 49-54, ilustr. <a href="http://aas.bf.uni-lj.si/marec2014/05Gregori.pdf">http://aas.bf.uni-lj.si/marec2014/05Gregori.pdf</a>. [COBISS.SI-ID 7930745]</li> <li>3. GREGORI, Andrej. Cordycepin production by <i>Cordyceps militaris</i> cultivation on spent brewery grains = Proizvodnja kordicepina z gojenjem glive <i>Cordyceps militaris</i> na pivovarskih tropinah. <i>Acta biologica slovenica : ABS</i>, ISSN 1408-3671. [Tiskana izd.], 2014, vol. 57, št. 2, str. 45-52, ilustr. [COBISS.SI-ID 1024584554]</li> <li>4. BEROVIČ, Marin, HABIJANIČ, Jožica, BOH PODGORNIK, Bojana, GREGORI, Andrej, ŠVAGELJ, Mirjan, WRABER-HERZOG, Branka. Production of antitumor fungal polysaccharides of <i>Ganoderma lucidum</i> and</li> </ol>

Grifola frondosa by solid state cultivation of wood industry wastes. *Annals of Agrarian Science*, ISSN 1512-1887, 2014, vol. 12, no. 3, str. 8-14. [COBISS.SI-ID [1024554602](#)]

5. CÖR, Darija, BOTIČ, Tanja, KNEZ, Željko, BATISTA, Urška, GREGORI, Andrej, POHLEVEN, Franc, BONČINA, Tonica. Two-stage extraction of antitumor, antioxidant and antiacetylcholinesterase compounds from *Ganoderma lucidum* fruiting body. *The Journal of supercritical fluids*, ISSN 0896-8446. [Print ed.], Jul. 2014, vol. 91, str. 53-60, doi: [10.1016/j.supflu.2014.04.006](#). [COBISS.SI-ID [17803030](#)]
6. BEROVIČ, Marin, ŠVAGELJ, Mirjan, HABIJANIČ, Jožica, GREGORI, Andrej, BOH PODGORNIK, Bojana, PANKL, Mojca, WRABER-HERZOG, Branka. Cultivation of medicinal mushrooms *Ganoderma lucidum* and *Grifola frondosa* mycelia and polysaccharides in bioreactors. *International journal of chemical engineering*, 2015, vol. 2, iss. 1, str. 53-57. <http://seekdl.org/nm.php?id=6861>. [COBISS.SI-ID [1536628419](#)]

#### **Borut Štrukelj:**

1. TAVČAR BENKOVIČ, Eva, GROHAR, Tina, ŽIGON, Dušan, ŠVAJGER, Urban, JANEŠ, Damjan, KREFT, Samo, ŠTRUKELJ, Borut. Chemical composition of the silver fir (*Abies alba*) bark extract Abigenol and its antioxidant activity. *Industrial crops and products*, ISSN 0926-6690, vol. 52, jan. 2014, str. 23-28
2. SABOTIČ, Jerica, BLEULER-MARTINEZ, Silvia, RENKO, Miha, AVANZO CAGLIČ, Petra, KALLERT, Sandra, ŠTRUKELJ, Borut, TURK, Dušan, AEBI, Markus, KOS, Janko, KÜNZLER, Markus. Structural basis of trypsin inhibition and entomotoxicity of cospin, a serine protease inhibitor involved in defence of *Coprinopsis cinerea* fruiting bodies. *The Journal of biological chemistry*, ISSN 0021-9258, 2012, vol. 287, issue 6, str. 3898-3907
3. PAŠKULIN, Roman, JAMNIK, Polona, DANEVČIČ, Tjaša, KOŽELJ, Gordana, KRAŠOVEC, Rok, KRSTIĆ-MILOŠEVIČ, Dijana, BLAGOJEVIČ, Duško, ŠTRUKELJ, Borut. Metabolic plasticity and the energy economizing effect of ibogaine, the principal alkaloid of *Tabernanthe iboga*. *Journal of ethnopharmacology*, ISSN 0378-8741. [Print ed.], 2012, vol. 143, issue 1, str. 319-324, doi: [10.1016/j.jep.2012.06.039](#). [COBISS.SI-ID [4106104](#)]
4. POHLEVEN, Jure, BRZIN, Jože, VRABEC, Lara, LEONARDI, Adrijana, ČOKL, Andrej, ŠTRUKELJ, Borut, KOS, Janko, SABOTIČ, Jerica. Basidiomycete *Clitocybe nebularis* is rich in lectins with insecticidal activities. *Applied microbiology and biotechnology*, ISSN 0175-7598, 2011, vol. 91, no. 4, str. 1141-1148, doi: [10.1007/s00253-011-3236-0](#). [COBISS.SI-ID [24763431](#)]
5. RADIĆ, Nataša, JEVNIKAR, Zala, OBERMAJER, Nataša, KRISTL, Jernej, KOS, Janko, POHLEVEN, Franc, ŠTRUKELJ, Borut. Influence of culinary-medicinal maitake mushroom, *grifola frondosa* (dicks.: fr.) s.f. gray (aphyllophoromycetideae) polysaccharides on gene expression in jurkat t lymphocytes. *International journal of medicinal mushrooms*, ISSN 1521-9437, 2010, vol. 12, iss. 3, str. 245-255. [http://dl.begellhouse.com/journals/708ae68d64b17c52\\_2da9c44d295f30f8.html](http://dl.begellhouse.com/journals/708ae68d64b17c52_2da9c44d295f30f8.html). [COBISS.SI-ID [2847345](#)]
6. RAVNIKAR, Matjaž, IRMAN, Andreja, RADIĆ, Nataša, LUNDER, Mojca, ŠTRUKELJ, Borut, et al. Chemoporation using saponins or cholates: an alternative method for transformation of bacterial. *Biotechnology letters*, ISSN 0141-5492, 2009, iss. 12, vol. 31, str.1943-1946. <http://www.springerlink.com/content/m614735385788p16/>, doi: [10.1007/s10529-009-0101-7](#). [COBISS.SI-ID [2682481](#)]

#### **Samo Kreft:**

1. SLANC, Petra, DOLJAK, Bojan, KREFT, Samo, LUNDER, Mojca, JANEŠ, Damjan, ŠTRUKELJ, Borut. Screening of selected food and medicinal plant extracts for pancreatic lipase inhibition. *Phytotherapy research*, ISSN 0951-418X, 2009, vol. 23, no. 6, str. 874-877. <http://www3.interscience.wiley.com/journal/112593704/issue>, doi: [10.1002/ptr.2718](#). [COBISS.SI-ID [2491505](#)]
2. KREFT, Samo, JANEŠ, Damjan, KREFT, Ivan. The content of fagopyrin and polyphenols in common and tartary buckwheat sprouts. *Acta pharmaceutica*, ISSN 1330-0075, 2013, vol. 63, no. 4, str. 553-560, ilustr. <http://public.carnet.hr/acphee/55313.pdf>, <http://public.carnet.hr/acphee/55313.htm>. [COBISS.SI-ID [3577457](#)]
3. KOČEVAR GLAVAČ, Nina, KOŠIR, Iztok Jože, RODE, Janko, KREFT, Samo. Optimization and use of a spectrophotometric method for determining polysaccharides in *Echinacea purpurea*. *Central European journal of biology*, ISSN 1895-104X, 2012, vol. 7, issue 1, str. 126-131, doi: [10.2478/s11535-011-0091-z](#). [COBISS.SI-ID [583820](#)]
4. KOČEVAR GLAVAČ, Nina, KREFT, Samo. Excretion profile of glycyrrhizin metabolite in human urine. *Food chemistry*, ISSN 0308-8146. [Print ed.], 2012, vol. 131, iss. 1, str. 305-308.

