BIOLOGIJA – TEORETIČNI PREDMETI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Analiza starodavne in muzejske DNA
Course title:	Analysis of ancient and museum DNA
Članica nosilka/UL Member:	

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Bioznanosti, tretja stopnja, doktorski	Ni členitve (študijski program)		Celoletni

Univerzitetna koda predmeta/University course code:	0640278

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	25	10	0	0	80	5

Nosilec predmeta/Lecturer:	Anja Palandačić

Izvajalci predavanj:	Anja Palandačić
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični /theoretical

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, poznavanje osnov genetike.	General conditions for enrolment in doctoral studies, basic knowledge of genetics.

Vsebina:	Content (Syllabus outline):
Študentje se bodo spoznali s pojmom starodavne DNA, izolirane iz biološkega materiala organizmov, ki so živeli v preteklosti.	Students will be introduced to the concept of ancient DNA isolated from the biological material of organisms that lived in the past.

Spoznali bodo zgodovino starodavne DNA in prvih raziskav na tem področju. V predmet bodo vključene teme o tem, kaj je starodavna DNA in kakšne so njene lastnosti (posebnosti zaradi njene degradacije). »Muzejska DNA« je pogovoren izraz za DNA izolirano iz organizmov hranjenih v muzejskih zbirkah, delno se pojem prekriva s pojmom starodavne DNA, predmet pa bo obravnaval njune podobnosti in razlike. Predstavljeno bo delo v muzejskih zbirkah – nekoč in danes – in zakaj so muzejske zbirke izjemnega pomena pri raziskovanju pretekle biodiverzitete ter njenemu ohranjanju. Predmet bo obsegal razlike v analizi starodavne (muzejske) DNA in analize standardne DNA, vse od prvih korakov izolacije do bioinformatske analize. Študentom bo predstavljena široka paleta znanstvenih področji, pri katerih se starodavna DNA uporablja (od antropologije, klimatskih sprememb pa do populacijske genetike). Sledili bodo izjemni primeri novih spoznanj, ki jih je omogočila analiza starodavne DNA: 1. V evoluciji človeka: analiza starodavne DNA Neandertalcev in Denisovancev, kaj smo podedovali od enih oziroma drugih, skrivnostna četrta vrsta, katere DNA je viden v genomu ostalih treh? 2. Izumrtja določenih živalskih vrst (mamuti, tasmanski tigri, dodo), kaj vse nam povedo njihovi genomi? 3. Klimatske spremembe in odgovori, ki nam jih ponuja starodavna DNA. Jurassic Park: kako daleč smo od obuditve dinozavrov, mamutov, neandertalcev – tehnične omejitve in etično-moralni vidiki.	They will learn about the history of ancient DNA and the first research in this field. The course will include topics about what ancient DNA is and what its properties are (specifics due to its degradation). “Museum DNA” is a colloquial term for DNA isolated from organisms stored in museum collections. The term partially overlaps with the expression ancient DNA, and we will address their similarities and differences. The work in museum collections, in the past and today will be presented together with the importance of museum collections in preserving biodiversity. The course will cover the differences in the analysis of ancient (museum) DNA and the analysis of standard DNA, from the first steps of isolation to bioinformatics analysis. Students will be introduced to a wide range of scientific fields in which ancient DNA is used (from anthropology and climate change to population genetics). Finally, some outstanding examples of the analysis of ancient DNA, which enabled new insights in their respective fields, will be presented/ discussed: (1) Human evolution: Analysis of the ancient DNA of Neanderthals and Denisovans, what did we inherit from one or the other, the mysterious fourth species whose DNA is visible in the genome of the other three. (2) Extinctions of certain animal species (mammoths, Tasmanian tigers, dodos), what do their genomes tell us? (3) Climate change and the answers offered to us by ancient DNA. (4) Jurassic Park: how far are we from the revival of dinosaurs, mammoths, Neanderthals - technical limitations and ethical-moral aspects.

Temeljna literatura in viri/Readings:

Splošno o starodavni DNA (General about aicent DNA):

Bouwman A, Rühli F. 2016. Archaeogenetics in evolutionary medicine. Journal of Molecular Medicine (Berl), 94(9): 971–7.

Cappellini E, Prohaska A, Racimo F. 2018. Ancient Biomolecules and Evolutionary Inference. Annual Review of Biochemistry, 87: 1029-106.

Hagelberg E, Hofreiter M, Keyser C. 2015. Ancient DNA: the first three decades. Philosophical Transactions of the Royal Society B: Biological Sciences, 370: 20130371.

Zupanič Pajnič I. 2019. Molekularnogenetski vidiki preiskav starodavne DNA,Zdravniški vestnik, 88.

O muzejskih zbirkah in »muzejski« DNA (About museum collections and »museum« DNA):

Boessenkool S, Star B, Scofiled RP, Seddon PJ, Walters JM. 2010. Lost in translation or deliberate falsification? Genetic analyses reveal erroneous museum data for historic penguin specimens. Proceedings Royal Society Series B, 277: 1057–1064.
Kruckenhauser L, Haring E. 2010. Advantages and limits of DNA analyses of specimens from scientific museum collections. 5th Biennial European Bird Curators Meeting, 225-235.

Analize starodavne in muzejske DNA (Analysis of ancient and museum DNA):

Allentoft ME, Collins M, Harker D, et al. 2012. The half-life of DNA in bone: measuring decay kinetics in 158 dated fossils. Proceedings of the Royal Society B: Biological Sciences, 279(1748): 4724-33.
Burrell AS, Disotell TR, Bergey CM. 2014. The use of museum specimens with high-throughput DNA sequencers. Journal of Human Evolution, 79: 35–44.
Cappellini E, Welker F, Pandolfi L et al. 2019. Early Pleistocene enamel proteome from Dmanisi resolves Stephanorhinus phylogeny. Nature, 574: 103–107.

1. Evolucija človeka (Human evolution):

Meyer M, Kircher M, Gansauge MT. 2012. A High-Coverage Genome Sequence from an Archaic Denisovan Individual. Science, 338 (6104): 222-226.
Prüfer K, Racimo F, Patterson N, Jay F. 2014. The complete genome sequence of a Neanderthal from the Altai Mountains. Nature, 505(7481): 43-9.

2. Izumrtja (Extinctions):

Feigin CY, Newton AH, Doronina L. et al. 2018. Genome of the Tasmanian tiger provides insights into the evolution and demography of an extinct marsupial carnivore. Nature Ecology and Evolution, 2: 182–192.
Rogers RL, Slatkin M. 2017. Excess of genomic defects in a woolly mammoth on Wrangel island. Plos Genetics, 13(3): e1006601.
Shapiro B, Sibthorpe, Rambaut A et. Al. 2002. Flight of the Dodo. Science, 295: 1683.

3. Klimatske spremembe (Climate change):

Hadly EA, Ramakrishnan U, Chan YL, et al. 2004. Genetic response to climatic change: insights from ancient DNA and phylochronology. PLoS Biology, 2(10): e290.

4. Invazivne vrste (Invasive species):

Palandačić A, Kruckenhauser L, Ahnelt H, Mikschi E. 2020. European minnows through time: museum collections aid genetic assessment of species introductions in freshwater fishes (Cyprinidae: Phoxinus species complex). Heredity, 124: 410–422.

5. Jurassic Park:

Bailleul AM, Zheng W, Horner JR, Hall BK, Holliday CM, Schweitzer MH. 2020. Evidence of proteins, chromosomes and chemical markers of DNA in exceptionally preserved dinosaur cartilage National Science Review: 7(4): 815–822.

Cilji in kompetence:	Objectives and competences:
Cilji predmeta je seznaniti študente z lastnostmi starodavne DNA in številnimi znanstvenimi področji, kjer se uporablja. V tem kontekstu bo poudarek na študijah in konkretnih primerih, kjer je uporaba ključno doprinesla k razjasnitvi nekaterih vprašanj. Predstavljena bo tudi t.i. muzejska DNA in delo v muzejskih zbirkah, ki ga študentje običajno ne spoznajo tekom študija. Kompetence študentov po opravljenem predmetu vključujejo znanje o starodavni in muzejski DNA ter njihova sposobnost vključiti to področje raziskav v njihove trenutne raziskave ali za uporabo v prihodnosti.	The objectives of the course are to present the properties of ancient DNA and the many scientific fields where it is used. In this context, the focus will be on studies and concrete cases where the application has made a key contribution to clarifying research questions. The so-called museum DNA and work in museum collections will also be introduced as this subject is currently not represented in the curriculum. Students' competences after completing the course include knowledge of ancient and museum DNA and their ability to incorporate

	the newly acquired knowledge into their current research or for future use.

Predvideni študijski rezultati:	Intended learning outcomes:
Študentje bodo osvojili teoretično in praktično znanje o: - lastnostih starodavne in muzejske DNA, - delu v muzejskih zbirkah, - znanstvenih področjih, kjer se starodavna in muzejska DNA uporabljata (in sta doprinesli ključna spoznanja za njihov razvoj), - razlike v analizi v primerjavi s »standardno« DNA – od laboratorija do bioinformatike, - praktično delo, ki bo pripravilo študenta na dejansko uporabo starodavne DNA na izbranem področju.	Students will gain theoretical and practical knowledge of: - properties of ancient and museum DNA, - work in museum collections, - the scientific fields where ancient and museum DNA are used (and have contributed key insights to their development), - differences in analysis compared to "standard" DNA - from laboratory to bioinformatics, - practical work that will prepare the student for the actual use of ancient DNA in the chosen field.

Metode poučevanja in učenja:	Learning and teaching methods:
Metode poučevanja bodo odvisne od števila prijavljenih študentov. Predvidena so predavanja, kjer bodo predstavljene teoretične osnove in zgoraj navedeni konkretni primeri. V primeru manjšega števila študentov, bodo te osnove in primere spoznali preko navedene literature, ki jim bodo sledile konzultacije. Glede na področje raziskovanja oziroma interes bodo študentje pripravili seminarsko nalogo (ali predavanje, ali manuskript), ki se bo poglobila v eno izmed tem. Praktično delo bo prilagojeno zmožnostim/času študentov: omogočen bo obisk Prirodoslovnega muzeja na Dunaju in našega laboratorija, ki je specializiran za delo z muzejsko in starodavno DNA, ali pa bo praktično delo bioinformatske narave. Glede na področje raziskovanja doktorskega študenta se lahko analizo starodavne DNA tudi konkretno vključi v doktorsko raziskavo in objavi v obliki znanstvenega članka.	Teaching methods will depend on the number of students enrolled. In case of lectures (more than five students enrolled), the theoretical foundations and the above-mentioned concrete examples will be presented. In case of a small number of students, they will learn these basics and examples through studying the cited literature, followed by consultations. Depending on the field of research or interest, students will prepare a seminar (either in a form of a lecture or text), within one of the topics. The practical work will be adapted to the abilities / time of the students: it will be possible to visit the Natural History Museum in Vienna and our laboratory, which specializes in working with museum and ancient DNA, or the practical work will be of bioinformatics nature. Depending on the field of research of the doctoral student, the analysis of ancient DNA can also be concretely included in the doctoral research and published in the form of a scientific article.

Načini ocenjevanja:	Delež/Weight	Assessment:
Seminarska naloga (alternativno: priprava znanstvenega članka)	60,00 %	Project preparation (alternativly outline/draft of a manuscript)
Ustni izpit	40,00 %	Oral exam

Reference nosilca/Lecturer's references:

Anja Palandačić

BRAVNIČAR J, **PALANDAČIĆ A**, SUŠNIK BAJEC S, SNOJ A. Neotype designation for Thymallus aeliani Valenciennes, 1848 from a museum topotype specimen and its affiliation with Adriatic grayling on the basis of mitochondrial DNA. ZooKeys, 2020, 999: 165-178.

ENGLMAIER G, VIÑUELA RODRIGUEZ N, WAIDBACHER H, **PALANDAČIĆ A**, TESFAYE G, GESSL W and MEULENBROEK P. New data on Garra makiensis (Cyprinidae, Labeoinae) from the Awash River (Ethiopia) with remarks on its relation to congeners on the Arabian Peninsula. Zookeys, 2020, 984: 133-163.

PALANDAČIĆ A, KRUCKENHAUSER L, AHNELT H, MIKSCHI E. European minnows through time: museum collections aid genetic assessment of species introductions in freshwater fishes (Cyprinidae: Phoxinus species complex). Heredity, 2020, 124, 410–422.

SIDELEVA V G, NASEKA A, NOWAK M, **PALANDAČIĆ A**. The finding of holotype and redescription of Cottus microstomus Heckel 1837 (Cottidae). Ichthyological Research, 2019, 66, 249–257.

PALANDAČIĆ A, NASEKA A, RAMLER D, AHNELT H. Contrasting morphology with molecular data: an approach to revision of species complexes based on the example of European Phoxinus (Cyprinidae). BMC Evolutionary Biology, 2017, 17 (1), 1.

RAMLER D, **PALANDAČIĆ A**, DELMASTRO GB, WANZENBÖCK J, AHNELT H. Morphological divergence of lake and stream Phoxinus of Northern Italy and the Danube basin based on geometric morphometric analysis. Ecology and Evolution, 2017, 7(2): 572-584.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Biološko izobraževanje
Course title:	Biological education

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

Univerzitetna koda predmeta/University course code:	3774

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	20	15	0	0	80	5

Nosilec predmeta/Lecturer:	Iztok Tomažič

Izvajalci predavanj:	Iztok Tomažič
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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 requirements for doctoral study.

Vsebina:	Content (Syllabus outline):
Študenti pri predmetu spoznajo zgodovino razvoja in raziskovanja biološkega izobraževanja. Seznanijo se s sodobnimi smernicami raziskovanja na omenjenem področju, ki posega tako v formalna kot neformalna učna okolja. S pregledom in analizo znanstvene literature področja spoznajo pomen razvijanja naravoslovnih kompetenc ter sodobne metode in oblike pedagoškega dela. Na praktičnih	The students will become familiar with the history of biology education and research in this area. They will learn about current research trends in the area, which extends both to formal and informal learning environments. By reviewing and analysing scientific literature, they become aware of the significance of developing natural science competencies and contemporary teaching methods and types. On the basis of practical examples, they learn

primerih spoznajo pomen in vlogo izkustvenega učenja in raziskovalnega pouka ter razvoj kritičnega mišljenja z vključevanjem obravnave družbeno-znanstvenih tem v biološko izobraževanje. Na podlagi priprave, izvedbe, analize in evalvacije dveh nastopov, enega v formalni učni ustanovi in enega v obliki predstavitve širši javnosti (neformalno učno okolje), študenti spoznajo pomen promocije znanosti za razvoj naravoslovne pismenosti.	about the significance and role of experience-based learning and learning through inquiry. They also learn about the importance of development of critical thinking by including socio-scientific issues in biology education. By preparing, delivering, analysing and evaluating two instructional units, one for a formal learning environment and the other as part of a presentation to the wider public (informal learning environment) the students learn about the significance of promoting science for development of scientific literacy.

Temeljna literatura in viri/Readings:
• Biological Sciences Curriculum Study. The Biology Teacher's Handbook: NSTA Press., (2009), 338 strani, ISBN: 087355244X • National Research Council. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press, 2012. • SCIENCE, evolution, and creationism [Elektronski vir] / National Academy of Sciences, Institute of Medicine. - El. knjiga. - Washington, D.C. : National Academies Press, cop. 2008. - xv, 70 str. : ill. (chiefly col.) ; 26 cm • Revijalni članki s področja (revije Journal of Biological education, The American Biology Teacher, International Journal of Science Education in druge),

Cilji in kompetence:	Objectives and competences:
Predmet je prvotno namenjen doktorskim študentom, ki raziskujejo na področju naravoslovnega izobraževanja. Predmet vključuje vsebine, ki omogočajo študentom širše razumevanje vloge in pomena biološkega izobraževanja, smernice na področju biološkega izobraževanja ter aplikacijo oziroma prenos teh spoznanj v pedagoško prakso.	The subject is primarily intended for doctoral students researching natural science education. It includes content that enables students a wider understanding of the role and significance of biology education and applying findings in actual teaching.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Študenti pridobijo znanje za izvajanje pedagoškega dela ter pedagoškega raziskovanja na področju biološkega izobraževanja v formalnih (osnovne, srednje šole in gimnazije ter fakultete) in neformalnih učnih okoljih (živalski in botanični vrtovi, krajinski parki, muzeji, centri šolskih in obšolskih dejavnosti) ter pridobijo znanje za promocijo znanosti širši javnosti.	Knowledge and understanding: The students acquire the knowledge to carry out pedagogical work and research in formal (primary and secondary schools, grammar schools and faculties) and informal learning environments (zoos, botanical gardens, landscape parks, museums, centres for school-related and extracurricular activities), and acquire the knowledge to promote science to the wider public.