<http://www.sciencedirect.com/science/article/pii/S0308814611012350>, doi: [10.1016/j.foodchem.2011.08.081](https://doi.org/10.1016/j.foodchem.2011.08.081). [COBISS.SI-ID 3299953]

5. TAVČAR, Eva, TURK, Erika, KREFT, Samo. Simple modification of Karl-Fischer titration method for determination of water content in colored samples. *Journal of Analytical Methods in Chemistry (Print)*, ISSN 2090-8865, 2012, vol. 2012, art. no. 379724, str. 379724-1-379724-6. <http://www.hindawi.com/journals/jamc/2012/379724/>, doi: [10.1155/2012/379724](https://doi.org/10.1155/2012/379724). [COBISS.SI-ID 3257201]
6. JANEŠ, Damjan, PROSEN, Helena, KREFT, Samo. Identification and quantification of aroma compounds of tartary buckwheat (*Fagopyrum tataricum* gaertn.) and some of its milling fractions. *Journal of food science*, ISSN 0022-1147, 2012, vol. 7, no. 7, str. C746-C751, ilustr. <http://onlinelibrary.wiley.com/doi/10.1111/j.1750-3841.2012.02778.x/pdf>, doi: [10.1111/j.1750-3841.2012.02778.x](https://doi.org/10.1111/j.1750-3841.2012.02778.x). [COBISS.SI-ID 3287153]

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Naslednje generacije molekulskih markerjev
Course title:	Next generation of molecular markers

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3793
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
12	16	0	0	12	85	5

Nosilec predmeta/Lecturer:	Nataša Štajner
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Izvajalci predavanj:	Jernej Jakše, Nataša Štajner
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij.	General conditions for enrollment in doctoral studies.

Vsebina:	Content (Syllabus outline):
<p>Genetski molekularni markerji so dedni polimorfizmi, ki so povezani s spremembami v DNA zaporedju in jih lahko odkrijemo in določimo v eni ali več populacijah preiskovanih organizmov. So nedvoumno izborno orodje moderne genetike in omogočajo študije pomembnih vprašanj populacijske genetike, ekološke genetike in evolucije. Tehnologije naslednjih generacij določevanja nukleotidnih zaporedij (NGS) povzročajo revolucionarne spremembe v genetskih analizah. Trenutno se večina NGS pristopov uporablja za sekvenciranje individualnih genomov, vendar se zaradi znatne globine sekvenciranja podatki lahko aplicirajo tudi na področju molekularnih markerjev. Posebno so atraktivni za uporabo npr. v populacijskih analizah nemodelnih organizmov.</p> <p>Pri predmetu bomo študentom predstavili naslednje vsebine:</p> <p>a) Kratke osnove trenutno uporabnih NGS pristopov in vpliv NGS na tehnologije genetskih markerjev (primerjave s tradicionalnimi molekularnimi markerji).</p> <p>b) Odkrivanje NGS molekularnih markerjev in trenutne genotipizacijske metode (sekvenciranje zmanjšane vzorca kot sta metodi knjižnice zmanjšanih vzorcev – RRL in zmanjšane kompleksnosti polimorfni zaporedij – CroPS; RAD-seq oz. z restrikcijskimi mesti povezani DNA markerji; genotipizacija z nizko pokritostjo, ki vključuje genotipizacijo s sekvenciranjem (GBS) in hkratno hitro genotipizacijo (MSG)).</p> <p>c) Načrtovanje eksperimentov pridobivanja markerjev naslednjih generacij (cilji, dostopnost referenčnega genoma, pričakovan nivo polimorfizma, izbira restrikcijskih encimov, adapterji, PCR pomnoževanje, združevanje osebkov ali hkratna analiza, izzivi).</p> <p>d) Izzivi analize podatkov (pristopi, programska oprema)</p> <p>e) Nadaljni razvoj področja.</p> <p>f) Izbrani literaturni primeri uporabe.</p>	<p>Genetic molecular markers are heritable polymorphisms that are related to changes in DNA sequence and can be detected and measured in one or more populations of individuals. They are the tools of choice of modern genetics and enable the study of important questions in population genetics, ecological genetics, and evolution. Next generation sequencing (NGS) is about to revolutionize genetic analysis. Currently NGS techniques are mainly used to sequence individual genomes, but due to the high sequence coverage these data can be applied in the field of molecular markers as well. They are especially attractive for use in e.g. population analysis of non-model organisms.</p> <p>The following topics will be included:</p> <p>a) short overview of currently used NGS methods and their impact on genetic marker technology (comparison with traditional molecular markers)</p> <p>b) NGS molecular marker discovery and current genotyping methods (reduced representation sequencing, including reduced-representation libraries (RRLs) and complexity reduction of polymorphic sequences (CroPS); Restriction site associated DNA markers or RAD-seq; and low coverage genotyping, including multiplexed shotgun genotyping (MSG) and genotyping by sequencing (GBS)).</p> <p>c) Design of next generation marker discovery experiments (goals, availability of reference genome, expected degree of polymorphisms, choice of restriction enzymes, adapters, PCR amplification, sequencing, polling of individuals or multiplexing, challenges).</p> <p>d) Data analysis challenges (methods, availability of program packages)</p> <p>e) Future directions of the field.</p> <p>f) Selected literature examples of the use.</p>

Temeljna literatura in viri/Readings:

Izbrana poglavja iz sledečih knjg:

1) Molecular Markers in Plants. Robert J. Henry (Editor). ISBN: 978-1-118-47299-6. 216 pages. September 2012, Wiley-Blackwell

2) Tag-based Next Generation Sequencing. Matthias Harbers (Editor), Guenter Kahl (Editor) ISBN: 978-3-527-32819-2. 608 pages. December 2011, Wiley-Blackwell

3) Relevantni članki (Relevant articles)

Revijalni članki s področja, tekoča periodika in druga učna gradiva.

Cilji in kompetence:	Objectives and competences:
Osnovni izobraževalni cilj predmeta je predstaviti študentom metode in pristope, ki se uporabljajo na področju naslednjih generacij molekularskih markerjev s poudarkom na nemodelnih organizmih.	The main educational aim of the course is to present methods and research activities, which are used in the field of next generation molecular markers with emphasis on non-model species.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Študent osvoji trenutna znanja, ki se tičejo razvoja in uporabe molekularskih markerjev, ki temeljijo na NGS pristopih.  Osvojene vsebine so dobra osnova za reševanje raziskovalnih problemov iz različnih področij uporabe molekularskih markerjev.	Knowledge and understanding: Acquisitions of knowledge related to design and use of molecular markers based on NGS use.  Students will get knowledge and competences which will allow them to solve research problems in the field of molecular markers.

Metode poučevanja in učenja:	Learning and teaching methods:
Učenje se izvaja v obliki predavanj, v obliki seminarja in s konzultacijami.	Lectures, seminar and consultations.

Načini ocenjevanja:	Delež/Weight	Assessment:
1) Ustno preverjanje znanja.	50,00 %	1) Oral exam.
2) Seminar in njegova predstavitev.	50,00 %	2) Seminar and its demonstration.

Reference nosilca/Lecturer's references:

**Štajner Nataša**

1. ŠTAJNER, Nataša, TOMIĆ, Lidija, IVANIŠEVIĆ, Dragoslav, KORAĆ, Nada, JOVANOVIĆ CVETKOVIĆ, Tatjana, BELESKI, Klime, ANGELOVA, Elizabeta, MARAŠ, Vesna, JAVORNIK, Branka. Microsatellite inferred genetic diversity and structure of Western Balkan grapevines (*Vitis vinifera* L.). Tree genetics & genomes, ISSN 1614-2942, 2013, vol. 10, iss. 1, str. 127-140.

<http://dx.doi.org/10.1007/s11295-013-0670-4>, doi: 10.1007/s11295-013-0670-4. [COBISS.SI-ID 7753593]

2. ŠTAJNER, Nataša, JAKŠE, Jernej, JAVORNIK, Branka, MASUELLI, R. W., MARTÍNEZ, L. E. Highly variable AFLP and S-SAP markers for the identification of 'Malbec' and 'Syrah' clones. *Vitis*, ISSN 0042-7500, 2009, letn. 48, no. 3, str. 145-150. [COBISS.SI-ID [6051961](#)]

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4. TOMIĆ, Lidija, ŠTAJNER, Nataša, JOVANOVIĆ-CVETKOVIĆ, Tatjana, CVETKOVIĆ, Miljan, JAVORNIK, Branka. Identity and genetic relatedness of Bosnia and Herzegovina grapevine germplasm. *Scientia horticulturae*, ISSN 0304-4238. [Print ed.], 2012, vol. 143, str. 122-126. <http://dx.doi.org/10.1016/j.scienta.2012.05.023>. [COBISS.SI-ID 7172473]

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6. ŠTAJNER, Nataša, ANGELOVA, Elizabeta, BOZINOVIĆ, Zvonimir, PETKOV, Mihail, JAVORNIK, Branka. Microsatellite marker analysis of Macedonian grapevines (*Vitis vinifera* L.) compared to Bulgarian and Greek cultivars. *Journal international des sciences de la vigne et du vin*, ISSN 1151-0285, 2009, vol. 43, no. 1, str. 29-34. [COBISS.SI-ID 5951609]



## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Rastlinska biotehnologija
Course title:	Plant biotechnology

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3795
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	50	0	0	30	150	10

Nosilec predmeta/Lecturer:	Nataša Štajner
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Izvajalci predavanj:	Borut Bohanec, Nataša Štajner, Špela Baebler, David Dobnik
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Zaključen drugostopenjski študij iz smeri biotehniških ved (UL-Biotehniška fakulteta). Za študente, ki v predhodnih programih niso zaključili zgoraj navedenih ustreznih smeri, se lahko določi opravljanje dodatnih obveznosti iz manjkajočih predmetov v obsegu od 10 do 30 KT prvo oz. drugostopenjskih programov.	Completed second degree of academic studies (MSc) at the Biotechnical Faculty. Students completing other related second degree study programmes may be required to enroll in additional 10-30 ECTS level 1 or 2 courses to meet the requirements.

Vsebina:	Content (Syllabus outline):
<ol style="list-style-type: none"> <li>Biotehnološki pristopi k premoščanju ovir pri manipulacijah genov in genomov pri rastlinah.</li> <li>Strategije genskega spreminjanja rastlin</li> </ol>	<ol style="list-style-type: none"> <li>Biotechnological approaches to plant gene and genome manipulation</li> <li>Strategies of plant genetic modification</li> <li>Biosafety of genetically modified plants</li> </ol>

<p>3. Presoja tveganja uporabe gensko spremenjenih rastlin</p> <p>4. Žlahtnjenje rastlin s pomočjo markerjev</p> <p>5. Diagnostika rastlinskih patogenov</p> <p>6. Primerjalna genomika pri rastlinah</p> <p>8. Rastlinska translacijska genomika</p> <p>Pri premoščanju ovir pri manipulacijah genov in genomov pri rastlinah se bodo študentje seznanili z inovativnimi biotehnološkimi metodami žlahtnjenja rastlin predvsem z genskim inženiringom in s tehnologijami mestno specifičnih nukleaz, žlahtnjenje s pomočjo markerjev in podobno. Predstavljene bodo strategije genskega spreminjanja rastlin za izboljšanje agronomskih lastnosti, odpornosti na biotske in abiotske strese, ustrežnejšo kakovost, produkcijo zdravil ali drugih komponent. Obravnavana bodo področja biološke varnosti gensko spremenjenih rastlin ter biotehnološki pristopi pri diagnostiki rastlinskih patogenov. Slušatelji se bodo nadalje seznanili z usmeritvami primerjalne genomike pri rastlinah ter z uporabo genomskih podatkov modelnih organizmov pridobljenih z visoko zmogljivimi tehnologijami in funkcijskimi analizami v žlahtnjenju rastlin.</p>	<p>4. Marker assisted selection</p> <p>5. Diagnostics of plant pathogenes</p> <p>6. Plant comparative genomics</p> <p>7. Plant translation genomics</p> <p>Student will learn about innovative biotechnological breeding methods, particularly genetic engineering, site-specific nuclease technologies and marker assisted selection. The strategies of plant genetic manipulation will include agronomic traits, resistance to biotic and abiotic stress, improvement of quality, production of drugs and other materials. Students will gain knowledge of scientific and legal aspects of biosafety and of advanced methods used in plant pathogen diagnostics. Students will also learn about plant comparative genomics and genomic data of model organisms obtained by high throughput technologies (NGS, proteomics, transcriptomics, metabolomics) and functional analysis, and their application in plant biotechnology</p>
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Temeljna literatura in viri/Readings:

Pregledni znanstveni članki področja / Review articles from specific fields

<p>Cilji in kompetence:</p> <p>Cilj je osvojitev konceptov rastlinske biotehnologije pri razvoju biotehnoloških orodij, žlahtnjenju novih kultivarjev in diganostiki rastlinskih patogenov. Poleg trdnih osnov iz rastlinkse biotehnologije je cilj predmeta predstaviti najsodobnejša znanj iz področij ekspertiz predavateljev, ki se z raziskovalnim delom uveljavljajo na mednarodni ravni.</p> <p>Kompetence, ki jih bo študent pridobil, so zlasti sposobnost celovitega razumevanja biotehnoloških konceptov in razvijanje "biotehnološkega" načina razmišljanja pri obravnavanju problemov s področja rastlinske pridelave, uporabo biotehnologije za analizo in razumevanje delovanja večplastnih bioloških sistemov, sposobnost načrtovanja poskusov ter usposobljenost za vrhunsko in odgovorno</p>	<p>Objectives and competences:</p> <p>Students in this course should be able to acquire knowledge of a wide spectrum of biotechnological concepts in the development of biotechnological tools, breeding of new cultivars and in plant pathogen diagnostics. In addition to providing solid knowledge of plant biotechnology, the aim of the course is also to present advanced, state of the art topics in plant biotechnology drawing on the expertise of course lecturers in internationally recognized research.</p> <p>Competences gained cover a comprehensive understanding of biotechnological concepts and development of a biotechnological approach to agricultural production. Competence in using advanced biotechnological tools will enable students to analyse and understand multiple layers of</p>
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delovanje na raziskovalnem področju ter v relevantnih strokovnih in svetovalnih državnih telesih (npr. etične komisije, odbori za gensko spremenjene organizme ipd.)	biological systems. Students should be competent in conducting research in plant biotechnology and participation in professional and advisory bodies (e.g., ethical committees, scientific advisory boards on genetically modified organisms etc.).
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Predvideni študijski rezultati:	Intended learning outcomes:
Pridobljeno znanje bo zadoščalo za učinkovito raziskovalno delo na področju rastlinske biotehnologije. Študent bo pridobil tudi osnovna znanja strokovnih in pravnih vidikov uporabe proizvodov rastlinske biotehnologije.	Knowledge gained in this course should provide a solid basis for efficient research work in plant biotechnology. Students will also gain basic knowledge of professional and legal issues on the use of plant biotechnology products.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja: predstavitev glavnih konceptov ter uvajanja v problematiko Seminarska naloga: obravnava specifičnega problema Individuvalne konzultacije	Lectures: introduction to concepts and topics Seminar project: work on specific topics Individual consultations

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit	60,00 %	Written final exam
opravljena seminarska naloga	40,00 %	seminar project

Reference nosilca/Lecturer's references:
<p><b>Štajner Nataša</b></p> <ol style="list-style-type: none"> <li>1. PROGAR, Vasja, JAKŠE, Jernej, <b>ŠTAJNER</b>, Nataša, RADIŠEK, Sebastjan, JAVORNIK, Branka, BERNE, Sabina. Comparative transcriptional analysis of hop responses to infection with <i>Verticillium nonalfalfae</i>. <i>Plant cell reports</i>, ISSN 0721-7714. [Print ed.], 2017, vol. 36, iss 10, str. 1599-1613</li> <li>2. POKORN, Tine, RADIŠEK, Sebastjan, JAVORNIK, Branka, <b>ŠTAJNER</b>, Nataša, JAKŠE, Jernej. Development of hop transcriptome to support research into host-viroid interactions. <i>PLoS one</i>, ISSN 1932-6203, Sep. 2017, vol. 12, iss. 9, 0184528.]</li> <li>3. FLAJŠMAN, Marko, MANDELIC, Stanislav, RADIŠEK, Sebastjan, <b>ŠTAJNER</b>, Nataša, JAKŠE, Jernej, KOŠMELJ, Katarina, JAVORNIK, Branka. Identification of novel virulence - associated proteins secreted to xylem by <i>Verticillium nonalfalfae</i> during colonization of hop plants. <i>Molecular plant-microbe interactions</i>, ISSN 0894-0282, 2016, vol. 29, no. 5, str. 362-373</li> <li>4. CREGEEN, Sara, RADIŠEK, Sebastjan, MANDELIC, Stanislav, TURK, Boris, <b>ŠTAJNER</b>, Nataša, JAKŠE, Jernej, JAVORNIK, Branka. Different gene expressions of resistant and susceptible hop cultivars in response to infection with a highly aggressive strain of <i>Verticillium albo-atrum</i>. <i>Plant molecular biology reporter</i>, ISSN 0735-9640, 2015, vol. 33, iss. 3, str. 689-704</li> <li>5. <b>ŠTAJNER</b>, Nataša, TOMIĆ, Lidija, PROGAR, Vasja, POKORN, Tine, LACOMBE, Thierry, LAUCOU, Valérie, BOURSICQUOT, Jean-Michel, JAVORNIK, Branka, BACILIERI, Roberto. Genetic clustering and parentage analysis of Western Balkan grapevines (<i>Vitis vinifera</i> L.). <i>Vitis</i>, ISSN 0042-7500, 2015, vol. 54, spec. iss., str. 67-72.</li> </ol>

6. REŠETIČ, Tjaša, **ŠTAJNER**, Nataša, BANDELJ, Dunja, JAVORNIK, Branka, JAKŠE, Jernej. Validation of candidate reference genes in RT-qPCR studies of developing olive fruit and expression analysis of four genes involved in fatty acids metabolism. *Molecular breeding*, ISSN 1380-3743. [Tiskana izd.], 2013, vol. 32, issue 1, str. 211-222.
7. **ŠTAJNER**, Nataša, CREGEEN, Sara, JAVORNIK, Branka. Evaluation of reference genes for RT-qPCR expression studies in hop (*Humulus lupulus* L.) during infection with vascular pathogen *Verticillium albo-atrum*. *PLoS one*, ISSN 1932-6203, 2013, vol. 8, issue 7, str. 1-13 (
8. **ŠTAJNER**, Nataša, TOMIČ, Lidija, IVANIŠEVIČ, Dragoslav, KORAČ, Nada, JOVANOVIĆ CVETKOVIĆ, Tatjana, BELESKI, Klime, ANGELOVA, Elizabeta, MARAŠ, Vesna, JAVORNIK, Branka. Microsatellite inferred genetic diversity and structure of Western Balkan grapevines (*Vitis vinifera* L.). *Tree genetics & genomes*, ISSN 1614-2942, 2013, vol. 10, iss. 1, str. 127-140.
9. **ŠTAJNER**, Nataša, RUSJAN, Denis, KOROŠEC-KORUZA, Zora, JAVORNIK, Branka. Genetic characterization of old Slovenian grapevine varieties of *Vitis vinifera* L. by microsatellite genotyping. *American journal of enology and viticulture*, ISSN 0002-9254. [Print ed.], 2011, vol. 62, issue 2, str. 250-255
10. JAKŠE, Jernej, **ŠTAJNER**, Nataša, LUTHAR, Zlata, JELTSCH, Jean-Marc, JAVORNIK, Branka. Development of transcript-associated microsatellite markers for diversity and linkage mapping studies in hop (*Humulus lupulus* L.). *Molecular breeding*, ISSN 1380-3743. [Tiskana izd.], 2011, vol. 28, no. 2, str. 227-239.