Metode poučevanja in učenja:	Learning and teaching methods:
Teoretična znanja v obliki predavanj; projektno delo: (1) seminarji kot priprava, analiza in	Theoretical knowledge in the form of lectures; project work: (1) seminars as preparation,

evalvacija projektnega dela, (2) vaje v obliki dveh nastopov, enega v formalnem in enega v neformalnem učnem okolju. Konzultacije med pripravo projektnega dela. Samostojno delo študenta z uporabo spletne učilnice.	analysis and evaluation of project work, (2) tutorials in the form of two presentations, one in a formal and the other in an informal learning setting. Consulation during the preparation of project work. Independent work of students using the online classroom.

Načini ocenjevanja:	Delež/Weight	Assessment:
Ustni izpit	50,00 %	Oral exam
Projektno delo	50,00 %	Project work

Reference nosilca/Lecturer's references:

1. TOMAŽIČ, Iztok, VIDIC, Tatjana. Future science teachers´ understandings of diffusion and osmosis concepts. Journal of Biological Education, ISSN 0021-9266, 2012, vol. 46, issue 2, str. 66-71. http://dx.doi.org/10.1080/00219266.2011.617765, doi: 10.1080/00219266.2011.617765. [COBISS.SI-ID 2440527]
2. ŠORGO, Andrej, LAMANAUSKAS, Vincentas, ŠIMIĆ ŠAŠIĆ, Slavica, KUBIATKO, Milan, PROKOP, Pavol, FRANČOVIČOVA, Jana, BILÉK, Martin, TOMAŽIČ, Iztok, ERDOGAN, Mehmet. A cross-national study of prospective elementary and science teachers' creativity styles. Journal of Baltic science education, ISSN 1648-3898, 2012, vol. 11, no. 3, str. 285-292. [COBISS.SI-ID 19354120]
3. ŠORGO, Andrej, AMBROŽIČ-DOLINŠEK, Jana, TOMAŽIČ, Iztok, JANŽEKOVIČ, Franc. Emotions expressed toward genetically modified organisms among secondary school students and pre-service teachers. Journal of Baltic science education, ISSN 1648-3898, 2011, vol. 10, no. 1, str. 53-64. [COBISS.SI-ID 18312456]
4. TOMAŽIČ, Iztok, RAZDEVŠEK-PUČKO, Cveta. Živali v očeh učencev. Pedagoška obzorja, ISSN 0353-1392, 2011, letn. 26, [št.] 4, str. 45-65, graf. prikazi, tabele. [COBISS.SI-ID 9066057]
5. TOMAŽIČ, Iztok. Seventh graders' direct experience with, and feelings toward, amphibians and some other nonhuman animals. Society & animals, ISSN 1063-1119, 2011, no. 3, vol. 19, str. 225-247. [COBISS.SI-ID 2409807]
6. TOMAŽIČ, Iztok. Pre-service biology teachers' and primary school students' attitudes toward and knowledge about snakes. Eurasia, ISSN 1305-8223, 2011, no. 3, vol. 7, str. 161-171. http://www.ejmste.com/v7n3/EURASIA_v7n3_Tomazic.pdf. [COBISS.SI-ID 2409551]
7. TOMAŽIČ, Iztok. Reported experiences enhance favourable attitudes toward toads. Eurasia, ISSN 1305-8223, 2011, vol. 7, no. 4, str. 253-262. http://www.ejmste.com/v7n4/EURASIA_v7n4_Tomazic.pdf. [COBISS.SI-ID 2452559]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Ekologija
Course title:	Ecology

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

Univerzitetna koda predmeta/University course code:	3775

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	20	0	0	40	170	10

Nosilec predmeta/Lecturer:	Alenka Gaberščik

Izvajalci predavanj:	Andraž Čarni, Marko Debeljak, Alenka Gaberščik, Mateja Germ, Ivan Kos, Matevž Likar, Tomaž Skrbinšek, Gorazd Urbanič, Al Vrezec
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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):
Sklop 1: Funkcionalna ekologija rastlin Sklop vključuje različne vidike interakcij rastlin z okoljem, vlogo rastlin pri oblikovanju okolja ter njihove prilagoditve na razmere v okolju. Posebej bo izpostavljena interakcija rastlin s sevanjem, pozitivni in negativni učinki UV-B	**Set 1: Functional plant ecology** The set includes various aspects of the interactions between plants and the environment, their role in creating environment as well as their adaptations to the environmental conditions. In particular, the interactions of plants with radiation (including

sevanja na rastline in prilagoditve, ki so s tem povezane. **Sklop 2: Ekologija vodnih rastlin** Sklop bo zajemal najnovejše izsledke o vlogi vodnih rastlin v ekosistemu, o pojavu invazivnih tujerodnih vodnih rastlin, uporabnosti vodnih rastlin kot bioindikatorjev, odzivu rastlin na strese iz okolja (UV-B, Se). Zajemal vsebine o vsebnosti selena v izbranih slovenskih vodotokih, vplivu Se na vodne in kopenske rastline, vključno s kmetijskimi, sposobnost rastlin za privzem selena, njegove pretvorbe v kopenskih in vodnih rastlinah. **Sklop 3: Vegetacija** Sklop povzema preučevanje vegetacije in obsega obdelavo najnovejših domačih dosežkov in pregled metodološkega razvoja vede v preteklem obdobju. Poseben poudarek bo na obdelavi velikih podatkovnih baz in uporabi numeričnih metod pri iskanju odgovorov na različna raziskovalna vprašanja (fitogeografska, ekološka, iskanje razlogov za spremembe v okolju itd.). Poleg tega pa se bomo tudi seznanili s uporabno vrednostjo rastlinskih združb pri opredelitvi habitatnih tipov in vrednotenju sprememb v okolju. **Sklop 4: Medvrstni odnosi** Sklop vključuje: (1) uvod v ekologijo medvrstnih odnosov in funkcionalne povezave vrst v združbah, (2) tipe in značilnosti neposrednih odnosov, (3) večvrstne interakcijske komplekse (posredne odnose), (4) vpliv sprememb medvrstnih odnosov na delovanje ekosistemov, (5) problematiko vnašanja tujerodnih vrst v naravne ekosisteme (6) invazijski proces naturalizacije tujerodnih vrst v naravnih ekosistemih, (7) ekologijo invazijskih stopenj in (8) koevolucijo sobivajočih vrst (pravilo Rdeče kraljice). **Sklop 5: Ekologija mikorize** Študentu bodo predstavljeni ekološki aspekti interakcij mikorize, ki obsegajo: (1) pojavljanje in značilnosti mikoriznih povezav glede na klimatski pas in ekosistem, (2) pomen mikoriznih interakcij na nivoju rastlinske in glivne združbe in (3) potencialni vplivi klimatskih sprememb na oblikovanje in funkcioniranje mikoriznih povezav.	positive and negative effects of UV-B radiation) will be addressed. **Set 2: Ecology of aquatic plants** This set will cover the latest findings on the role of aquatic plants in ecosystem, occurence of invasive alien species and usefulness of aquatic plants as bioindicators as well as the response of plants to environmental stresses (UV-B radiation, selenium). It will address the content of selenium concentration in selected Slovenian rivers, the effects of selenium on aquatic and terrestrial plants, including agricultural, the ability of plants to uptake of selenium, its transformation in terrestrial and aquatic plants. **Set 3: Vegetation** The set deals with the study of vegetation and elaborates the latest achievements and overview of the methodological development of science in the recent period. Special emphasis will be on the processing of large databases and application of numerical methods to address different research questions (phytogeographical, ecological, reasons for changes in the environment, etc.). In addition, we also noted the practical value of plant communities in defining habitat types and evaluation of changes in the environment. **Set 4: Species interactions** The set includes: (1) the introduction to ecology of interspecific interactions and functional relations in natural assemblages, (2) types and characteristics of direct interactions, (3) multispecies interaction complex (indirect interactions, (4) Influence of altered interspecific interaction on ecosystem function (5) problem of alien species introductions to natural ecosystems (6) invasion naturalization process of alien species, (7) ecology of invasion steps and (8) coevolution of coexisting species (The Red-Queen Hypothesis) **Set 5: Ecology of mycorrhiza** Student will receive detailed knowledge on ecological aspects of mycorrhizal interactions that will include: (1) formation and characteristics of mycorrhizal interactions in different climatic zones and ecosystems, (2) importance of mycorrhizal interactions at the level od plant and fungal communities, and (3) potential effects of climatic changes on the formation and function of mycorrhizal interactions.

Sklop 6: Funkcionalna biodiverziteta Obravnava funkcionalne biodiverzitete v kopenskih ekosistemih s poudarkom na evolucijsko pogojeni vlogi živalskih populacij. Na primeru referenčnih živalskih skupin (Lumbricidae, Chilopoda; Mammalia) predstavitev vloge pri ključnih ekosistemskih procesih. Vključevanje omenjenih skupin v upravljanje s kopenskimi ekosistemi. Njihova ogroženost in varstvo v kulturni krajini. **Sklop 7: Ekologija celinskih voda** Sklop vključuje naslednja področja: (1) Naravne in antropogene spremembe v vodnih ekosistemih in njihovih prispevnih območjih: sprememba habitata, onesnaževanje, raba zemljišč, čezmerna izraba ekosistemov in vrst, spremembe količine vode, klimatske spremembe, fragmentacija habitata, tujerodne vrste. (2) Ugotavljanje soodvisnosti med okoljskimi spremembami in združbami organizmov v vodnih ekosistemih; vrste odzivov združb na spremembe, primerjava odzivov med različnimi združbami v istem okolju, primerjava odzivov med podobnimi združbami v različnih okoljih; spremembe v pestrosti, sestavi, delovanju; merjenje odzivov z različnimi orodji, interpretacija odzivov. (3) Vrednotenje okoljskih sprememb in ekološkega stanja vodnih ekosistemov: tipologija voda; metode primerjave združb in klasifikacija; za tip okolja značilna združba, izhodiščno (referenčno) stanje značilne združbe, merjenje odstopanja od izhodiščnega stanja (razmerje ekološke kakovosti), razvoj indeksov; indikatorske vrste v združbi, primernost različnih združb vodnih organizmov za ugotavljanje vpliva okoljskih spremembe, negotovosti pri vrednotenju ekološkega stanja. **Sklop 8: Sistemska biologija** Vsebinski sklop seznani študente s sistemsko ekologijo, ki sodi v širše področje ekologije ekosistemov. Sistemska ekologija s pomočjo splošne teorije sistemov in ekološkega modeliranja preučuje strukture in delovanje ekosistema na ravneh višjih od osebka ali vrste. Sklop sestajajo tri vsebinska področja: ekosistemska teorija, koncepti modeliranja in	**Set 6: Functional Biodiversity** Review of function of biodiversity in terrestrial ecosystems. Evolutionary base of animal population functions in land ecosystems. Function of some animal group ((Lumbricidae, Chilopoda; Mammalia) in some key ecosystem processes. Including of these groups in ecosystems management. Their endangerment and conservation in human dominated landscape. **Set 7: Freshwater ecology** Sed inclides the following topics: (1) Natural and anthropogenic changes in the aquatic ecosystems and their catchments: habitat change, pollution, land use, excessive exploitation of ecosystems and species, changes in water quantity, climate change, fragmentation of habitats, alien species. (2) Establishing relationship between environmental changes and assemblages in aquatic ecosystems; species responses of assemblages to environmental change, comparison of responses between different assemblages in the same environment, comparison of responses between similar assemblages in different environments; changes in diversity, composition, functioning; measuring responses with different tools, interpretation of responses. (3) Assessing environmental changes and ecological status of aquatic ecosystems: typology of aquatic ecosystems; methods of assemblages comparison and classifications; type specific assemblages, reference state of a type-specific assemblage, development of assessment indices, indicative species, measuring deviation from the reference state (relations of ecological quality) as well as appropriateness of varied aquatic assemblages to assess the impact of the environmental changes, uncertainty at the ecological status assessment. **Set 8: Systems ecology** This part of the course is designed to introduce students to systems ecology which is a branch of ecosystem ecology. Systems ecology attempts to clarify the structures and functions of ecosystems by investigations at the levels beyond that of the individual and species through the application of general system theory and ecological modelling. The course

uporaba orodij za modeliranje na izbranih študijskih primerih. **Sklop 9: Molekularna ekologija** Predstavljeno bo področje molekularne ekologije in ogromen potencial, ki ga ima za ekološke raziskave. Preko primerov iz realnega sveta bodo študentje spoznavali sodobne molekularno-ekološke metode: ocenjevanje velikosti populacij z neinvazivnim genetskim vzorčenjem, prepoznavanje prostorske strukturiranosti in migracij iz prostorske razporeditve genotipov, uporabo genetike razumevanje razvoja kvantitativnih lastnosti in oceno biotske pestrosti s pomočjo DNA črtnih kod. Pojasnjena bo povezava med genetsko pestrostjo in sposobnostjo populacije/vrste, da obstane, genetsko ozadje viabilnosti populacij in problemi, ki spremljajo male populacije.	consists of three main topics: ecosystem theory, concepts and modelling theory and application of modelling tools to selected case studies. **Set 9: Molecular ecology** We will introduce the field of molecular ecology and its enormous potential for ecological research. We will use real-world examples to introduce the students to modern molecular-ecology methods: population size estimates through noninvasive genetic sampling, recognition of spatial structuring and migration from distribution of genotypes, use genetics to understand development of quantitative traits and genetic barcoding to assess biodiversity. We will explain the relation between genetic diversity and survival of a population/species, genetic background of population viability and the problems that plague small populations.

Temeljna literatura in viri/Readings:

Funkcionalna ekologija rastlin/ Functional plant ecology

Larcher, W., 2003. Physiological Plant Ecology. 513 pages, Springer, 4 edition, ISBN: 3540435166

Schulze, E.-D., Beck, E., Müller-Hohenstein, K., 2002. Plant ecology. Springer, Berlin, Heidelberg, New York, 680 pages. ISBN: 354020833

Ekologija vodnih rastlin / Ecology of aquatic plants

Falkowski, P.G., and Raven, J.A. 2007. Aquatic photosynthesis. Princeton University Press, ISBN - 10: 0-691-11551-6, str. 1-201, 319-364.

Germ, M., 2013. Biologija vodnih rastlin: učbenik. Ljubljana: samozal.. 78 str., ISBN 978-961-276-921-5.

Vegetacija / Vegetation

Dierschke, H. 1994. Pflanzensociologie. Grundlagen und Methoden. Ulmer, Stuttgart.

Maarel van der, E., Franklin, J., 2013. Vegetation ecology. John Wiley & Sons, Chichester.

Medvrstni odnosi / Species interactions

Begon, M., C. R. Townsend, Harper, J. L., 2006. Ecology. Blackwell Publishing, Oxford.

Kryštufek, B., 1999. Osnove varstvene biologije. Tehniška založba Slovenije, Ljubljana.

Lockwood, J. L., Hoopes, M. F., Marchetti, M. P., 2007. Invasion Ecology. Blackwell Publishing, Oxford.

Tokeshi, M., 1999. Species coexistence, ecological and evolutionary perspectives. Blackwell Science, Oxford.

Tome, D., 2006. Ekologija: organizmi v prostoru in času. Tehniška založba Slovenije, Ljubljana.

Ekologija mikorize / Ecology of mycorrhiza

Smith, S.E., Read, D.J., 2008. Mycorrhizal Symbiosis, Academic Press London

Funkcionalna biodiverziteta / Functional Biodiversity

Naeem, S., Bunker, D. E., Hector, A., Loreau, M. & Perrings, C. (Eds), 2009. Biodiversity, Ecosystem Functioning, and Human Wellbeing : An Ecological and Economic Perspective. Oxford University Press, Oxford, United Kingdom.
Loreau,M., Naeem, S, Inchausti, P. (Eds), 2002. Biodiversity and Ecosystem Functioning: Synthesis and Perspectives. Oxford University Press, Oxford.