#### **Borut Bohanec**

- DUANGJIT, Janejira, WELSH, Kent, WISE, Mitchel L., BOHANEC, Borut, HAVEY, Michael J. Genetic analyses of anthocyanin concentrations and intensity of red bulb color among segregating haploid progenies of onion. *Molecular breeding*, ISSN 1380-3743. [Tiskana izd.], 2014, v tisku.
- SUSIČ, Nik, BOHANEC, Borut, MUROVEC, Jana. Agrobacterium tumefaciens-mediated transformation of bush monkey-flower (*Mimulus aurantiacus* Curtis) with a new reporter gene ZsGreen. *Plant cell, tissue and organ culture*, ISSN 0167-6857. [Print ed.], 2014, vol. 116, iss. 2, str. 243-251.
- KOŠMRLJ, Kristina, MUROVEC, Jana, BOHANEC, Borut. Haploid induction in hull-less seed pumpkin through parthenogenesis induced by X-ray-irradiated pollen. *Journal of the American Society for Horticultural Science*, ISSN 0003-1062. [Print ed.], 2013, vol. 138, no. 4, str. 310-316.
- MUROVEC, Jana, BOHANEC, Borut. Haploid induction in *Mimulus aurantiacus* Curtis obtained by pollination with gamma irradiated pollen. *Scientia horticulturae*, ISSN 0304-4238. [Print ed.], 2013, vol. 162, str. 218-225.
- ORAŽEM, Petra, **ŠTAJNER**, Nataša, BOHANEC, Borut. Effect of X-ray irradiation on olive shoot culture evaluated by morphological measurements, nuclear DNA content and SSR and AFLP markers. *Trees*, ISSN 0931-1890, 2013, vol. 27, issue 6, str. 1587-1595.
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#### **Špela Baebler**

- LUKAN, Tjaša, POMPE NOVAK, Maruša, BAEBLER, Špela, TUŠEK-ŽNIDARIČ, Magda, KLADNIK, Aleš, KRIŽNIK, Maja, BLEJEC, Andrej, ZAGORŠČAK, Maja, STARE, Katja, DUŠAK, Barbara, COLL RIUS, Anna, POLLMANN, Stephan, MORGIEWICZ, Karolina, HENNIG, Jacek, GRUDEN, Kristina. Precision transcriptomics of viral foci reveals the spatial regulation of immune-signaling genes and identifies RBOHD as an important player in the incompatible interaction between potato virus Y and potato. *The Plant journal*, ISSN 0960-7412, 2020, vol. , iss. , str. 1-17, ilustr., doi: 10.1111/tpj.14953. [COBISS.SI-ID 27546883]

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LUKAN, Tjaša, MACHENS, Fabian, COLL RIUS, Anna, BAEBLER, Špela, MESSERSCHMIDT, Katrin, GRUDEN, Kristina. Plant X-tender : an extension of the AssemblX system for the assembly and expression of multigene constructs in plants. *PloS one*. 2018, vol. 13, iss. 1, str. 1-19, ilustr. ISSN 1932-6203. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0190526>, DOI: 10.1371/journal.pone.0190526. [COBISS.SI-ID 4609359]

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### **David Dobnik**

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Potato virus Y strains. *Analytical and bioanalytical chemistry*. 2018, vol. 410, iss. 16, str. 3815-3825. ISSN 1618-2642. DOI: [10.1007/s00216-018-1053-3](https://doi.org/10.1007/s00216-018-1053-3). [COBISS.SI-ID 4684879],

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## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Sodobna biološka zdravila
Course title:	Modern biological medicines

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3796
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	20	5	0	5	85	5

Nosilec predmeta/Lecturer:	Borut Štrukelj
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Izvajalci predavanj:	Borut Štrukelj
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij	General prerequisites for application on doctoral study

Vsebina:	Content (Syllabus outline):
V okviru predmeta »Sodobna biološka zdravila« bo slušatelj spoznal razvrstitev, pripravo in molekularno delovanje sledečih sodobnih bioloških zdravilnih učinkovin: <ol style="list-style-type: none"> <li>1. Eritropoetini</li> <li>2. Inzulini</li> <li>3. Monoklonska protitelesa</li> <li>4. Rekombinantna cepiva</li> <li>5. Citokini</li> </ol>	Within the frame of subject »Modern biological medicines« attendants will be subjected to structure, activity and distribution of the following modern biological medicinal substances: <ol style="list-style-type: none"> <li>1. Erythropoietins</li> <li>2. Insulins</li> <li>3. Monoclonal antibodies</li> <li>4. Recombinant vaccines</li> </ol>

6. Podobna biološka zdravila	5. Cytokines
7. Genske učinkovine	6. Biosimilars
	7. Gene products

Temeljna literatura in viri/Readings:

1. *Biološka zdravila* : od gena do učinkovine. 1. izd. Ljubljana: Slovensko farmacevtsko društvo, 2007, Urednika: Borut Štrukelj, Janko Kos; ISBN 978-961-90099-8-7.
2. *Gary Walsh: Pharmaceutical Biotechnology. Concepts and Applications.* John Wiley & Sons, Ltd, 2007. ISBN 978-0-470-01244-4.
3. Pregledni članki in novejši znanstveni članki s področja/Review papers and recent scientific papers

Cilji in kompetence:	Objectives and competences:
Cilj predmeta je razjasniti in poglobiti znanja na področju sodobne farmacevtske biotehnologije. Poleg teoretskih znanj bo študent pridobil kompetenco priprave, izvedbe in reševanja težjih biotehnoških nalog in problemov, ki jih bo s pridom implementiral v času doktorskega dela in kasneje v praksi.	The main goal of the subject is to clarify and upgrade broad theoretical and practical knowledge and competencies in the field of pharmaceutical biotechnology. Student will be qualified to plan, perform and solve complex biotechnological problems and will achieve competences for their implementation during doctoral work and later in real professional environment.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje:  Z osvojitvijo in razumevanjem tematik programa ter z uspešno izdelavo in rešitvijo farmacevtsko-biotehnoškega problema bo študent pridobil sposobnost hitrejšega, boljšega in popolnejšega načrtovanja in izvajanja doktorskega dela kot tudi zmožnost širitve znanja na sodelavce v nadaljnjem profesionalnem okolju.	Knowledge and understanding:  By absolving the content of the syllabus with the outcome of biotech problem learning students will be able to achieve the knowledge that lead to individual, fully-responsible planning of research experiments as well as to transfer the topics to other co-workers in real conditions.

Metode poučevanja in učenja:	Learning and teaching methods:
Neposredna predavanja z aktivno udeležbo slušateljev; e-študij preko telekonference; pomoč in nadzor pri projektnem delu, pomoč in diskusija pri pripravi preglednega ali poljudno-strokovnega članka	Frontal ex-cathedra teaching with active discussion; e-learning by means of teleconferences; supervision of project-based learning; monitoring and supervising in the manuscript preparation, discussion and consultation.