Ekologija celinskih voda / Freshwater ecology
Allan, J.D., Castillo, M.M., 2007. Stream Ecology: Structure and Function of Running Waters, 2nd Ed. Springer.
Lawton, J.H., 2000. Community Ecology in Changing World. In: Kinne O (ed) Excellence in ecology. Book 11. International Ecology Institute, Oldendorf/Luhe.
Begon, M., C. R. Townsend, Harper, J. L., 2008. Ecology. From individuals to ecosystems. 4th Ed. Blackwell Publishing, Oxford.
Legendre, P., Legendre, L., 1998. Numerical Ecology. 2nd Ed. Elsevier Science.

Sistemska ekologija / Systems ecology
Jorgensen, S.E., 2012. Introduction to Systems Ecology (Applied Ecology and Environmental Management). CRC Press.
Jorgensen, S.E., 2009. Ecosystem ecology. Elsevier.
Von Bertalanffy, L., 2009. General systems theory. 17 izdaja, George Braziller.

Molekularna ekologija / Molecular ecology
Frankham, R., Ballou, J.D., Briscoe, D.A., 2002. Introduction to Conservation Genetics. Cambridge University Press, Cambridge.
Beebee, T.J.C., Rowe, G., 2008. An introduction to molecular ecology. Oxford University Press.

Pri vseh sklopih tudi revijalni članki s področja, tekoča periodika ter druga učna gradiva / In all set salso scientific articles in the field of ecology, current periodicals and other learning materials

Cilji in kompetence:	Objectives and competences:
Sklop 1: Funkcionalna ekologija rastlin Poznavanje prilagoditev rastlin v različnih okoljih. Zavedenje, da prilagojenost omogoča nemoten vnos energije v ekosisteme, vsakršne motnje pa to učinkovitost zmanjšajo, kar se odraža v slabšanju kakovosti okolja. Zavedanje medsebojne povezanosti med rastlinami in okoljem, kot osnove za trajnostno gospodarjenje z rastlinskimi viri (kmetijstvo, gozdarstvo). Poznavanje možnosti uporabe rastlin za blaženje sprememb v okolju. **Sklop 2: Ekologija vodnih rastlin** Prepoznavanje bioindikacijske vloge makrofitov in invazivnega potenicala tujerodnih vodnih rastlin. Prepoznavanje sposobnosti vodnih in kopenskih, vključno s kmetijskimi rastlinami, za privzem selena ter znanje o metabolizmu selena v rastlinah in vplivu različnih kemijskih oblik selena na rastline.	**Set 1: Functional plant ecology** Knowledge on plant adaptations in different environments. The awareness that adaptations optimize the input of energy into the ecosystems and that any disturbance or pressure affect efficiency and result in the ecosystem quality. The awareness of inter-relations between plants and environment as a basis for sustainable management of plants and ecosystems (agriculture, forestry). The knowledge on the use of plants for alleviation of changes in the environment. **Set 2: Ecology of aquatic plants** Acquaintance with the latest literature on the role of macrophytes as biondicators and the invasive potential of allien species. Knowledge in the field of the ability of water and terrestrial, including agricultural plants, the uptake of selenium and knowledge of the metabolism of selenium in plants and the

Sklop 3: Vegetacija Vedenje, da vegetacija predstavlja rastlinsko komponento biosfere, ki jo gradijo posamezne rastlinske združbe in so tako osnovni del večine kopenskih ekosistemov. Ti pa so deli krajin, tako naravnih kot kulturnih, ki predstavljajo okolje, v katerem živijo živa bitja. Poznavanje vegetacije nam pomaga razumeti krajine, hkrati pa je tudi okolja za živa bitja, ki jo soustvarjajo**.** **Sklop 4: Medvrstni odnosi** Razvoj kritičnega pogleda na razumevanje delovanja ekosistemov, evolucije in vidikov ekosistemskega varstva z vidika biotskih odnosov. Posebej izpostavljena je problematika tujerodnih vrst, ki so danes pomemben okoljskih dejavnik s stališča varstva ekosistemov in ekonomskega izkoriščanja naravnih virov. Predmet je nadgradnja osnovnih ekoloških principov zgradbe in delovanja ekosistema s poudarkom na razumevanju biotskega okoljskega dejavnika, ki je razdelan tako iz temeljnih kot aplikativnih vidikov. **Sklop 5: Ekologija mikorize** Poznavanje ekoloških vidikov mikoriznih interakcij in sposobnost lastnega načrtovanja in opravljanja raziskav na tem raziskovalnem področju. **Sklop 6: Funkcionalna biodiverziteta** Seznaniti študente z novimi spoznanji o funkcijski vlogi raznolikosti življenja, razumevanje evolucijskega izhodišča razvoja biote in funkcionalnih ekosistemov. Utrditi pomen znanja pri trajnostnem upravljanju kopenskih ekosistemov. Prepoznati grožnje biodiverziteti in razviti sposobnost za iskanje ustreznih rešitev za njeno varstvo. **Sklop 7: Ekologija celinskih voda** Temeljni izobraževalni cilji so: (1) razumevanje odziva vodnih ekosistemov na naravne in antropogeno povzročene spremembe v okolju, (2) poznavanje najnovejših metod vrednotenja ekološkega stanja vodnih ekosistemov na podlagi združb organizmov, (3) razumevanje ekosistemskega pristopa pri upravljanju voda. **Sklop 8: Sistemska biologija** Cilj tega sklopa predmeta je podati znanje o sistemsko-ekološke značilnostih strukture in delovanja ekosistema za potrebe njegovega	effects of various chemical forms of selenium on plants. **Set 3: Vegetation** The knowledge about vegetation as a component of the biosphere built by plant communities and is one of the basic part of most terrestrial ecosystems. These are parts of the landscape, both natural and cultural, which constitute the environment in which appear living beings. Knowledge of vegetation helps us understand the landscape, but also the environment of living beings, who (co-)create it. **Set 4: Species interactions** The development of critical thinking about ecosystem functioning, evolution and ecosystem conservation in regard to biotic interactions. As a key example the problem of invasive alien species is set, which are recently one the most important environmental problems on the field of ecosystem conservation and economic exploitation of natural resources. The subject is aimed to enhance basic knowledge on ecological principles regarding ecosystem structure and function regarding biotic environmental factors from the basic and applicative points of view. **Set 5: Ecology of mycorrhiza** The knowledge of ecological aspects of mycorrhizas. And the ability of planning and carring out the research in the field of ecology of mycorrhiza. **Set 6: Functional Biodiversity** Acquaintance of students with the latest knowledge on the role of biodiversity, to understanding of evolutionary base of biota development and development of functional ecosystems. To improve the important of science knowledge into sustainable management of land ecosystems. To be able to identified treats to biodiversity and found adequate solutions for their conservation. **Set 7: Freshwater ecology** Basic educational aims: (1) understanding the response of aquatic ecosystems on natural and anthropogenic environmental changes, (2) knowing of the most recent methods of community-based ecological status assessment methods of aquatic ecosystems, (3)understanding of the ecosystem approach in the water management. **Sklop 8: Systems ecology**

razumevanja, napovedovanja njegovega obnašanja in upravljanja z njim. **Sklop 9: Molekularna ekologija** Omogočiti študentom vpogled v hitro razvijajoče področje molekularne ekologije. Predstaviti najsodobnejše raziskovalne metode, ki zadnja desetletja premikajo meje izvedljivosti ekoloških raziskav.	The aim this part of the course is to provide systems approach to the knowledge about the characteristics of the structure and functioning of the ecosystem for the purpose of explanations, predictions and management. **Set 9: Molecular ecology** To provide the students with the first glimpse into the rapidly developing field of molecular ecology. To introduce the modern research methods that have been fort the last couple of decades redefining the limits of what can be done in ecological research.

Predvideni študijski rezultati:	Intended learning outcomes:
Sklop 1: Funkcionalna ekologija rastlin Poznavanje prilagoditev rastlin v različnih okoljih. Zavedenje, da prilagojenost omogoča nemoten vnos energije v ekosisteme, vsakršne motnje pa to učinkovitost zmanjšajo, kar se odraža v slabšanju kakovosti okolja. Zavedanje medsebojne povezanosti med rastlinami in okoljem, kot osnove za trajnostno gospodarjenje z rastlinskimi viri (kmetijstvo, gozdarstvo). Poznavanje možnosti uporabe rastlin za blaženje sprememb v okolju. **Sklop 2: Ekologija vodnih rastlin** Prepoznavanje bioindikacijske vloge makrofitov in invazivnega potenicala tujerodnih vodnih rastlin. Prepoznavanje sposobnosti vodnih in kopenskih, vključno s kmetijskimi rastlinami, za privzem selena ter znanje o metabolizmu selena v rastlinah in vplivu različnih kemijskih oblik selena na rastline. **Sklop 3: Vegetacija** Vedenje, da vegetacija predstavlja rastlinsko komponento biosfere, ki jo gradijo posamezne rastlinske združbe in so tako osnovni del večine kopenskih ekosistemov. Ti pa so deli krajin, tako naravnih kot kulturnih, ki predstavljajo okolje, v katerem živijo živa bitja. Poznavanje vegetacije nam pomaga razumeti krajine, hkrati pa je tudi okolja za živa bitja, ki jo soustvarjajo**.** **Sklop 4: Medvrstni odnosi** Razvoj kritičnega pogleda na razumevanje delovanja ekosistemov, evolucije in vidikov ekosistemskega varstva z vidika biotskih odnosov. Posebej izpostavljena je problematika tujerodnih vrst, ki so danes pomemben	Knowledge and understanding: **Set 1: Functional plant ecology** The students gain understanding on responses of plants to environmental factors and their role in shaping and maintenance favourable environmental conditions. They get acquainted with the plasticity of plant response in different environment and its deterioration due to unexpected changes. They are aware of the optimization of the structure and function of plants as a part of the complex system. **Set 2: Ecology of aquatic plants** Students will recognise the role of aquatic plants in ecosystem, and the characteristics of aquatic plants as bioindicators. Students will be familiar with the most common invasive non-native aquatic plants and their invasive potential and threat to native flora.They will learn about the latest findings on the ability of terrestrial and aquatic plants to uptake of selenium as well as differences in metabolism of selenium between aquatic and terrestrial plants. Students will recognize the possibility of enrichment of agricultural crops with selenium and use of these plants as a functional food for humans and animals. **Set 3: Vegetation** Students will become familiar with contemporary approaches to the study of vegetation that will allow them to reseach in this field and possible results achieved with this methodology. In addition, they will learn about the possibilities available to the vegetation surveys to provide the designation of the environment of the individual living beings and for understanding of the landscape as a whole. **Set 4: Species interactions**

okoljskih dejavnik s stališča varstva ekosistemov in ekonomskega izkoriščanja naravnih virov. Predmet je nadgradnja osnovnih ekoloških principov zgradbe in delovanja ekosistema s poudarkom na razumevanju biotskega okoljskega dejavnika, ki je razdelan tako iz temeljnih kot aplikativnih vidikov. **Sklop 5: Ekologija mikorize** Poznavanje ekoloških vidikov mikoriznih interakcij in sposobnost lastnega načrtovanja in opravljanja raziskav na tem raziskovalnem področju. **Sklop 6: Funkcionalna biodiverziteta** Seznaniti študente z novimi spoznanji o funkcijski vlogi raznolikosti življenja, razumevanje evolucijskega izhodišča razvoja biote in funkcionalnih ekosistemov. Utrditi pomen znanja pri trajnostnem upravljanju kopenskih ekosistemov. Prepoznati grožnje biodiverziteti in razviti sposobnost za iskanje ustreznih rešitev za njeno varstvo. **Sklop 7: Ekologija celinskih voda** Temeljni izobraževalni cilji so: (1) razumevanje odziva vodnih ekosistemov na naravne in antropogeno povzročene spremembe v okolju, (2) poznavanje najnovejših metod vrednotenja ekološkega stanja vodnih ekosistemov na podlagi združb organizmov, (3) razumevanje ekosistemskega pristopa pri upravljanju voda. **Sklop 8: Sistemska biologija** Cilj tega sklopa predmeta je podati znanje o sistemsko-ekološke značilnostih strukture in delovanja ekosistema za potrebe njegovega razumevanja, napovedovanja njegovega obnašanja in upravljanja z njim. **Sklop 9: Molekularna ekologija** Omogočiti študentom vpogled v hitro razvijajoče področje molekularne ekologije. Predstaviti najsodobnejše raziskovalne metode, ki zadnja desetletja premikajo meje izvedljivosti ekoloških raziskav.	Students will be stimulated to research thinking at the field of studies of interspecific interactions and there interconnection at different levels of ecosystem research. An important issue is that students will be able to include different interspecific interaction aspects into formation of scientific questions in applicative as well as basic studies in order to incorporate greater complexity approach into research problem solutions. **Set 5: Ecology of mycorrhiza** The students gain understanding about functioning of mycorrhizal interactions, distribution of mycorrhizal interactions across different climate zones and ecosystems, the importance of mycorrhizal interactions at the community level and potential impact of climate changes on the formation and functioning of mycorrhizal interactions. **Set 6: Functional Biodiversity** The students gain understanding about the development of biodiversity and the role of diversity for ecosystem function. They will complete their knowledge on function of some animal groups in terrestrial ecosystems. They will integrate biological knowledge that will enable them to understand holistic approach in sustainable environment management. They will gain knowledge on factors with negative influence on conservation status of biodiversity and possible effective meassures for its conservation. **Set 7: Freshwater ecology** The envisaged learning outcome is to qualify a candidate for work with the methods and tools dealt with, which the candidate can use in basic and applicative research of associations. **Set 8: Systems ecology** Students will obtain methodological skills that will allow them to acquire new knowledge about the behavior of the studied ecosystems, they will be able to predict its behavior and to structure the acquired knowledge into a form suitable for the management of ecosystems. **Set 9: Molecular ecology** The students will gain an insight into the field of molecular ecology and the opportunities it provides. They will get an overview of modern research methods and the solutions they offer. In this manner they will extend their knowledge of research tools. With additional study they

	will be able to utilize this knowledge in their own research.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanje, konzultacije, seminar, razprava	Lectures, consultations, seminar, discussion

Načini ocenjevanja:	Delež/Weight	Assessment:
Izpitno vprašanje	100,00 %	The examination

Reference nosilca/Lecturer's references:

Prof. dr. Alenka Gaberščik

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UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Fiziologija in morfologija rastlin – integrativni pristop
Course title:	Physiology and Morphology of Plants- an Integrative Approach

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

Univerzitetna koda predmeta/University course code:	0566693

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	30	0	0	10	190	10

Nosilec predmeta/Lecturer:	Marjana Regvar

Izvajalci predavanj:	Kristina Gruden, Marjana Regvar, Katarina Vogel Mikuš
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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 in doctoral studies.

Vsebina:	Content (Syllabus outline):
Predmet obravnava zgradbo in delovanje rastlin na več ravneh biološke organizacije in pri tem povezuje številne vede in področja raziskav, ki obravnavajo zgradbo in delovanje rastlin: morfologijo in anatomijo, histologijo, biokemijo in predstavitev sodobnih analiznih metod v fiziologiji rastlin. Nedavni napredek v molekulski biologiji, vključno z razkritjem zaporedja mnogih genomov, je priložnost za	The course provides knowledge of the form and function of living organisms at levels of biological organization plants and covers a diverse array of fields in research including physiology, morphology and anatomy, histology, biochemistry and modern analytical approaches in plant physiology. The recent advances in molecular biology, including the sequencing of genomes, have provided an

uporabo tega znanja. Novo znanje je pripomoglo k razumevanju, kako geni v kompleksnih sistemih omogočijo emergenčne lastnosti fenotipov. Interdisciplinarni pristop k raziskavam organizmov zahteva uporabo naprednih tehnologij, mikroskopije, spektroskopske analize, tehnike molekulske genetike in računalniške analize slik in signalov. Integracija znanja med številnimi ravnmi biologije je potrebno za razkrivanje temeljnih načel delovanja organizmov pod vplivom različnih biotskih in abiotskih dejavnikov. Integracija znanja je potrebna tudi za uporabo biologije v industriji in družbi.	opportunity to use this information to understand how the genes enable emergent phenotypes in complex systems. Multi-disciplinary approach to studying organisms requires the ability to utilize advanced technologies such as microscopy, spectroscopic analyses, molecular genetics and computer assisted image and signal analysis. Integration of knowledge across levels of biological complexity is required for elucidating fundamental principles of biological function under different biotic and abiotic factors or as the basis for novel applications.

Temeljna literatura in viri/Readings:
Geoffrey M. Cooper. The cell, A Molecular Approach, 6th Edition, Boston University Suderland (MA), Sinauer Assoc. 2013 Russel Jones et al. The Molecular Life of Plants. Willey-Blackwell, ASPB, 2013 Lincoln Teiz, Eduardo Zeiger. Plant Physiology. Sinauer Assoc, 2010 John D. Bancroft, Marilyn Gamble. Theory and Practice of Histological Techniques, 6e. Churchill Livingstone, Elsevier, ISBN-13: 978-0443102790, 2008. Tekoča periodika in zlasti pregledni članki s področij: fiziologije, anatomije, morfologije in raziskovalne tehnologije

Cilji in kompetence:	Objectives and competences:
Temeljni izobraževalni cilj je razumevanje mehanizmov delovanja organizmov ter njihove regulacije. Pri tem se povezujejo ravni od molekule in celice do odnosa organizmov z okoljem. Študent pridobi kompetence pri razumevanju procesov v rastlinah.	The educational aim of the course is to understand mechanisms that govern functioning of organisms and gain knowledge of their regulation. In this the levels of organisation from molecules and cells to interactions with the environment are considered. Students gain competences in understanding of processes in plants.

Predvideni študijski rezultati:	Intended learning outcomes:
Predviden študijski rezultat je nadgraditi in povezati znanje s področja fiziologije, anatomije, morfologije in uporaba novega znanja za razumevanje delovanja organizmov pod vplivom biotskih in abiotskih dejavnikov	The course is aiming to upgrade and integrate the competences and knowledge from the fields of physiology, anatomy, morphology, and to apply the acquired knowledge in understanding functions of organisms under adverse biotic and abiotic conditions

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, diskusijske delavnice predstavljenih seminarjev, predstavitve v laboratorijih. Pri izvajanju sodelujejo vabljeni predavatelji.	Lectures, workshops with seminars, lab presentations in cooperation with invited lecturers. The course is adjusted to the research field of the student.

Izvedba je prilagojena raziskovalni tematiki študenta.	

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit iz tem predavanj.	50,00 %	Written examination
Predstavitev individualnega projekta	50,00 %	Project presentation

Reference nosilca/Lecturer's references:

prof. dr. Marjana Regvar

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UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Fiziologija in morfologija živali – integrativni pristop
Course title:	Physiology and Morphology of Animals - an Integrative Approach

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

Univerzitetna koda predmeta/University course code:	0566745

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	30	0	0	10	190	10

Nosilec predmeta/Lecturer:	Marko Kreft

Izvajalci predavanj:	Damjana Drobne, Gordana Glavan, Petra Golja, Marko Kreft, Jasna Štrus, Meta Virant - Doberlet, Primož Zidar
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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 in doctoral studies.

Vsebina:	Content (Syllabus outline):
Predmet obravnava zgradbo in delovanje živali na več ravneh biološke organizacije in pri tem povezuje številne vede in področja raziskav, ki obravnavajo zgradbo in delovanje živali in človeka: morfologijo in anatomijo, histologijo, etologijo, nevroznanost, kemijo, biomehaniko, fiziko, inženirstvo. Nedavni napredek v molekulski biologiji, vključno z	The course provides knowledge of the form and function at levels of biological organization of animals and humans, and covers a diverse array of fields in research including physiology and ethology, morphology and anatomy, histology, neuroscience, chemistry, biomechanics, physics, engineering. The recent advances in molecular biology, including the sequencing of

razkritjem zaporedja mnogih genomov, je priložnost za uporabo tega znanja. Novo znanje je pripomoglo k razumevanju, kako geni v kompleksnih sistemih omogočijo emergenčne lastnosti fenotipov. Interdisciplinarni pristop k raziskavam organizmov zahteva uporabo naprednih tehnologij, elektrofiziologije, mikroskopije, spektroskopske analize, tehnike molekulske genetike in računalniške analize slik in signalov. Integracija znanja med številnimi ravnmi biologije je potrebno za razkrivanje temeljnih načel delovanja organizmov pod vplivom različnih biotskih in abiotskih dejavnikov. Integracija znanja je potrebna tudi za uporabo biologije v industriji in družbi.	genomes, have provided an opportunity to use this information to understand how the genes enable emergent phenotypes in complex systems. Multi-disciplinary approach to studying organisms requires the ability to utilize advanced technologies such as electrophysiology, microscopy, spectroscopic analyses, molecular genetics and computer assisted image and signal analysis. Integration of knowledge across levels of biological complexity is required for elucidating fundamental principles of biological function under different biotic and abiotic factors or as the basis for novel applications.

Temeljna literatura in viri/Readings:
Geoffrey M. Cooper. The cell, A Molecular Approach, 6th Edition, Boston University Suderland (MA), Sinauer Assoc. 2013 Stephen J. McPhee, Gary D. Hammer. Pathophysiology of Disease, 6 Edition, 768 pages. McGraw-Hill Medical 2009 William D. McArdle, Frank I. Katch, Victor L. Katch. Exercise Physiology, 6th Revised edition, 1184 pages, Lippincott Williams and Wilkins, 2006. Les Watling, M.Thiel. Functional morphology and diversity: The Natural History of Crustacea, Volume 1, Oxford University Press 2013, izbrana poglavja Geoffrey A. Manley, Arthur N. Popper, Richard R. Fay (2004): Evolution of the Vertebrate Auditory System, Springer, ISBN:038721089X John D. Bancroft, Marilyn Gamble. Theory and Practice of Histological Techniques, 6e. Churchill Livingstone, Elsevier, ISBN-13: 978-0443102790, 2008. Tekoča periodika in zlasti pregledni članki s področij: fiziologije, etologije, anatomije, morfologije in raziskovalne tehnologije

Cilji in kompetence:	Objectives and competences:
Temeljni izobraževalni cilj je razumevanje mehanizmov delovanja organizmov ter njihove regulacije. Pri tem se povezujejo ravni od molekule in celice do odnosa organizmov z okoljem. Študent pridobi kompetence pri razumevanju procesov v živalih in človeku.	The educational aim of the course is to understand mechanisms that govern functioning of organisms and gain knowledge of their regulation. In this the levels of organisation from molecules and cells to interactions with the environment are considered. Students gain competences in understanding of processes in animals and humans.

Predvideni študijski rezultati:	Intended learning outcomes:
Predviden študijski rezultat je nadgraditi in povezati znanje s področja fiziologije, anatomije, morfologije, etologije in uporaba novega znanja za razumevanje delovanja	The course is aiming to upgrade and integrate the competences and knowledge from the fields of physiology, anatomy, morphology, ethology and to apply the acquired knowledge

organizmov pod vplivom biotskih in abiotskih dejavnikov.	in understanding functions of organisms under adverse biotic and abiotic conditions.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, diskusijske delavnice predstavljenih seminarjev, predstavitve v laboratorijih. Pri izvajanju sodelujejo vabljeni predavatelji. Izvedba je prilagojena raziskovalni tematiki študenta.	Lectures, workshops with seminars, lab presentations in cooperation with invited lecturers. The course is adjusted to the research field of the student.

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit iz tem predavanj	50,00 %	Written examination
Predstavitev individualnega projekta	50,00 %	Project presentation

Reference nosilca/Lecturer's references:

prof. dr. Marko Kreft

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prof. dr. Damjana Drobne

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doc. dr. Primož Zidar

ZIDAR, Primož, KOS, Monika, ILIĆ, Eva, MAROLT, Gregor, DROBNE, Damjana, JEMEC KOKALJ, Anita. Avoidance behaviour of isopods (Porcellio scaber) exposed to food or soil contaminated with Ag- and CeO2- nanoparticles. Applied soil ecology, ISSN 0929-1393, 2019, vol. 141, str. 69-78, doi: 10.1016/j.apsoil.2019.05.011

ZIDAR, Primož, ŠKUFCA, David, PREVORČNIK, Simona, KALČÍKOVÁ, Gabriela, JEMEC KOKALJ, Anita. Energy reserves in the water louse Asellus aquaticus (Isopoda, Crustacea) from surface and cave populations : seasonal and spatial dynamics. Fundamental and applied limnology, ISSN 1863-9135, 2018, vol. 191, no. 3, str. 253-265, doi: 10.1127/fal/2018/1118.

JEMEC KOKALJ, Anita, ŠKUFCA, David, PREVORČNIK, Simona, FIŠER, Žiga, ZIDAR, Primož. Comparative study of acetylcholinesterase and glutathione S-transferase activities of closely related cave and surface Asellus aquaticus (Isopoda: Crustacea). PloS one, ISSN 1932-6203, 2017, vol. 12, iss. 5, str. 1-14, ilustr., doi: 10.1371/journal.pone.0176746.

ZIDAR, Primož, KRŽIŠNIK, Špela, DEBELJAK, Marta, ŽIŽEK, Suzana, VOGEL-MIKUŠ, Katarina. The effect of selenium on mercury transport along the food chain. Agrofor, ISSN 2490-3434, 2016, vol. 1, no. 3, str. 119-126, ilustr., doi: 10.7251/AGRENG1603119Z.

ZIDAR, Primož, KOS, Monika, VOGEL-MIKUŠ, Katarina, ELTEREN, Johannes Teun van, DEBELJAK, Marta, ŽIŽEK, Suzana. Impact of ionophore monensin on performance and Cu uptake in earthworm Eisenia andrei exposed to copper-contaminated soil. Chemosphere, ISSN 0045-6535. [Print ed.], 2016, vol. 161, str. 119-126, doi: 10.1016/j.chemosphere.2016.07.013.

6. GESTEL, Cornelis A. M. van, LOUREIRO, Susana, ZIDAR, Primož. Terrestrial isopods as model organisms in soil ecotoxicology : a review. ZooKeys, ISSN 1313-2989, 2018, vol. 801, str. 127-162, doi: 10.3897/zookeys.801.21970.,

doc. dr. Meta Virant-Doberlet

KUHELJ, Ana, DE GROOT, Maarten, PAJK, Franja, SIMČIČ, Tatjana, VIRANT-DOBERLET, Meta (2015). Energetic cost of vibrational signalling in a leafhopper. Behavioral Ecology and Sociobiology, 69: 815-828, A'.

KUHELJ, Ana, DE GROOT, Maarten, BLEJEC, Andrej, VIRANT-DOBERLET, Meta (2015). The effect of timing of female vibrational reply on male signalling and searching behaviour in the leafhopper Aphrodes makarovi. PloS ONE, 10, doi: 10.1371/journal.pone.0139020, A'.

KORINŠEK, Gašper, DERLINK, Maja, VIRANT-DOBERLET, Meta, TUMA, Tadej (2016). An autonomous system of detecting and attracting leafhopper males using species- and sex-specific substrate borne vibrational signals. Computers and Electronics in Agriculture, 123: 29-39, A'.
KUHELJ, Ana, DE GROOT, Maarten, BLEJEC, Andrej, VIRANT-DOBERLET, Meta (2016). Sender-receiver dynamics in leafhopper vibrational duetting. Animal Behaviour, 114: 139-146, A'.
PREŠERN, Janez, POLAJNAR, Jernej, DE GROOT, Maarten, ZOROVIĆ, Maja, VIRANT-DOBERLET, Meta (2018). On the spot: utilization of directional cues in vibrational communication of a stink bug. Scientific Reports, 8, doi: 10.1038/s41598-018-23710-x, A'.
VIRANT-DOBERLET, Meta, KUHELJ, Ana, POLAJNAR, Jernej, ŠTURM, Rok (2019). Predator-prey interactions and eavesdropping in vibrational communication networks. Frontiers in Ecology and Evolution, 7, doi: 10.3389/fevo.2019.00203, A1/2.

doc. dr. Gordana Glavan

GLAVAN, Gordana, KOS, Monika, BOŽIČ, Janko, DROBNE, Damjana, SABOTIČ, Jerica, JEMEC KOKALJ, Anita. Different response of acetylcholinesterases in salt- and detergent-soluble fractions of honeybee haemolymph, head and thorax after exposure to diazinon. Comparative biochemistry and physiology.Part C, Toxicology & pharmacology. 2018, vol. 205, str. 8-14. ISSN 1532-0456. DOI: 10.1016/j.cbpc.2017.12.004.
PIŠLAR, Anja, TRATNJEK, Larisa, GLAVAN, Gordana, ŽIVIN, Marko, KOS, Janko. Upregulation of cysteine protease cathepsin X in the 6-hydroxydopamine model of Parkinson's disease. Frontiers in molecular neuroscience. Nov. 2018, vol. 11, str. 1-12, ilustr. ISSN 1662-5099. https://www.frontiersin.org/articles/10.3389/fnmol.2018.00412/full, DOI: 10.3389/fnmol.2018.00412.
KOS, Monika, JEMEC KOKALJ, Anita, GLAVAN, Gordana, MAROLT, Gregor, ZIDAR, Primož, BOŽIČ, Janko, NOVAK, Sara, DROBNE, Damjana. Cerium (IV) oxide nanoparticles induce sublethal changes in honeybees after chronic exposure. Environmental science.Nano. 2017, vol. 4, iss. 12, str. 2297-2310. ISSN 2051-8153. http://dx.doi.org/10.1039/c7en00596b, DOI: 10.1039/c7en00596b.
TRATNJEK, Larisa, ŽIVIN, Marko, GLAVAN, Gordana. Synaptotagmin 7 and SYNCRIP proteins are ubiquitously expressed in the rat brain and co-localize in Purkinje neurons. Journal of chemical neuroanatomy. 2017, vol. 79, str. 12-21, ilustr. ISSN 0891-0618. DOI: 10.1016/j.jchemneu.2016.10.002.
TESOVNIK, Tanja, CIZELJ, Ivanka, ZORC, Minja, ČITAR, Manuela, BOŽIČ, Janko, GLAVAN, Gordana, NARAT, Mojca. Immune related gene expression in worker honey bee (Apis mellifera carnica) pupae exposed to neonicotinoid thiamethoxam and Varroa mites (Varroa destructor). PloS one. 2017, vol. 12, no. 10, str. 1-15, e0187079, ilustr. ISSN 1932-6203. DOI: 10.1371/journal.pone.0187079
CIZELJ, Ivanka, GLAVAN, Gordana, BOŽIČ, Janko, OVEN, Irena, MRAK, Vesna, NARAT, Mojca. Prochloraz and coumaphos induce different gene expression patterns in three developmental stages of the Carniolan honey bee (Apis mellifera carnica Pollmann). Pesticide biochemistry and physiology. 2016, vol. 128, str. 68-75. ISSN 0048-3575. DOI: doi:10.1016/j.pestbp.2015.09.015.

doc. dr. Petra Golja

GOLJA, Petra, CETTOLO, Valentina, FRANCESCATO, Maria Pia. Calculation algorithms for breathby-breath alveolar gas exchange : the unknowns!. European journal of applied physiology. [Print ed.]. 2018, vol. 118, iss. 9, str. 1869-1876.
ZDEŠAR KOTNIK, Katja, JURAK, Gregor, STARC, Gregor, PUC, Martina, GOLJA, Petra. Use of dietary supplements in differently physically active adolescents. Journal of food and nutrition research. 2018, vol. 57, no. 3, str. 231-241.
LUČOVNIK, Miha, STARC, Gregor, GOLJA, Petra, VERDENIK, Ivan, ŠTUCIN GANTAR, Irena. Effects of perinatal factors on body mass index and physical fitness of school-age children = Vpliv perinatalnih dejavnikov na indeks telesne mase in gibalno učinkovitost osnovnošolcev. Zdravstveno varstvo : Slovenian journal of public health. [Tiskana izd.]. 2018, letn. 57, št. 2, str. 81-87.

ROBIČ PIKEL, Tatjana, STARC, Gregor, STREL, Janko, KOVAČ, Marjeta, BABNIK, Janez, GOLJA, Petra. Impact of prematurity on exercise capacity and agility of children and youth aged 8 to 18. Early human development. 2017, vol. 110, str. 39-45

ZDEŠAR KOTNIK, Katja, JURAK, Gregor, STARC, Gregor, GOLJA, Petra. Faster, stronger, healthier : adolescent-stated reasons for dietary supplementation. Journal of Nutrition Education and Behavior : the official journal of the Society for Nutrition Education. 2017, vol. 49, iss. 10, str. 817-826.