Načini ocenjevanja:	Delež/Weight	Assessment:
Priprava in oddaja farmacevtsko-biotehnoškega projekta;	70,00 %	Elaboration of pharma-biotech project,
sodelovanje v pripravi preglednega strokovnega ali poljudno-strokovnega članka	30,00 %	colaboration in the preparation of review or popular-scientific article



Reference nosilca/Lecturer's references:

1. ZADRAVEC, Petra, MAVRIČ, Anja, BOGOVIČ MATIJAŠIĆ, Bojana, ŠTRUKELJ, Borut, BERLEC, Aleš. Engineering BmpA as a carrier for surface display of IgG-binding domain on *Lactococcus lactis*. *Protein engineering, design & selection*, ISSN 1741-0126, 2014, vol. 27, no. 1, str. 21-27.
2. BERLEC, Aleš, MALOVRH, Tadej, ZADRAVEC, Petra, STEYER, Andrej, RAVNIKAR, Matjaž, SABOTIČ, Jerica, POLJŠAK-PRIJATELJ, Mateja, ŠTRUKELJ, Borut. Expression of a hepatitis A virus antigen in *Lactococcus lactis* and *Escherichia coli* and evaluation of its immunogenicity. *Applied microbiology and biotechnology*, ISSN 0175-7598, 2013, vol. 97, iss. 10, str. 4333-4342.
3. VODNIK, Miha, MOLEK, Peter, ŠTRUKELJ, Borut, LUNDER, Mojca. Peptides binding to the hunger hormone ghrelin. *Hormone and Metabolic Research*, ISSN 0018-5043, 2013, vol. 45, no. 5, str. 372-377.
4. VODNIK, Miha, ŠTRUKELJ, Borut, LUNDER, Mojca. HWGMWSY, an unanticipated polystyrene binding peptide from random phage display libraries. *Analytical biochemistry*, ISSN 0003-2697, 2012, vol. 424, iss. 2, str. 83-86.
5. BERLEC, Aleš, ŠTRUKELJ, Borut. Generating a custom TA-cloning expression plasmid for *Lactococcus lactis*. *Biotechniques*, ISSN 0736-6205, 2012, vol. 52, no. 1, str. 51-53.
6. BERLEC, Aleš, RAVNIKAR, Matjaž, ŠTRUKELJ, Borut. Lactic acid bacteria as oral delivery systems for biomolecules. *Pharmazie*, ISSN 0031-7144, 2012, vol. 67, no. 11, str. 891-898.
7. MOLEK, Peter, ŠTRUKELJ, Borut, BRATKOVIČ, Tomaž. Peptide phage display as a tool for drug discovery: targeting membrane receptors. *Molecules*, ISSN 1420-3049, 2011, vol. 16, no. 1, str. 857-887.

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Sodobne biotehnološke metode
Course title:	Modern biotechnological methods

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3797
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	0	5	0	25	85	5

Nosilec predmeta/Lecturer:	Igor Križaj
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Izvajalci predavanj:	Igor Križaj, Radovan Komel
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Slovenščina, Angleščina,
	Vaje/Tutorial:	Slovenščina, Angleščina,

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij.	General prerequisites to enter doctoral study.

Vsebina:	Content (Syllabus outline):
<b>Proteini:</b> Čiščenje: viri proteinov; homogenizacija; centrifugiranje; ultrafiltracija; dializa; principi različnih vrst tekočinske kromatografije (gelska, hidrofobna, ionska, afinitetna ...) in načini njihove izvedbe (klasična, FPLC, HPLC ...); elektroforetske metode (nativna in NaDS PAGE, izoelektrično fokusiranje, prenos Western); izolacija membranskih proteinov (detergenti ...). Metode za detekcijo, kvantifikacijo in karakterizacijo proteinov: v	<b>Proteins:</b> Purification: protein sources; homogenization; centrifugation; ultrafiltration; dialysis; principles of liquid chromatography (gel filtration, hydrophobic, ion-exchange, affinity ...) and modes of their implementation (classical, FPLC, HPLC ...); electrophoretic methods (native and SDS PAGE, isoelectric focussing, Western blotting ...); isolation of membrane proteins (detergents). Methods for detection, quantification and characterization

raztopinah, gelih, bioloških membranah in na sintetičnih membranah (imunološke, imunokemijske radioizotopske in spektroskopske metode, barvila). Strukturna karakterizacija proteinov: določanje aminokislinske sestave in zaporedja; post-translacijskih modifikacij. Proteomika: 2D PAGE; masna spektrometrija, tehnologija MudPIT. **Nukleinske kisline (NK):** *Izolacija in čiščenje* (biološki viri/tkiva – shranjevanje in homogeniziranje; varnostni ukrepi; obarjanje in centrifugiranje NK; elektroforezne metode in izolacija NK; kromatografske metode; subtrakcija). *Izdelava genske knjižnice/banke* (restriksijski encimi, fragmentiranje DNA, delna restrikcija, metoda PCR in njene izvedenke; vektorji za prenos DNA, vnos in kloniranje DNA v različnih gostiteljskih celicah, selekcija rekombinantnih klonov; genomske in cDNA knjižnice). *Preiskava genskih knjižnic* (gensko-specifične sonde, hibridizacija kolonij/plakov, ekspresijske knjižnice; RFLP, pozicijsko kloniranje, sprehod/skok po kromosomu). *Določanje nukleotidnega zaporedja* (metoda po Sangerju, po-genomski pristopi – avtomatizacija). *Karakterizacija NK* (restriksijska analiza, prenosa Southern in Northern; iskanje podobnosti nukleotidnih zaporedij; analiza genskih mutacij in polimorfizmov). *Mutageneza* (naključna in usmerjena/mestno-specifična mutageneza; proteinsko inženirstvo). *Izražanje tujih genov* (fuzijski proteini, sekrecija; analiza mRNA, RT-PCR; hibridizacija *in situ*, FISH; »DNA-prstni odtis«; kvasni dvohibridni sistem; diferencialne metode, fagni prikaz, qPCR, DNA mikromreže (bio-čipi)). *Transgeneza pri evkariontih* (opis metod; utišanje genov). Preurejanje genomov (CRISPR/Cas, gensko zdravljenje, imunoterapija/CAP-T). *Analiza genomov* (kartiranje, določanje nukleotidnih zaporedij, primerjalna genomika; transkriptomika). *Bioinformatika, podatkovne baze in Internet*.