ZDEŠAR KOTNIK, Katja, ROBIČ PIKEL, Tatjana, GOLJA, Petra. Which method to use for a fast assessment of body fat percentage?. Physiological measurement. [Print ed.]. 2015, vol. 36, no. 7, str. 1453-1468.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Geografski informacijski sistemi kot raziskovalno orodje v biologiji in varstvu narave
Course title:	Geographic information systemsas a research tool for biology and nature conservation

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

Univerzitetna koda predmeta/University course code:	3777

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	20	20	0	0	85	5

Nosilec predmeta/Lecturer:	Maja Zagmajster

Izvajalci predavanj:	Tomaž Skrbinšek, Maja Zagmajster
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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 to enroll in Doctoral Study Programme.

Vsebina:	Content (Syllabus outline):
Prikaz prostorskih podatkov: koordinatni sistemi, projekcije, georefenciranje. Urejanje podatkov in prostorske podatkovne baze.	Displaying spatial data: coordinate systems, geographic projections, georeferencing. Data management and spatial databases.

Osnove GIS: tipi podatkov, prikaz podatkov, izdelava kart. Analize v GIS: analize razdalj, prostorske razporeditve, prostorske avtokorelacije, prostorska algebra. Uporaba GIS-a v prostorskih raziskavah in naravovarstvu.	GIS basics: data types, data presentation, map production. Analyses in GIS: analyses of distances, spatial distributions, spatial autocorrelation, spatial algebra. Application of GIS in spatial studies and nature conservation

Temeljna literatura in viri/Readings:
Longley, Paul A., Goodchils, Michael F., Maguire David J., Rhind, David W. 2005. Geographical Information Systems and Science, 2nd Edition. John Wiley & Sons, Ltd., 517 str. Revijalni članki s področja, internetna učna gradiva (http://www.esri.com/what-is-gis/books, http://www.qgis.org/en/docs/gentle_gis_introduction/index.html, itd.). Journal articles from the study field, internet tutorials (http://www.esri.com/what-is-gis/books, http://www.qgis.org/en/docs/gentle_gis_introduction/index.html, etc.)

Cilji in kompetence:	Objectives and competences:
Seznaniti študente z uporabo geografskih informacijskih sistemov in prostorskih podatkovnih baz, da bodo lahko samostojno in kompetentno uporabljali in analizirali prostorske podatke za potrebe lastnih raziskav.	To introduce the students to geographic information systems and spatial databases and build competence for independent use and analysis of spatial data in their own research.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: - osnov kartografije in izdelave kart - principov priprave in obdelave prostorskih podatkov, - posebnosti prostorskih analiz in modeliranj. Znanje praktične uporabe izbranega GIS programskega paketa, sposobnost prenosa praktičnih izkušenj na druge GIS programe. Znanje praktične uporabe GIS orodij pri reševanju lastnih raziskovalnih vprašanj.	Knowledge and understanding: - of the basics of cartography and map production, - of the principles of spatial data preparation and analyses, - of the specifics of spatial analyses and modelling. Ability to use the chosen GIS software; based on experiences of working with it, being able to work with other GIS software. Being able to use GIS tools in own research.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja: teoretične osnove za razumevanje prikaza in analize prostorskih podatkov. **Praktično delo (Vaje)**: učenje preko praktičnega dela s programskim paketom ArcGIS in seznanjanje z odprtokodnimi GIS programi. Vodeno delo na računalnikih.	**Lectures**: theoretical foundation for understanding visualization and analysis of spatial data. **Practical work (Tutorial)**: hands-on learning though practical work with ArcGIS software and introduction to open source GIS software. Guided practical work with computers.

Seminar: izdelava seminarja iz teme doktorske disertacije študenta ali tematskega sklopa po njegovem/njenem izboru/zanimanju.	**Seminar**: production of a seminar. The topic is selected by the student, either from his/her doctoral dissertation or from other interests.

Načini ocenjevanja:	Delež/Weight	Assessment:
Seminar	100,00 %	Seminar

Reference nosilca/Lecturer's references:

ZAGMAJSTER, Maja, Culver, David C., Sket, Boris (2008). Species richness patterns of obligate subterranean beetles (Insecta: Coleoptera) in a global biodiversity hotspot-effect of scale and sampling intensity. *Diversity and distributions*, 14(1): 95-105.

Deharveng, Louis, Stoch, Fabio, Giberrt, Janine, Bedos, Anne, Galassi, Diana Maria Paola, ZAGMAJSTER, Maja, Brancelj, Anton, Camacho, Ana Isabel, Fiers, Frank, Martin, P., GianiI, N., Magniez, G., Marmonier, P. (2009). Groundwater biodiversity in Europe. *Freshwater Biology*, 54(4): 709-726.

ZAGMAJSTER, Maja, Culver, David C., Christman, Mary, Sket, Boris (2010). Evaluating the sampling bias in pattern of subterranean species richness : combining approaches. *Biodiversity and conservation*, 19(11): 3035-3048.

Utevsky, Serge Y., ZAGMAJSTER, Maja, Atemasov, Andrei, Zinenko, Oleksandr, Utevska, Olga, Utevsky, Andrei Y., Trontelj, Peter (2010). Distribution and status of medicinal leeches (genus *Hirudo*) in the Western Palaearctic : anthropogenic, ecological, or historical effects? *Aquatic conservation*, 20(2): 198-210.

Prevorčnik, Simona, Verovnik, Rudi, ZAGMAJSTER, Maja, Sket, Boris (2010). Biogeography and phylogenetic relations within the Dinaric subgenus *Monolistra* (*Microlistra*) (Crustacea: Isopoda: Sphaeromatidae), with a description of two new species. *Zoological journal of the Linnean Society*, 159(1): 1-21.

Fišer, Cene, ZAGMAJSTER, Maja, Ferreira, Rodrigo L. (2013). Two new amphipod families recorded in South America shed light on an old biogeographical enigma. *Systematics and biodiversity*, 11(2): 117-139.

Culver, David C., Trontelj, Peter, ZAGMAJSTER, Maja, Pipan, Tanja (2013). Paving the way for standardized and comparable subterranean biodiversity studies. *Subterranean biology*, 10: 43-50.

Tomaž Skrbinšek

Jerina K, Jonozovič M, Krofel M, Skrbinšek T (2013) Range and local population densities of brown bear Ursus arctos in Slovenia. *European Journal of Wildlife Research*, **59**, 459-467.

Karamanlidis A, Stojanov A, Gabriel Hernando M, Ivanov G, Kocijan I, Melovski D, Skrbinšek T, Zedrosser A (2014) Distribution and genetic status of brown bears in FYR Macedonia: implications for conservation. *Acta Theriologica*, **59**, 119-128.

Krofel M, Skrbinšek T, Kos I (2012) Use of GPS location clusters analysis to study predation, feeding, and maternal behavior of the Eurasian lynx. *Ecol Res*, 1-14.

Milner-Gulland EJ, Arroyo B, Bellard C, Blanchard J, Bunnefeld N, Delibes-Mateos M, Edwards C, Nuno A, Palazy L, Reljic S, Riera P, Skrbinsek T (2010) New directions in management strategy

evaluation through cross-fertilization between fisheries science and terrestrial conservation. *Biology Letters*, **6**, 719-722.
Sindičić M, Polanc P, Gomerčić T, Jelenčič M, Huber Đ, Trontelj P, Skrbinšek T (2013) Genetic data confirm critical status of the reintroduced Dinaric population of Eurasian lynx. *Conservation Genetics*, **14**, 1009-1018.
Krofel M, Skrbinšek T, Kljun F, Potočnik H, Kos I (2009) The killing technique of Eurasian lynx. *Belgian Journal of Zoology*, **139**, 2.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Interakcije nukleinskih kislin in proteinov
Course title:	Protein-nucleic acid interaction

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

Univerzitetna koda predmeta/University course code:	3778

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	15	10	0	5	85	5

Nosilec predmeta/Lecturer:	Matej Butala

Izvajalci predavanj:	Matej Butala, Rok Kostanjšek
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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):
(i) Vloge proteinov, ki interagirajo z nukleinskimi kislinami v prokariontih, evkariontih in virusih (oblikovanje, vzdrževanje, podvojevanje kromosoma in plazmidov; molekulski motorji; prepis genov; uravnavanje apoptoze celic; genotoksini; proteini ribosoma; izrezovanje intronov; sistem CRISPR/Cas; ...).	i) Function of proteins that interact with nucleic acids in prokaryotes, eukaryotes and viruses (involved in chromosome folding, maintainance and replication; gene expression; molecular motors; regulation of cell apoptosis; ribosomal proteins; RNA splicing; CRISPR/Cas system; ...). (ii) Characteristics of the DNA/RNA binding proteins (Thermal diffusion/electrostatic

(ii) Lastnosti DNA/RNA vezavnih proteinov (termalna difuzija/elektrostatske interakcije proteinov po nukleinskih kislinah; konformacijske spremembe v specifično/nespecifično vezanih proteinih; vpliv struktutre nukleinske kisline ter kemijskih modifikacij nukleinskih kislin na interakcijo; vpliv okoljskega medija, koncentracija ionov, kofaktorjev na specifično vezavo ter učinkovanje DNA/RNA vezavnih proteinov). (iii) Metode za prepoznavo in analizo interakcij nukleinskih kislin in proteinov (tradicionalne *in vitro* tehnike; spektrometrične metode; afinitetna kromatografija spojena z masno spektroskopijo; površinska plazmonska resonanca; Microscale Thermophoresis (MST); DNA sampling; bioinformatska orodja; metode imunoprecipitacije: iCLIP, ChIP-chip, ChIP-seq). (iv) Študije kinetike interakcij proteinov in nukleinskih kislin (uporaba površinske plazmonske resonance ter MST; konstanta hitrosti asociacije, disociacije, študija kooperativnosti). (v) Vizualizacija, lokalizacija interakcij nukleinskih kislin in proteinov *in vitro* ter *in vivo* (označevanje molekul; fluorescentna, dekonvolucijska, elektronska mikroskopija). (vi) Biotehnološka uporabnost (proteinski inženiring, urejanje genomov evkariontov s sistemom CRISPR-Cas9, izgradnja logičnih vezij, tehnologija Nanopore).	interactions of protein along the nucleic acids; conformational changes in specificaly/non-specificaly bound proteins; influence of DNA/RNA structure and of chemical modifications of the nucleic acids on protein binding; the effect of the ion and cofactor concentratioin on specific complex formation). (iii) Methods for the identification and analysis of the nucleic acids-protein complexes (traditional *in vitro* techniques; spectophotometric methods; affinity cromatography combined with mass spectrometry; surface plasmon resonance; Microscale Thermophoresis (MST); DNA sampling; bioinformatic tools; immunoprecipitation methods: iCLIP; ChIP-chip; ChIP-seq). (iv) Protein-nucleic acids kinetics studies (use of the plasmon surface resonance sectroscopy and MST to determine association, dissociation constants; study the cooperativity of interactions). (v) Visualization and localisation of protein-nucleic acids complexes *in vitro* and *in vivo* (labeling of molecules; fluorescent, deconvolution, electron microscopy). (vi) Biotechnological use of protein/nucleic acids complexes (preotein engineering; genome editing of the eukaryots by the CRISPR/Cas9 system; genetic programs constructed from logic gates in the cells; The Nanopore technology).

Temeljna literatura in viri/Readings:
RBPome special issue. 2014. Genome Biology. Ed. Rinn, J., Ule, J. Methods. Gene regulation via protein-RNA interactions. 2014. Ed. Ule, J., Elsevier. ZDA. Protein-nucleic acid interactions: Structural biology. 2008. RCSPublishing. Ed. Rice, P.A., Correll, C.C. VB. Analytics of protein-DNA interactions. 2007. Springer. Ed. Scheper, T., Seitz, H. Nemčija. Gene regulatory networks. Methods and protocols. 2012. Humana press. Deplancke, B., Gheldof, N. ZDA.

Cilji in kompetence:	Objectives and competences:
i) Razumevanje molekularnih mehanizmov, ki omogočijo delovanje, ter celične vloge	i) To understand the molecular mechanisms that enable the cytosolic and the membrane

pomembnejših cito-/nukleo-solnih in membranskih proteinov, ki interagirajo z nukleinskimi kislinami. Razumevanje, da signali okolja lahko spremenijo afiniteto proteinov do nukleinskih kislin kar privede do uravnave vrste procesov v celici. (ii) Znanje o sodobnih metodah s katerimi identificiramo proteine, ki interagirajo z nukleinskimi kislinami, preučimo njihova tarčna mesta na nukleinskih kislinah, afiniteto kompleksa, lokalizacijo interakcij v celicah. Zastavitev analiz konformacijskih sprememb proteina ob vezavi na specifično mesto ter analiz aktivnosti kompleksa. (iii) Zmožnost preučitve kinetike interakcij protein-nukleinska kislina. Določiti konstanti asociacije in disociacije za interakcijo protein-nukleinska kislina z enim ali dvema vezavnima mestoma. Analiza kooperativnosti med ligandom in analitom. (iv) Prepoznati biotehnološki potencial kompleksov protein-nukleinska kislina.	proteins to interact with nucleic acids and exert their function. To understand that environmental signals often change the affinity of the proteins for the nucleic acids and consequently modulate the cell processes. (ii) To obtain knowledge of the modern methods used to identify proteins that interact with the nucleic acids and resolve the DNA/RNA binding motifs, affinity of the complexes, cellular localisation of the complexes. To set up the analysis to examine conformational changes in the protein upon its specific binding and to analyse the activity of the complex. (iii) To determine the protein-nucleic acids interaction kinetics. Define the association and the dissociation constants for the complexes with one or the two binding sites. To analyse the cooperativity among the ligand and the analyte. (iv) To identify the biotechnological potential of the protein-nucleic acid complexes.

Predvideni študijski rezultati:	Intended learning outcomes:
Razumevanje dinamike interakcij proteinov z nukleinskimi kislinami ter znanje o vplivu interakcij na biološke procese v celicah. Zmožnost študentov, da zastavijo študije: (i) identifikacije nepoznanih proteinov, ki interagirajo z motivi na nukleinskih kislinah, (ii) konformacijskih sprememb v DNA/RNA vezavnem proteinu, (iii) kinetike interakcij protein-nukleinska kislina in generiranje interakcijskih map proteinov z nukleinskimi kislinami, ki temeljijo na kinetiki. Uporabiti znanje o lastnostih DNA/RNA vezavnih proteinov za razvoj ali posodobitev molekularnih orodij, oziroma biotehnoloških aplikacij.	To get an insight into the dynamics of the protein-nucleic acid interaction and how this interaction affect biological processes in the cell. Students will learn how to design experimets to: (i) identify unknown proteins that interact with specific motifs in DNA or RNA, (ii) study conformational changes in the DNA/RNA binding proteins, (iii) study kinetics of the protein-nucleic acid interaction and to generate interacion maps based on the kinetic rather than quantitative data. To be able to use the knowledge of protein-nucleic acid interaction to develop or upgrade the molecular tools and to design novel biotechnological aplications.

Metode poučevanja in učenja:	Learning and teaching methods:
Razlaga snovi s programsko opremo za predstavitve. Video konference.	Lectures using the modern presentation software. Video conferences.

Motiviranje študentov za iskanje in razumevanje novejših člankov. Praksa v laboratoriju in demonstracija metod. Teoretična zasnova nove metode, orodja.	Motivating students to search for recently publised research articles. Practical laboratory work and demonstration of the methods. Theoretical set up of new methods and tools to study the protein-nucleic acid interactions.

Načini ocenjevanja:	Delež/Weight	Assessment:
izpit: Kolokvij in izpit se opravljata po zaključenih laboratorijskih vajah, predavanjih in individualnemu delu v pisni obliki.	70,00 %	Exam: Examination after finished laboratory practice, individual work and lectures will be in written format.
seminar	30,00 %	seminar

Reference nosilca/Lecturer's references:

Doc. dr. Matej Butala

WALTER, M., Beata, RUPNIK, Maja, HODNIK, Vesna, ANDERLUH, Gregor, DUPUY, Bruno, PAULIČ, Nejc, ŽGUR-BERTOK, Darja, **BUTALA, Matej**. The LexA regulated genes of the *Clostridium difficile*. *BMC Microbiology*, 2014, in press.