of proteins: in solution, gels, biological membranes and on synthetic membranes (immunological, radioisotopic and spectroscopic methods, dyes). Structural characterization of proteins: determination of amino acid composition and sequence; post-translational modifications. Proteomics: 2D PAGE; mass spectrometry, MudPIT technology. **Nucleic acids (NA):** *Isolation and purification* (biological sources/tissues – storage and homogenization; protection provisions; NA precipitation and centrifugation; electrophoresis and isolation of NA; chromatography; subtraction). *Construction of gene library/bank* (restriction enzymes, cutting and joining DNA molecules, partial digestion, PCR methods; vectors and DNA transfer, DNA cloning in various host cells, selection of recombinant clones; genomic and cDNA libraries). *Gene library screening* (gene specific probes, colony hybridization, expression libraries; RFLP, positional cloning, chromosome walking/jumping). *DNA sequencing* (Sanger method, post-genomic approaches – automatization). *Characterization of NA* (restriction analysis, Southern and Northern blotting; comparative sequence analysis; genetic polymorphisms and mutation analysis). *Mutagenesis* (random and site-specific mutagenesis; protein engineering). *Heterologous gene expression* (fusion proteins, secretion; mRNA analysis, RT-PCR, *in situ* hybridization, FISH; DNA fingerprinting; yeast two-hybrid system; differential screening, phage display, qPCR, DNA microarrays (biochips)). *Transgenesis* (methods; gene silencing). *Genome editing* (CRISPR/Cas, gene therapy, immunotherapy/CAR-T). *Genome analysis* (genome mapping and sequencing, comparative genomics; transcriptomics). *Bioinformatics, databases and Internet*.

#### Temeljna literatura in viri/Readings:

WILLSON, K., WALKER, J. (Eds.), 2005. Principles and Techniques of Biochemistry and Molecular Biology; 6th Edition. Cambridge University Press, Cambridge (U.K.), 783 str., ISBN 0-521-82889-9.

S. B. Primrose and R. M. Twyman (2006): Principles of Gene Manipulation and Genomics; 7th Edition. Blackwell Publishing, Malden (U.S.A.), Oxford (U.K.), Carlton (Austr.), 390 str., ISBN: 1-4051-3544-1.

Zapiski predavanj, revijalni članki s področja, tekoča periodika, druga učna gradiva.

Cilji in kompetence:	Objectives and competences:
Temeljni izobraževalni cilj je seznanitev študentov z metodami in tehnikami sodobne biokemije in molekularne biologije s posebnim poudarkom na tistih, ki se uporabljajo v tako imenovani 'sodobni biotehnologiji'. Predmet usmerja študenta k samostojnemu teoretičnemu (analiza literature, reševanje problemov, sinteza zaključkov) in eksperimentalnemu delu (organiziranje in načrtovanje dela).	The main educational goal is to familiarize students with the contemporary methods and techniques of biochemistry and molecular biology especially emphasising those used in the so-called "modernbiotechnology". The course directs students to autonomous theoretical (analysis of literature, problem solving, formulation of conclusions) and experimental work (organization and planning of the work).

Predvideni študijski rezultati:	Intended learning outcomes:
Študent spozna ali poglobi znanje o metodah in tehnikah analize proteinov in nukleinskih kislin. Predmet usmerja študenta k uporabi pridobljenega znanja v temeljnih ali aplikativnih raziskavah na področju njegovega raziskovalnega ali razvojnega dela. Usmerja ga k samostojnemu načrtovanju analitskih postopkov, reševanju problemov z organiziranjem in načrtovanjem eksperimentalnega dela.	Student learns or deepens the knowledge about methods and techniques for analysis of proteins and nucleic acids.-The course leads student towards application of the acquired knowledge in his research or developmental work. It teaches students to devise their analytical procedures and to resolve their research problems by organizing and designing their experimental work autonomously.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, vodene diskusije, problemsko-zasnovano učenje, demonstracije v laboratoriju, konzultacije.	Lectures, moderated discussions, problem-based learning, laboratory demonstrations, consultations.

Načini ocenjevanja:	Delež/Weight	Assessment:
Ustni izpit.	100,00 %	Oral examination.

Reference nosilca/Lecturer's references:
<b>Igor Križaj</b>  Latinović, Z., Leonardi, A., Koh, C.Y., Kini, R.M., Trampuš Bakija, A., Pungerčar, J. and <b>Križaj, I.</b> (2020): The procoagulant snake venom serine protease potentially having a dual, blood coagulation factor V and X-activating activity. <i>Toxins</i> 12(6), 358.  Lang Balija M., Leonardi, A., Brgles, M., Sviben, D., Kurtović, T., Halassy, B. and <b>Križaj, I.</b> (2020): Biological activities and proteomic profile of the venom of <i>Vipera ursinii</i> ssp., a very rare karst viper from Croatia. <i>Toxins</i> 12(3), 187.

Leonardi, A., Sajevec, T., Pungerčar, J. and **Križaj, I.** (2019): A comprehensive study of the proteome and transcriptome of the venom of the most venomous European viper: Discovery of a new subclass of ancestral snake venom metalloproteinase precursor-derived proteins. *J. Proteome Res.* 18, 2287–2309.

Šribar, J., Kovačič, L., Oberčkal, J., Ivanušec, A., Petan, T., Fox, J.W. and **Križaj, I.** (2019): The neurotoxic secreted phospholipase A<sub>2</sub> from the *Vipera a. ammodytes* venom targets cytochrome c oxidase in neuronal mitochondria *Sci. Rep.* 9, 293.

Latinović, Z., Leonardi, A., Kovačič, L., Koh, C.Y., Šribar, J., Trampuš Bakija, A., Venkateswarlu D., Kini, R.M. and **Križaj, I.** (2018): The first intrinsic tenase complex inhibitor with serine protease structure offers a new perspective in anticoagulant therapy. *Thromb. Haemost.* 118(10), 1713–1728.

Latinović, Z., Leonardi, A., Šribar, J., Sajevec, T., Žužek, C.M., Frangež, R., Halassy, B., Trampuš-Bakija, A., Pungerčar, J. and **Križaj, I.** (2016): Venomics of *Vipera berus berus*; an explanation of differences in pathology elicited by *Vipera ammodytes ammodytes* envenomation: Therapeutic implications. *J. Proteomics* 146, 34–47.

#### **Radovan Komel:**

Kastelic, D., Soler, N., Komel, R. and Pompon, D. (2013): The Global Sequence Signature algorithm unveils a structural network surrounding heavy chain CDR3 Loop in Camelidae variable domains. *Biochim. Biophys. Acta, Gen. Subj.* 1830, 3373–3381.  
[doi: [10.1016/j.bbagen.2013.02.014](https://doi.org/10.1016/j.bbagen.2013.02.014)]

Berne, S., Podobnik, B., Zupanec, N., Novak M., Kraševac, N., Turk, S., Korošec, B., Lah, L., Šuligoj, E., Stojan, J., Gobec, S. and Komel, R. (2012): Virtual screening yields inhibitors of novel antifungal drug target, benzoate 4-monooxygenase. *J. Chem. Inf. Model.* 52, 3053–3063.  
[doi: [10.1021/ci3004418](https://doi.org/10.1021/ci3004418)]

Liović, M., Ožir, M., Bedina Zavec, A., Peternel, Š., Komel, R. and Zupančič, T. (2012): Inclusion bodies as potential vehicles for recombinant protein delivery into epithelial cells. *Microb. Cell Factories* 11, 67 [1–5].  
[doi: [10.1186/1475-2859-11-67](https://doi.org/10.1186/1475-2859-11-67)]