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BUTALA, Matej, SONJAK, Silva, KAMENŠEK, Simona, HODOŠČEK, Milan, BROWNING, Douglas F., ŽGUR-BERTOK, Darja, BUSBY, Steve J. W. Double locking of an Escherichia coli promoter by two repressors prevents premature colicin expression and cell lysis. *Molecular microbiology*, 2012, vol. 86, issue 1, str. 129-139.

BUTALA, Matej, KLOSE, Daniel, HODNIK, Vesna, REMS, Ana, PODLESEK, Zdravko, KLARE, Johann P., ANDERLUH, Gregor, BUSBY, Steve J. W., STEINHOFF, Heinz-Jürgen, ŽGUR-BERTOK, Darja. Interconversion between bound and free conformations of LexA orchestrates the bacterial SOS response. *Nucleic acids research*, 2011, vol. 39, issue 15, str. 6546-6557.

BUTALA, Matej, BUSBY, Steve J. W., LEE, David J. DNA sampling: a method for probing protein binding at specific loci on bacterial chromosomes. *Nucleic acids research*, 2009, issue 5, vol. 37, str. E37-1 - e37-6.

BUTALA, Matej, ŽGUR-BERTOK, Darja, BUSBY, Steve J. W. The bacterial LexA transcriptional repressor. *Cellular and molecular life sciences*, 2009, issue 1, vol. 66, str. 82-93.

Prof. dr. Rok Kostanjšek

SCHULZ, Frederik, LAGKOUVARDOS, Ilias, WASCHER, Florian, AISTLEITNER, Karin, **KOSTANJŠEK, Rok**, HORN, Matthias. Life in an unusual intracellular niche : a bacterial symbiont infecting the nucleus of amoebae. *The ISME journal*, 2014, vol. , no. , 11 str., [in press].

SIXT, Barbara S., **KOSTANJŠEK, Rok**, MUSTEDANAGIC, Azra, TOENSHOFF, Elena R., HORN, Matthias. Developmental cycle and host interaction of Rhabdochlamydia porcellionis, an intracellular parasite of terrestrial isopods. *Environmental microbiology*, 2013, vol. , no. , 14 str., [in press].

BAVDEK, Andrej, **KOSTANJŠEK, Rok**, ANTONINI, Valeria, LAKEY, Jeremy H., DALLA SERRA, Mauro, GILBERT, Robert J., ANDERLUH, Gregor. pH dependence of listeriolysin O aggregation and pore-forming ability. *FEBS journal*, 2012, vol. 279, iss. 1, str. 126-141.

KNEŽEVIĆ, Petar, OBREHT, Dragana, CURCIN, S., PETRUŠIĆ, Milivoje, ALEKSIĆ, Verica, **KOSTANJŠEK, Rok**, PETROVIC, O., et al. Phages of Pseudomonas aeruginosa: response to

environmental factors and in vitro ability to inhibit bacterial growth and biofilm formation. *Journal of applied microbiology*, 2011, issue 1, vol. 111, str. 245-254.
KOSTANJŠEK, Rok, MILATOVIČ, Maša, ŠTRUS, Jasna. Endogenous origin of endo-ß-1,4-glucanase in common woodlouse Porcellio scaber (Crustacea, Isopoda). *Journal of comparative physiology. B, Biochemical, systemic, and environmental physiology. B*, 2010, vol. 180, no. 8, str. 1143-1153.
KNEŽEVIĆ, Petar, **KOSTANJŠEK, Rok**, OBREHT, Dragana, PETROVIC, Olga. Isolation of Pseudomonas aeruginosa specific phages with broad activity spectra. *Current microbiology*, 2009, vol. 59, str. 173-180.
VALANT, Janez, DROBNE, Damjana, SEPČIĆ, Kristina, JEMEC, Anita, KOGEJ, Ksenija, **KOSTANJŠEK, Rok**. Hazardous potential of manufactured nanoparticles identified by in vivo assay. *Journal of hazardous materials*, 2009, issues 1-3, vol. 171, str. 160-165.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Interakcije v biologiji rastlin
Course title:	Interactions in plant biology

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

Univerzitetna koda predmeta/University course code:	0594913

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	20	0	0	15	80	5

Nosilec predmeta/Lecturer:	Marjana Regvar

Izvajalci predavanj:	Jasna Dolenc Koce, Kristina Gruden, Matevž Likar, Marjana Regvar, Katarina Vogel Mikuš
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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 in doctoral studies

Vsebina:	Content (Syllabus outline):
Razumevanje rastlinskih interakcij z drugimi organizmi je trenutno hitro razvijajoče področje s pomembnimi posledicami za življenje na zemlji. Poznavanje interakcij rastlin z mikroorganizmi je v zadnjih letih zelo napredovalo, razumevanje več-trofičnih interakcij rastlin z ostalimi organizmi pa je še neraziskano. Intenzivno sekvenciranje genomov	Knowledge on plant interactions with organisms is a rapidly evolving field, with long-term consequences for life on Earth. A wealth of knowledge accumulated in recent years expanding our understanding of plant interactions with microbes, while the information on multi-trophic interactions are still at their infancy. Extensive genome

rastlin in mikrobov nudi vpogled v udeleženost ključnih genov v regulacijo različnih interakcij, od mutualističnih do antagonističnih. Prav tako smo prišli do novih spoznanj v genski regulaciji interakcij rastlin z drugimi rastlinami, ki so osnova za poznavanje biologije parazitskih rastlin ter invazivnosti rastlin. Predmet obravnava interakcije rastlin z drugimi organizmi na različnih ravneh biološke organizacije in vključuje zadnja spoznanja rastlinske biokemije, molekulske in sistemske biologije. Predstavljene bodo tudi najnovejše tehnike raziskav v biologiji rastlinskih interakcij.	sequencing of plants and microorganisms revealed the involvement of the key genes regulating diverse interactions, from mutualisms to antagonisms. Also, new insights in the gene regulation of plant-plant interactions contributes to our understanding on biology of parasitic plants and plant invasions. The course focuses on the plant interactions with organisms at different levels of biological organization and includes recent advances in plant biochemistry, molecular biology and systems biology. The latest technology application in plant interactions research will be presented.

Temeljna literatura in viri/Readings:
Lugtenberg B. Principles of Plant-Microbe Interactions. Microbes for Sustainable Agriculture, Springer International Publishing , 2015 Varma A., Kharkwal AC. Symbiotic Fungi, Principles and Practice, Springer-Verlag Berlin Heidelberg (D), 2009 Varma A., Prasad R., Tuteja N. Mycorrhiza- Function, Diversity, State of the art, 4th ed. Springer International Publishing, 2017 Tekoča znanstvena periodika in pregledni članki s področij: fiziologije, anatomije, morfologije in raziskovalne metodologije

Cilji in kompetence:	Objectives and competences:
Temeljni izobraževalni cilj je razumevanje mehanizmov interakcij rastlin z drugimi organizmi ter njihove regulacije. Pri tem se povezujejo ravni od molekule in celice do odnosa organizmov z živim in neživim okoljem. Študent pridobi kompetence pri razumevanju procesov v rastlinah in osvoji analizne in statistične metode, ki se uporabljajo pri raziskavah na tem področju	The educational aim of the course is to understand mechanisms that govern functioning of plant interactions with other organisms and gain knowledge of their regulation. In this the levels of organisation from molecules and cells to interactions with biotic and abiotic environment are considered. Students gain competences in understanding of processes in plants and acquires knowledge on analytical and statistical methods from the field

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Predviden študijski rezultat je nadgraditi in povezati znanje s področja rastlinskih interakcij in uporaba novega znanja za razumevanje delovanja organizmov pod vplivom biotskih in abiotskih dejavnikov. Študenti bodo pridobili metodološka znanja za celostno obravnavo interakcij s posledicami za organizme in njihovo okolje.	Knowledge and understanding: The course is aiming to upgrade and integrate the competences and knowledge from the fields of plant interactions, and to apply the acquired knowledge in understanding functions of organisms under adverse biotic and abiotic conditions. Students will obtain methodological skills that will allow them integral discussion about interactions and their effects on organisms and environment.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, diskusijske delavnice predstavljenih seminarjev, predstavitve v laboratorijih. Pri izvajanju sodelujejo vabljeni predavatelji. Izvedba je prilagojena raziskovalni tematiki študenta	Lectures, workshops with seminars, lab presentations in cooperation with invited lecturers. The course is adjusted to the research field of the student

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit iz tem predavanj.	50,00 %	Written examination
Predstavitev individualnega projekta	50,00 %	Project presentation

Reference nosilca/Lecturer's references:

prof. dr. Marjana Regvar

LIKAR, Matevž, STRES, Blaž, RUSJAN, Denis, POTISEK, Mateja, REGVAR, Marjana. Ecological and conventional viticulture gives rise to distinct fungal and bacterial microbial communities in vineyard soils. *Applied soil ecology*, ISSN 0929-1393, 2017, vol. 113, str. 86-95.

KOVAČEC, Eva, REGVAR, Marjana, ELTEREN, Johannes Teun van, ARČON, Iztok, PAPP, Tamás, MAKOVEC, Darko, VOGEL-MIKUŠ, Katarina. Biotransformation of copper oxide nanoparticles by the pathogenic fungus Botrytis cinerea. *Chemosphere*, ISSN 0045-6535. [Print ed.], 2017, vol. 180, str. 178-185.

LIKAR, Matevž, VOGEL-MIKUŠ, Katarina, POTISEK, Mateja, HANČEVIĆ, Katarina, RADIĆ, Tomislav, NEČEMER, Marijan, REGVAR, Marjana. Importance of soil and vineyard management in the determination of grapevine mineral composition. *Science of the total environment*, ISSN 0048-9697, 2015, vol. 505, str. 724-731.

RADIĆ, Tomislav, HANČEVIĆ, Katarina, LIKAR, Matevž, REGVAR, Marjana, ZDUNIĆ, Goran. High incidence of arbuscular mycorrhizal fungi in rare and endangered wild grapevine. *Plant Biosystems*, ISSN 1126-3504, 2018, vol. , no. , 4 str., [in press].]

DOLINAR, Nataša, REGVAR, Marjana, ABRAM, Dragan, GABERŠČIK, Alenka. Water-level fluctuations as a driver of Phragmites australis primary productivity, litter decomposition, and fungal root colonisation in an intermittent wetland. *Hydrobiologia*, ISSN 0018-8158, 2016, vol. 774, iss. 1, str. 69-80.

GABERŠČIK, Alenka, DOLINAR, Nataša, KRŽIČ, Nina, REGVAR, Marjana. What have we learnt from studying mycorrhizal colonisation of wetland plant species? : the potential for sustainable viticulture?. V: VARMA, Ajit (ur.), PRASAD, Ram (ur.), TUTEJA, Narendra (ur.). Mycorrhiza - function, diversity, state of the art. 4th ed. Cham: Springer. 2017, str. 291-304.

prof. dr. Kristina Gruden

PODPEČAN, Vid, RAMŠAK, Živa, GRUDEN, Kristina, TOIVONEN, Hannu, LAVRAČ, Nada. Interactive exploration of heterogeneous biological networks with Biomine Explorer. Bioinformatics. [Print ed.]. 2019, 4 str., [in press]. ISSN 1367-4803.

STARE, Tjaša, RAMŠAK, Živa, KRIŽNIK, Maja, GRUDEN, Kristina. Multiomics analysis of tolerant interaction of potato with potato virus Y. Scientific data. 2019, vol. 6, str. 1-11, ilustr. ISSN 2052-4463.

ZAGORŠČAK, Maja, BLEJEC, Andrej, RAMŠAK, Živa, PETEK, Marko, STARE, Tjaša, GRUDEN, Kristina. DiNAR: revealing hidden patterns of plant signalling dynamics using Diferential Network Analysis in R. Plant methods. 2018, vol. 14, str. 1-9. ISSN 1746-4811.

RAMŠAK, Živa, COLL RIUS, Anna, STARE, Tjaša, TZFADIA, Oren, BAEBLER, Špela, VAN DE PEER, Yves, GRUDEN, Kristina. Network modelling unravels mechanisms of crosstalk between ethylene and salicylate signalling in potato. Plant physiology. 2018, vol. 178, str. 488-499. ISSN 0032-0889.

SCHOVILLE, Sean D., CHEN, Yolanda H., ANDERSSON, Martin N., BENOIT, Joshua B., BHANDARI, Anita, BOWSHER, Julia H., BREVIK, Kristian, CAPPELLE, Kaat, CHEN, Mei-Ju M., CHILDERS, Anna K., GRUDEN, Kristina, PETEK, Marko, et al. A model species for agricultural pest genomics : the genome of the Colorado potato beetle, Leptinotarsa decemlineata (Coleoptera: Chrysomelidae). Scientific reports. 2018, vol. 8, str. 1-18, ilustr. ISSN 2045-2322.
KRIŽNIK, Maja, PETEK, Marko, DOBNIK, David, RAMŠAK, Živa, BAEBLER, Špela, POLLMANN, Stephan, KREUZE, Jan F., ŽEL, Jana, GRUDEN, Kristina. Salicylic acid perturbs sRNA-gibberellin regulatory network in immune response of potato to Potato virus Y infection. Frontiers in plant science. 2017, vol. 8, str. 1-14.

Izr. prof. dr. Katarina Vogel-Mikuš

DEBELJAK, Marta, ELTEREN, Johannes Teun van, ŠPRUK, Ana, IZMER, Andrei, VANHAECKE, Frank, VOGEL-MIKUŠ, Katarina. The role of arbuscular mycorrhiza in mercury and mineral nutrient uptake in maize. *Chemosphere*. [Print ed.]. Dec. 2018, vol. 212, str. 1076-1084. ISSN 0045-6535.
WU, Songlin, VOSÁTKA, Miroslav, VOGEL-MIKUŠ, Katarina, KAVČIČ, Anja, KELEMEN, Mitja, ŠEPEC, Luka, PELICON, Primož, SKÁLA, Roman, VALERO POWTER, Antonio Roberto, TEODORO, Manuel, MICHÁLKOVÁ, Zuzana, KOMÁREK, Michael. Nano zero-valent iron mediated metal(loid) uptake and translocation by arbuscular mycorrhizal symbioses. *Environmental science & technology*. [Print ed.]. 2018, vol. , no. , 12 str., [in press]. ISSN 0013-936X.
KODRE, Alojz, ARČON, Iztok, DEBELJAK, Marta, POTISEK, Mateja, LIKAR, Matevž, VOGEL-MIKUŠ, Katarina. Arbuscular mycorrhizal fungi alter Hg root uptake and ligand environment as studied by X-ray absorption fine structure. *Environmental and Experimental Botany*. [Print ed.]. Jan. 2017, vol. 133, str. 12-23, ISSN 0098-8472.
KAVČIČ, Anja, MIKUŠ, Klemen, DEBELJAK, Marta, ELTEREN, Johannes Teun van, ARČON, Iztok, KODRE, Alojz, KUMP, Peter, KARYDAS, Andreas-Germanos, MIGLIORI, Alessandro, CZYZYCKI, Mateusz, VOGEL-MIKUŠ, Katarina. Localization, ligand environment, bioavailability and toxicity of mercury in Boletus spp. and Scutiger pes-caprae mushrooms. *Ecotoxicology and environmental safety*. 2019, vol. , 13 str., [in press]. ISSN 0147-6513.
TORRENT, Laura, IGLESIAS, Mònica, MARGUÍ, Eva, HIDALGO, Manuela, VERDAGUER, Dolors, LLORENS, Laura, KODRE, Alojz, KAVČIČ, Anja, VOGEL-MIKUŠ, Katarina. Uptake, translocation and ligand of silver in Lactuca sativa exposed to silver nanoparticles of different size, coatings and concentration. *Journal of hazardous materials*. [Print ed.]. 2019, vol. , 43 str., [in press], ilustr. ISSN 0304-3894.
VOGEL-MIKUŠ, Katarina, ELTEREN, Johannes Teun van, REGVAR, Marjana, CHAIPRAPA, Jitrin, JENČIČ, Boštjan, ARČON, Iztok, KODRE, Alojz, KUMP, Peter, KAVČIČ, Anja, KELEMEN, Mitja, METARAPI, Dino, NEČEMER, Marijan, VAVPETIČ, Primož, PELICON, Primož, PONGRAC, Paula. Recent advances in 2D imaging of element distribution in Plants by focused beam techniques. V: SABLOK, Gaurav (ur.). *Plant metallomics and functional omics : a system-wide perspective*. Cham: Springer, 2019. Str. 169-207.

Doc. dr. Jasna Dolenc Koce

PRŠIN, Tjaša, ANŽLOVAR, Sabina, DOLENC KOCE, Jasna. The effect of thyme essential oil on germination and early growth of wheat = Vpliv timijanovega eteričnega olja na kalitev in zgodnjo rast pšenice. *Acta biologica slovenica : ABS*. [Tiskana izd.]. 2018, vol. 61, št. 1, str. 3-11. ISSN 1408-3671.
DOLENC KOCE, Jasna, ŠOLN, Katarina. Phytotoxic effects of Fallopia japonica and F. xbohemica leaves. *Phyton : annales rei botanicae*. 2018, vol. 57, fasc. 1/2, str. 47-57. ISSN 0079-2047.
ANŽLOVAR, Sabina, LIKAR, Matevž, DOLENC KOCE, Jasna. Antifungal potential of thyme essential oil as a preservative for storage of wheat seeds. *Acta botanica Croatica : an international joural of botany*. 2017, vol. 76, no. 1, str. 64-71. ISSN 0365-0588.
DOLENC KOCE, Jasna. Effects of exposure to nano and bulk sized TiO [sub] 2 and CuO in Lemna minor. *Plant physiology and biochemistry*. [Print ed.]. 2017, vol. 119, str. 43-49. ISSN 0981-9428.

DOLENC KOCE, Jasna. The effects of leaf extracts of crack willow (Salix fragilis) on the growth of Japanese knotweed (Fallopia japonica) = Vpliv listnih izvlečkov krhke vrbe (Salix fragilis) na rast japonskega dresnika (Fallopia japonica). *Acta biologica slovenica : ABS*. [Tiskana izd.]. 2016, vol. 59, št. 1, str. 13-21. ISSN 1408-3671.

DOLENC KOCE, Jasna, DROBNE, Damjana, KLANČNIK, Katja, MAKOVEC, Darko, NOVAK, Sara, HOČEVAR, Matej. Oxidative potential of ultraviolet-A irradiated or nonirradiated suspensions of titanium dioxide or silicon dioxide nanoparticles on Allium cepa roots. *Environmental toxicology and chemistry*. 2014, vol. 33, no. 4, str. 858-867. ISSN 0730-7268.

Doc. dr. Matevž Likar

LIKAR, Matevž, GRANDIČ, Marjana, JAKOVAC-STRAJN, Breda, KOS, Katarina, CELAR, Franci Aco. Links between genetic groups, host specificity, and ergot-alkaloid profiles within *Claviceps purpurea* (Fr.) Tul. on Slovenian grasses. Plant disease. 2018, vol. 102, no. 7, str. 1334-1340. ISSN 0191-2917.

RUSJAN, Denis, PERŠIĆ, Martina, LIKAR, Matevž, BINIARI, Katerina, MIKULIČ PETKOVŠEK, Maja. Phenolic responses to esca-associated fungi in differently decayed grapevine woods from different trunk parts of 'Cabernet Sauvignon'. *Journal of agricultural and food chemistry*. 2017, vol. 65, iss. 31, str. 6615-6624. ISSN 0021-8561.

MARIČ, Ajda, SKOČAJ, Matej, LIKAR, Matevž, SEPČIĆ, Kristina, KRALJ CIGIĆ, Irena, GRUNDNER, Maja, GREGORI, Andrej. Comparison of lovastatin, citrinin and pigment production of different *Monascus purpureus* strains grown on rice and millet. *Journal of Food Science and Technology*. 2019, vol. , no. , 10 str., [in press], ilustr. ISSN 0022-1155.

RADIĆ, Tomislav, LIKAR, Matevž, HANČEVIĆ, Katarina, BOGDANOVIĆ, Irena, PASKOVIĆ, Igor. Occurrence of root endophytic fungi in organic versus conventional vineyards on the Croatian coast. *Agriculture, ecosystems & environment*. [Print ed.]. 2014, vol. 192, str. 115-121. ISSN 0167-8809.

LIKAR, Matevž, STRES, Blaž, RUSJAN, Denis, POTISEK, Mateja, REGVAR, Marjana. Ecological and conventional viticulture gives rise to distinct fungal and bacterial microbial communities in vineyard soils. *Applied soil ecology*. 2017, vol. 113, str. 86-95.

LIKAR, Matevž, VOGEL-MIKUŠ, Katarina, POTISEK, Mateja, HANČEVIĆ, Katarina, RADIĆ, Tomislav, NEČEMER, Marijan, REGVAR, Marjana. Importance of soil and vineyard management in the determination of grapevine mineral composition. Science of the total environment, ISSN 0048-9697, 2015, vol. 505, str. 724-731.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Molekulska in sistemska biologija
Course title:	Molecular and systems biolology

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

Univerzitetna koda predmeta/University course code:	3779

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	20	0	0	20	190	10

Nosilec predmeta/Lecturer:	Nina Gunde Cimerman

Izvajalci predavanj:	Aljoša Bavec, Maja Čemažar, Marina Dermastia, Damjan Glavač, Cene Gostinčar, Kristina Gruden, Nina Gunde Cimerman, Nataša Poklar Ulrih, Boris Rogelj, Kristina Sepčić, Gregor Serša
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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 requirements for the enrolment in PhD program.

Vsebina:	Content (Syllabus outline):
Molekulska in sistemska biologija sta temeljni naravoznanstveni vedi, ki se ukvarjata tako s celicami mikroorganizmov (bakterije, arheje, glive, alge, praživali) kot tudi živalskimi in	Molecular and systems biology are basic natural sciences, which are focused not only on microbial cells (archaea, bacteria, fungi, algae, protozoa), but also on animal and plant cells,

rastlinskimi celicami na nivoju molekulskih mehanizmov, vloge in strukture različnih molekul in makromolekul, odzivov na različne dejavnike okolja in posledičnih sprememb (regulacija, transkripcija, translacija in posttranslacijski mehanizmi). Raziskovanje je po eni strani usmerjeno v preučevanje normalno delujočih, neokvarjenih celic, po drugi strani pa v iskanje okvar, ki lahko vodijo do vzpostavitve bolezenskega stanja. V okvir molekulske in sistemske biologije spadata tudi področja genomike in metagenomike, ki obravnavata posamezno celico, mikrobne združbe ali tkiva kot nosilce dedne informacije, ki se potencijalno izrazi. Raziskave v okviru področja torej obravnavajo tako posamezne celice, izbrane kot modelni organizmi, kot tudi kompleksnejši nivo mikrobnih združb in tkiv, kar za razumevanje zahteva pristope, ki vključujejo modeliranje bioloških sistemov in sintezo pridobljenega znanja. V okviru predmeta bodo udeleženi izvajalci podrobneje seznanili študente z naborom spodaj navedenih tematik: 1.Molekulske osnove programirane celične smrti pri rastlinah v primerjavi z drugimi celicami, tako prokariontskimi kot evkariontskimi; 2. Prilagoditve ekstremofilnih mikrorganizmov na življenje v ekstremnih razmerah (npr. visoke ali nizke temperature, nizek ali visok pH, povečana slanost, tlak, radiacija) na nivoju makromolekul (proteini, nukleinske kisline, lipidi), v primerjavi z makromolekulami mezofilnih organizmov. Obravnavana bo termodinamska stabilnost naštetih makormolekul, s poudarkom na termodinamski in kinetični stabilnosti proteinov pri procesu zvitja in razvitja ter vlogi nepravilno zvitih proteinov in amiloidov pri različnih boleznih (npr. Parkinsonova bolezen, prionske bolezni); 3. Poznavanje sinteze, procesiranja, transporta in razgradnje RNA. Poznavanje različnih nekodirajočih RNA (mikroRNA, snoRNA in lncRNA) molekul ter razumevanje njihovega delovanja na različnih nivojih regulacije izražanja genov. Biološke in bolezenske funkcije različnih družin RNA (mRNA, miRNA, snoRNA, siRNA).Predstavljena bo regulatorna premreženost RNA, ki verjetno v največji meri	on the level of molecular mechanisms, role and structure of different molecules and macromolecules, responses to different environmental impacts and consequential changes (regulation, transcription, translation and post translational modifications). Research is on one hand focused on studying normally functioning cells, and on the other hand in searching for malfunctions, which can cause diseases. This frame includes also the field of genomics and metagenomics, focused on either individual cells, microbial communities or tissues, as bearers of potentially and selectively expressed genetic information. Investigations therefore include the level of individual cells, acting as model organisms or the more complex level of communities and tissues.Because of the complexity of information, understanding requires an approaches that include modelling of biological systems and synthesis of aquired knowledge. Within the framework of the subject, the participating lecturers will introduce students in more details to a selection of themes listed below: 1.Molecular basis of the programmed cell death in plants in comparison with other cells, both prokaryotic and eukaryotic; 2. Adaptations of extremophilic microorganisms to life in extreme environmental conditions (high or low temperatures, alcalic or acidic pH, high concentration of NaCl, high pressure or radiation) on the level of macromolecules (lipids, proteins, nucleic acids), in comparison with mesophilic homologues. Focus on therodynamic stability of listed biological molecules, with the main emphasis on thermodynamic and kinetic stability of proteins during folding and unfolding, role of misfolded proteins and amiloides in different diseases (Parkinson's disease and prionic diseases); 3. Learning about synthesis, processing, transport and turnover of RNA. Learning about the complex world of non-coding RNA molecules (microRNA, snoRNA and lncRNA) and their multilevel role in the expression of genes. Biological and disease related functions of different RNA families (mRNA, miRNA, snoRNA, siRNA).

vpliva na kompleksne značilnosti organizmov in ima pomembno vlogo pri razvoju, pa tudi pri nastanku bolezni; 4. Primerjava strukture in funkcije nekaterih klinično pomembnih peptidov (npr. insulini, inkretini...) in preučevanje mehanizma delovanja peptidnih agonistov in inhibitorjev ter njihova uporaba pri zdravljenju bolezni; 5.Poznavanje bioloških osnov rasti tumorjev, z opisom značilnih molekularnihi sprememb, kot molekularnimi tarčami za tarčna zdravila. Osnove genske terapije raka in njena uporabnost pri zdravljenju rakavih obolenj; 6. Spoznavanje genomike mikroorganizmov, s poudarkom na splošnih razlikah med prokariontskimi in evkariontskimi genomi, načini določanja genomskih zaporedij, metodami primerjave genomskih zaporedij. S primeri iz prakse bodo ponazorjene analize, ki jih omogočajo sodobna bioinformatska orodja na področju genomike in primerjalne genomike. 7. Spoznavanje biologije v post-genomskem obdobju, s poudarki na novih tehnologijah določanja nukleotidnega zaporedja, pristopi v metagenomiki, pristopi v metatranskriptomiki, genomiki posamezne celice, metagenomiki vodnih okolij, tal, sedimentov, človeka in metaviriomi. Področje tudi obsega uvod v Linux, sestavljanje in anotacijo prokariontskih genomov, analizo metagenomskih podatkovnih zbirk, sestavljanje in analizo metagenomske DNA; 8. Modeliranje v bioloških sistemih s spoznavanjem baz znanja, ki jih lahko uporabljamo, tipi formalizmov in njihovo namembnostjo, orodji za dinamično in strukturno modeliranje bioloških sistemov, pridobivanje eksperimentalnih podatkov za podporo modeliranju.	Presentation of the regulatory networking of RNA, which is likely to have important impact on the complex characteristics of organisms, and plays an important role in development and disease states; 4.Comparison of structure-function relationship of clinically relevant peptides, (insulins, incretins...) and the mechanism of action of peptide agonists, peptide inhibitors and their role in clinical treatment; 5. 5. Learning about tumors, with the description of characteristic molecular changes, as molecular targets for target drugs. Basics of cancer gene therapy and its usefuleness in treating different types of cancer; 6.Learning about genomics of microorganisms, with emphasis on general differences between the genomes of prokaryotes and eukaryotes, approaches to genome sequencing, methods of comparative genomics. Analyses made possible by modern bioinformatic tools in the fields of genomics and comparative genomics with illustration based on practical examples; 7.learning about post-genomic biology, new sequencing techniques, approaches in metagenomics, approaches in metatranscriptomics, single cell genomics, aquatic metagenomics, soil metagenomics, sediment metagenomics, human metagenomics, metavirioms, introduction to Linux, assembly and annotation of prokaryotic genomes, analysis of metagenomic libraries, assembly and annotation of metagenomic DNA; 8. Modelling in systems biology: knowledge bases used in molecular modelling, formalisms used in modelling of biological systems, tools available for structural and dynamic modelling and experimental data acquisition to support modelling.

Temeljna literatura in viri/Readings:
Novejši znanstveni pregledni in eksperimentalni članki s področja, druga učna gradiva in spodaj navedene knjige ter pregledni članki. Recent review scientific and experimental papers, literature from the field, text books, and books and review articles listed below. Knjige/Books: 1. Bioinformatics: Sequence and Genome Analysis, 2nd edition, David W. Mount. Cold Spring Harbor Laboratory Press.

2. Edda Klipp , Wolfram Liebermeister , Christoph Wierling , Axel Kowald , Hans Lehrach , Ralf Herwig: Systems Biology, Wiley, 2009
3. Eberhard Voit A First Course in Systems Biology, Garland Science, 2012
4. Dermastia, Marina. Pogled v rastline. Ljubljana: Nacionalni inštitut za biologijo, 2010. 237 str., ilustr. ISBN 978-961-92543-4-9. pp 1-74.
4. Radiobiology for Radiologists. E Hall and Amato J. Gaccia, seventh edition, Wolters Kluwer and Lippincott, 2012The Basic Science of Oncology. Fofth edition, Tannock I, Hill R, Bristow R, Harrington L. Mc Graw Hill 2013
5. Thermophiles: Biology and technology at high temperatures, Ed. F. Robb, G. Antranikian, D. Grogan, A. Driessen (2008). CRC Press, pp. 7-73.

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1. Dinger ME. Long non-coding RNAS in disease and development. Pathology. 2014 Feb;46 Suppl 1:S26.
2. Uversky, V. (2011) Intrinsically disordered proteins from A to Z. International Journal of Biochemistry & Cell Biology 43, 1090-1103.

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6. Bavec A (Poly)peptide-based therapy for diabetes mellitus: Insulins versus incretins. Life Sci. 2014 Jan 8. pii: S0024-3205(14)00005-8. doi: 10.1016/j.lfs.2013.12.210.

Cilji in kompetence:	Objectives and competences:
Študent se bo poglobil v ožjo raziskovalno področje, ki ga bo nadgrajeval v svoji doktorski disertaciji. Predmet ni namenjen ekstenzivnemu širjenju teoretičnega znanja, pač pa je cilj predstavitev določene problematike ter metod in pristopov, ki lahko pripomorejo k rešitvi znanstvenih problemov. Namenjen je tudi poznavanju predhodnih raziskav s področja bodoče doktorske disertacije študenta. Med cilje predmeta spada posredovanje ključne znanstvene literature iz področja izbrane znanstvene tematike, vključno s posredovanjem lastnega raziskovalčevega znanja in pomoč pri analizi eksperimentalno pridobljenih podatkov. Specifični cilji: • pridobivanje specialnih znanj s področja arhejske, bakterijske, glivne, živalske in rastlinske celice, • poznavanje fizikalnih zakonitosti, ki določajo stabilnost bioloških makromolekul v ekstremnih razmerah, • poznavanje različnih nekodirajočih RNA (mikroRNA, snoRNA in lncRNA) molekul in ter razumevanje njihovega delovanja na različnih nivojih regulacije izražanja genov,	Students will get deeper insight into the research area which he or she will upgrade in her/his doctoral thesis. The contents are not intended to extensively broaden theoretical knowledge, instead it should present specific problematic research areas and indicate methods and approaches which can facilitate solving of scientific problems. Student should get also familiar with previous research in the field of their doctoral thesis. One of the aims is to mediate key scientific literature from the chosen scientific field, including mediation of the lecturer's own experience and help in the analyses of experimentally obtained data. Specific aims: • gain of special knowledge associated with archeal, bacterial, fungal, animal and plant cell, • learning about the physical laws that determine the stability of biological macromolecules at extreme environmental conditions, • learning about the complex world of non-coding RNA molecules (microRNA, snoRNA and lncRNA) and their multilevel role in the expression of genes,

• razumevanje molekulskih mehanizmov delovanja klinično pomembnih peptidov. Razumevanje, da kemijske modifikacije naravnih peptidov lahko vodijo v nastanek biološko bolj učinkovitih molekul, ki so pomembne pri zdravljenju bolezni • razumevanje molekularnih mehanizmov in interakcijskih sistemov, ki so vpleteni v biogenezo, transport, delovanje in razgradnjo različnih družin RNA. Vpogled v bolezensko pomembne procese in načine zdravljenja. • razumevanje osnovnih značilnosti mikrobnih genomov in metod za njihovo analizo, Prepoznavanje možnosti za temeljna in uporabna spoznanja, ki jih nudi preučevanje genomov in omejitev tega pristopa (česar na podlagi genomskega zaporedja (še) ni mogoče ugotoviti) • pridobitev poglobljenega vpogleda v metagenomiko in raziskovalne možnosti, ki jih omogoča.. • seznanitev s področjem sistemske biologije, vključno z metodološkimi pristopi v eksperimentalnem delu kot tudi v analizi podatkov ter modeliranju.	• understanding the molecular mechanisms of clinically important peptides. Understanding that chemical modifications of natural peptides can change the biological activity of the native peptides and consequently lead to more efficient clinical therapy, • understanding the molecular mechanisms and interaction systems involved in biogenesis, transport, function and turnover of different families of RNA. To gain insight into disease significant processes and methods of treatment • understanding the basic characteristics of microbial genomes and methods for their analysis. Recognising the potentials for basic and applicable outcomes of genomic analyses and their limitations (what cannot (yet) be discerned on the basis of the genomic sequence). • gaining an in-depth insight into metagenomics and its research applications • familiarizing with the field of systems biology, including wet and dry lab methodologies.