Lah, L., Podobnik, B., Novak, M., Korošec, B., Berne, S., Vogelsang, M., Kraševac, N., Zupanec, N., Stojan, J., Bohlman, J. and Komel, R. (2011): The versatility of the fungal cytochrome P450 monooxygenase system is instrumental in xenobiotic detoxification. *Mol. Microbiol.* 85, 1374–1389.  
[doi: [10.1111/j.1365-2958.2011.07772.x](https://doi.org/10.1111/j.1365-2958.2011.07772.x)]

Peternel, Š. and Komel, R. (2010): Isolation of biologically active nanomaterial (inclusion bodies) from bacterial cells. *Microb. Cell Factories* 9, 66 [1–16].  
[doi: [10.1186/1475-2859-9-66](https://doi.org/10.1186/1475-2859-9-66)]

Vogelsang, M., Comino, A., Zupanec, N., Hudler, P. and Komel, R. (2009): Assessing pathogenicity of MLH1 variants by co-expression of human MLH1 and PMS2 genes in yeast. *BMC Cancer* 9, 1–9.



## UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Sodobne metode za optimizacijo komercialnih mikroorganizmov
Course title:	Modern methods for optimization of commercial microorganisms

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	biotehnologija		Celoletni

Univerzitetna koda predmeta/University course code:	3798
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Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	15	0	0	5	95	5

Nosilec predmeta/Lecturer:	Matic Legiša
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Izvajalci predavanj:	Matic Legiša
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical
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Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Splošni pogoji za vpis na doktorski študij	General conditions for PhD study application

Vsebina:	Content (Syllabus outline):
<ul style="list-style-type: none"> <li>• Glavne metabolne poti primarnega metabolizma: glikoliza, pentoza fosfatna pot, Cikel trikarboksilnih kislin, oksidativna fosforilacija</li> <li>• Regulacija primarnega metabolizma</li> <li>• Metabolni inženiring: analiza metabolnih pretokov (MFA); analiza metabolne kontrole (MCA)</li> <li>• Anapleroza - katapleroza</li> <li>• Glavne anaplerotske reakcije v celicah</li> </ul>	<ul style="list-style-type: none"> <li>• Major metabolic pathways of primary metabolism: glycolysis, pentose phosphate pathway, TCA cycle, OXPHOS</li> <li>• Regulation of primary metabolism</li> <li>• Metabolic engineering: Metabolic flow analysis (MFA), metabolic control analysis (MCA)</li> <li>• Anaplerosis- cataplerosis</li> <li>• Major anaplerotic reactions in the cells</li> <li>• Posttranslational modification of 6-phosphofructo-1-kinase (PFK1) as an important anaplerotic reaction</li> </ul>

- Post-translacijska modifikacija 6-fosfofrukto-1-kinaze (PFK1) kot poglavitna anaplerotska reakcija na nivoju glikolize
- Priprava modificiranega gena za sintezo kratkega fragmenta PFK1
- Post-translacijska modifikacija PFK1 pri sesalčjih celicah: proces povezan s transformacijo normalnih celic v rakaste
- Kaj je sekundarni metabolizem
- Kaj so sekundarni metaboliti

Sekundarni metaboliti z vidika producenta; biotehnološko uporabni sekundarni metaboliti

- Prekurzorji za sekundarne metabolite
- Vpliv primarnega metabolizma na produkcijo sekundarnih metabolitov
- Regulacija sekundarnega metabolizma

Genetski mehanizmi za izboljšavo procesov

Rekombinantna DNA tehnologija: povečano število genov, uporaba močnejših promotorjev, odstranitev regulatorskih proteinov, utišanje genov za druge premljajoče metabolite, vnos tujih genov ali klastrov genov

Novejši pristopi: sistemska biologija in metabolni inženiring, vodena evolucija, molekularne tehnike križanja, kombinatorna biosinteza

Indukcija specifičnih signalnih poti za povečanje produktivnosti

Endogena in eksogena indukcija signalnih poti

- Tehnologija pridobivanja heterolognih proteinov

Omejevanje proteolitične aktivnosti pri komercialnih mikrobih

Molekularna biologija sekrecijskih poti za proteine

- Construction of a modified gene encoding highly active short PFK1 fragment
- Posttranslational modification of human PFK-M enzyme as an important feature of cancer metabolism

Secondary metabolism – definition

Secondary metabolites – definition

Biotechnological value of secondary metabolites

Precursors for secondary metabolites

Influence of primary metabolites on the production of secondary metabolites

Regulation of secondary metabolism

Genetic mechanisms for the improvement of secondary metabolism

Recombinant DNA technology: increasing gene copy number, use of strong promoters, removal of regulatory proteins, deletion of the genes encoding other secondary metabolites, insertion of heterologous genes or gene clusters

Modern techniques: systems biology, metabolic engineering, directed evolution, molecular breeding techniques, combinatorial biosynthesis

Induction of specific signaling pathways

Endogenous or exogenous induction of signaling pathways

- Technology of heterologous protein production

Deletion of proteases in commercial microorganisms

Molecular biology of protein secretory pathways

Temeljna literatura in viri/Readings:

Stephanopoulos G.N., Aristidou A.A., Nielsen J. (1998) Metabolic engineering, Principles and methodologies, Elsevier Science.

R.K. Finn, P. Prave (1992) Biotechnology Focus 3, Fundamentals, Applications, Information, Hanser Publishers, Munich

Novejši pregledni članki s področja

Contemporary review papers from the field

Tekoča znanstvena periodika

Contemporary scientific papers



Cilji in kompetence:	Objectives and competences:
Temeljni izobraževalni cilj je študente seznaniti s pomenom regulacije metabolizma pri biotehnoških procesih. Sprememba ali odstranitev kontrolnih mehanizmov lahko povzroči hitrejše katabolne reakcije v celici, kar pripelje do pospešitve anabolnih reakcij in sinteze ključnih metabolitov z biotehnoško vrednostjo. Razložene bodo novejšje metode za doseg opisanega cilja.	Lecture objective is to describe contemporary methods that deregulate specific catabolic pathways and concomitantly lead to more rapid anabolic reactions in the cells. Some of those reactions may be used by commercial microorganisms for the synthesis of important products of biotechnological importance.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje procesov regulacije primarnega in sekundarnega metabolizma. Študentje se bodo seznanili z novejšimi metodami in procesi za pospešitev metabolnih procesov pri tvorbi specifičnih bio-produktov.	Knowledge and understanding of regulatory mechanisms of primary and secondary metabolism. The students will become familiar with the novel techniques for accelerating metabolic processes that lead to syntheses of specific bio-products.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, konzultacije	Lectures, consultations

Načini ocenjevanja:	Delež/Weight	Assessment:
Ustni izpit,	80,00 %	Colloquial exam
seminar	20,00 %	seminar

Reference nosilca/Lecturer's references:
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