Predvideni študijski rezultati:	Intended learning outcomes:
Zgoraj opisan pristop se mora odraziti v pravilnem načrtovanju raziskav in poskusov, ki vodijo k preiskusu hipotez zastavljenih v temi doktorske disertacije, poznavanju izbrane raziskovalne tematike, sposobnosti razlage najpomembnejših principov in interpretacije pridobljenih rezultatov. Znanje in razumevanje: razumevanje delovanja programov celične smrti pri rastlinah v primerjavi s programi celične smrti pri živalih in prokariontih, razumevanje stabiliziranja makromolekul ekstremofilnih mikroorganizmov, razumevanje regulatorne premreženosti RNA, ki verjetno v največji meri vpliva na kompleksne značilnosti organizmov in ima pomembno vlogo pri razvoju, pa tudi pri nastanku bolezni, razumevanje molekulskih mehanizmov, ki omogočajo delovanje peptidov v celicah in poznavanje uporabe peptidov pri zdravljenju bolezni,	Such an approach should result in the proper planning of research experiments which should enable testing of the hypotheses raised in the doctoral thesis, familiarity with the chosen research area, capability to explain the main principles and interpretation of the obtained results. Knowledge and understanding: understanding of plant cell death programs in comparison with programs in animal and microbial cells, understanding of macromolecular stabilisation of extremophiles, understanding of regulatory networking of RNA, likely to have an important impact on the complex characteristics of organisms, and in development of different diseases, understanding of the molecular mechanisms which enable peptides to exert their cell function and identification of peptides as clinically important molecules, understandinging of dynamics of RNA synthesis and processing, as well as of the crucial functions of different families of RNAs,

razumevanje dinamike sinteze in procesiranja RNA ter pomembnih funkcij različnih družin RNA, razumevanje značilnosti mikrobnih genomov, različnih (osnovnih) pristopov v analizi genomskih zaporedij in različnih (osnovnih) pristopov v primerjavi genomskih zaporedij, Razumevanje metagenomike kot porajajoče se znanost in kot raziskovalno orodje, pregled metodologije sistemske biologije in sposobnost ugotavljanja primernosti različnih pristopov za reševanje specifičnih problemov modeliranja bioloških sistemov.	understanding of characteristics of microbial genomes, of different (basic) approches for genomic sequence analysis and of different (basic) approches for genomic sequence comparison, Understanding of importance of metagenomics and its use in different research fields, acquirement of an overview of existing methodology in systems biology and the ability to identify the best methodlogical approach availabile for solving specific problems of biological systems modeling.

Metode poučevanja in učenja:	Learning and teaching methods:
Priprava in vodenje razprav o prebranih znanstvenih člankih, diskusije in konzultacije glede reševanja raziskovalnih problemov z metodo razlage, razgovora, demonstracije, dela s teksti, učenja z informacijskimi viri, raziskovalno učenje.. Predstavitev praktičnega raziskovalnega problema in poteka njegove analize s sprotno predstavitvijo relevantnih znanj, ki so za proces potrebna.	Preparation and supervision of Journal clubs, discussion and consultation in relation to scientific problems with explanations, discussions, demonstrations, text work, informatics, research learning. Describing a real-life research problem and the stages of its solving, with accompanying explanation of the relevant knowledge, important in the process.

Načini ocenjevanja:	Delež/Weight	Assessment:
- oddaja rešene problemske naloge	40,00 %	- presentation of problem solution,
- sodelovanje na journal club-ih	20,00 %	- participation at journal clubs
- aktivna udeležba na znanstvenih srečanjih.	40,00 %	- active participation at scientific meetings.

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Maja Čemažar

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UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Sistematska in evolucijska biologija
Course title:	Systematic and Evolutionary Biology

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

Univerzitetna koda predmeta/University course code:	3780

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	10	0	0	30	190	10

Nosilec predmeta/Lecturer:	Peter Trontelj

Izvajalci predavanj:	Cene Fišer, Božo Frajman, Nina Gunde Cimerman, Matjaž Kunter, Simona Prevorčnik, Peter Trontelj
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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 to enroll in Doctoral Study Programme.

Vsebina:	Content (Syllabus outline):
Izbrane vsebine iz sistematske biologije, filogenetike in filogenomike, evolucijske biologije, biogeografije, biodiverzitetne informatike ter sorodnih in povezovalnih disciplin. Doktorand skupaj z mentorjem pripravi osebni načrt študija predmeta v okviru predpisanih kreditnih točk, ki ga potrdi nosilec. Za posamezne točke iz načrta študija (npr. udeležba na delavnici, prisostvovanje predavanjem, aktivno sodelovanje na seminarjih, priprava znanstvenega članka, osvojitev laboratorijske veščine …) kandidat pridobi dokazilo. Naloga nosilca predmeta je, da spremlja doktorandovo izpolnjevanje načrta študija.	Selected topics in systematic biology, phylogenetics and phylogenomics, evolutionary biology, biogeography, biodiversity informatics and related disciplines. The studies proceed according to a personal study plan prepared by the student and his mentor. The plan needs to be approved by the lecturer, to whom the student reports her/is advance. It can contain various activities like attendance at workshops, lectures, seminars, work on a scientific paper, gaining new laboratory skills, etc.

Temeljna literatura in viri/Readings:
• Douglas J Futuyma (2014) Evolution, 742 pages. Sinauer Asociates. • Izbor znanstvenih člankov / Selected scientific papers • Izbrana poglavja drugih učbenikov / Selected chapters in other textbooks

Cilji in kompetence:	Objectives and competences:
• Spodbuditi razvoj samostojnega znanstvenega mišljenja na področju sistematske in evolucijske biologije. • Razumevanje in kritično sprejemanje novih znanstvenih spoznanj in metod na področju doktorske disertacije. • Sposobnost jasnega izražanja znanstvenih problemov s področja predmeta.	• To develop independent scientific thinking in the fields of systematic and evolutionary biology. • Understanding and critical evaluation of new scientific findings in the area of candidate's PhD work • To foster the ability to clearly formulate complex scientific problem in systematics and evolutionary biology.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Študent osvoji strokovno znanje iz sistematike in evolucije do te mere, da lahko v praksi preizkusi vsaj eno izmed osnovnih oblik znanstvene komunikacije na mednarodni ravni: aktivna udeležba na mednarodnem znanstvenem srečanju, objava izvirnega znanstvenega članka.	Knowledge and understanding: The student masters systematic and evolutionary knowledge to the degree where she or he can participate in scientific communication at the international level, e.g. by presenting her or his work at a scientific meeting or by writing a manuscript of a scientific paper.

Metode poučevanja in učenja:	Learning and teaching methods:
Individualen program, sestavljen v dogovoru z mentorjem. Potrdi ga nosilec. Sestavljen je lahko iz: 1. študija izbranih evolucijskih in sistematskih vsebin v povezavi z doktorsko disertacijo; 2. praktičnega usposabljanja v laboratorijskem in terenskem raziskovalnem delu; 3. predavanj izbranih tujih in domačih predavateljev; 4. strokovnih seminarjev (diskusije člankov) v okviru posameznih raziskovalnih skupin; 5. aktivne udeležbe na znanstvenih srečanjih; 6. udeležbe na delavnicah, poletnih šolah in drugih posebnih oblikah izobraževanja.	The work proceeds according to an individually tailored study plan, approved by the lecturer. The plan may consist of: 1. studies of selected topics in evolutionary and systematic biology; 2. practical training in laboratory and field; 3. attending lectures of invited speakers from abroad and Slovenia; 4. participating in seminars, discussion groups, journal clubs; 5. participating at scientific meetings; 6. participating at workshops, summer schools and other forms of education.

Načini ocenjevanja:	Delež/Weight	Assessment:
Seminarji in aktivnosti na strokovnih srečanjih in delavnicah	100,00 %	Seminars and activities on scientific meetings, workshops and summer schools

Reference nosilca/Lecturer's references:

Peter Trontelj

Fišer, C., Blejec, A., & Trontelj, P. (2012). Niche-based mechanisms operating within extreme habitats: a case study of subterranean amphipod communities. Biology Letters, 8, 578–581. doi:10.1098/rsbl.2012.0125

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Trontelj, P., & Utevsky, S. Y. (2012). Phylogeny and phylogeography of medicinal leeches (genus Hirudo): fast dispersal and shallow genetic structure. Molecular Phylogenetics and Evolution, 63(2), 475–85. doi:10.1016/j.ympev.2012.01.022
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HEKMATARA, M., ZAKŠEK, Valerija, HEIDARI BALADEHI, M., FIŠER, Cene. Two new species of Niphargus (Crustacea: Amphipoda) from Iran. Journal of natural history, ISSN 0022-2933, 2013, vol. 47, iss. 21/22, str. 1421-1449.
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Božo Frajman
FRAJMAN, Božo, EGGENS, Frida, OXELMAN, Bengt. Hybrid origins and homoploid reticulate evolution within Heliosperma (Sileneae, Caryophyllaceae)-a multigene phylogenetic approach with relative dating. Syst.Biol., 2009, vol. 58, no. 3, str. 328-345. http://dx.doi.org/10.1093/sysbio/syp030,
FRAJMAN, Božo, SCHNEEWEISS, Gerald M. A campanulaceous fate: the Albanian stenoendemic Asyneuma comosiforme in fact belongs to isophyllous Campanula. Syst. bot., 2009, vol. 34, no. 3, str. 595-601. ISSN: 0363-6445
FRAJMAN, Božo, HEIDARI, Nahid, OXELMAN, Bengt. Phylogenetic relationships of Atocion and Viscaria (Sileneae, Caryophyllaceae)inferred from chloroplast, nuclear ribosomal, and low-copy gene DNA sequences. Taxon, 2009, vol. 58, no. 3, str. 811-824. ISSN: 0040-0262.
FRAJMAN, Božo, SCHÖNSWETTER, Peter. Giants and dwarfs: molecular phylogenies reveal multiple origins of annual spurges within Euphorbia subg. Esula. Mol. phylogenet. evol. (Print), 2011, letn. 61, str. 413-424. ISSN: 1055-7903
Frajman, B., Thollesson, M., Oxelman, B., 2013: Taxonomic revision of Atocion and Viscaria (Sileneae, Caryophyllaceae). Botanical Journal of the Linnean Society 173: 194-210..
Frajman, B., Carlón, L., Kosachev, P., Sánchez Pedraja, Ó., Schneeweiss, G. M., Schönswetter, P., 2013: Phylogenetic position and taxonomy of the enigmatic Orobanche krylowii (Orobanchaceae), a predominatly Asian species newly found in Albania (SE Europe). Phytotaxa 137: 1-14.

Nina Gunde Cimerman

GOSTINČAR, Cene, GRUBE, Martin, DE HOOG, Sybren, ZALAR, Polona, GUNDE-CIMERMAN, Nina. Extremotolerance in fungi : evolution on the edge. FEMS microbiology, ecology, ISSN 0168-6496, 2010, vol. 71, str. 2-11. [COBISS.SI-ID 2166607]
GOSTINČAR, Cene, TURK, Martina, GUNDE-CIMERMAN, Nina. The evolution of fatty acid desaturases and cytochrome b5 in eukaryotes. The journal of membrane biology, ISSN 0022-2631, 2010, iss. 1-3, vol. 233, str. 63-72. http://dx.doi.org/10.1007/s00232-010-9225-x, doi: 10.1007/s00232-010-9225-x. [COBISS.SI-ID 2180431]
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LENASSI, Metka, GOSTINČAR, Cene, JACKMAN, Shaun, TURK, Martina, SADOWSKI, Ivan, NISLOW, Corey, GUNDE-CIMERMAN, Nina, PLEMENITAŠ, Ana, et al. Whole genome duplication and enrichment of metal cation transporters revealed by De Novo genome sequencing of extremely halotolerant black yeast Hortaea werneckii. PloS one, ISSN 1932-6203, Aug. 2013, vol. 8, iss. 8. http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0071328, doi: 10.1371/journal.pone.0071328. [COBISS.SI-ID 30761177]

Matjaž Kuntner
KUNTNER, Matjaž, CODDINGTON, Jonathan A., SCHNEIDER, Jutta M. Intersexual arms race? : genital coevolution in nephilid spiders (Araneae, Nephilidae). Evolution, ISSN 0014-3820, 2009, letn. 36, št. 6, str. 1451-1463.
AGNARSSON, Ingi, KUNTNER, Matjaž, MAY-COLLADO, Laura. Dogs, cats, and kin: a molecular species-level phylogeny of Carnivora. Molecular phylogenetics and evolution, ISSN 1055-7903, 2010, vol. 54, no. 3, str. 726-745.
KUNTNER, Matjaž, CODDINGTON, Jonathan A. Discovery of the largest orbweaving spider species : the evolution of gigantism in Nephila. PloS one, ISSN 1932-6203, 2009, vol. 4, no. 10, str. e7516.
KUNTNER, Matjaž, KRALJ-FIŠER, Simona, SCHNEIDER, J. M., LI, Daiqin. Mate plugging via genital mutilation in nephilid spiders : an evolutionary hypothesis. Journal of zoology, ISSN 0952-8369, 2009, vol. 277, issue 4, str. 257-266.
BLACKLEDGE, Todd A., KUNTNER, Matjaž, AGNARSSON, Ingi. The form and function of spider orb webs : evolution from silk to ecosystems. V: CASAS, Jérôme (ur.). Spider physiology and behaviour, Behaviour, (Advances in insect physiology, ISSN 0065-2806, vol. 41). 1st ed. London [etc.]: Elsevier: Academic Press, 2011, str. 175-262.
KUNTNER, Matjaž, AGNARSSON, Ingi. Phylogeny accurately predicts behaviour in Indian Ocean Clitaetra spiders (Araneae: Nephilidae). Invertebrate systematics, ISSN 1445-5226, 2009, 23, str. 193-204.

Simona Prevorčnik
PREVORČNIK, Simona, VEROVNIK, Rudi, ZAGMAJSTER, Maja, SKET, Boris. Biogeography and phylogenetic relations within the Dinaric subgenus Monolistra (Microlistra) (Crustacea: Isopoda:

Sphaeromatidae) with description of two new species. Zoological Journal of the Linnean Society, 2010, vol. 159, str. 1–21. [COBISS.SI-ID 2218575]
PREVORČNIK, Simona, LOPES FERREIRA, Rodrigo, SKET, Boris. Brasileirinidae, a new isopod family (Crustacea: Isopoda) from the cave in Bahia (Brazil) with a discussion on its taxonomic position. Zootaxa, ISSN 1175-5326, 2012, vol. 3452, str. 47–65. [COBISS.SI-ID 2630991]
JUGOVIC, Jure, PREVORČNIK, Simona, SKET, Boris. Development of sexual characters in the cave shrimp genus Troglocaris (Crustacea: Decapoda: Atyidae) and their applicability in taxonomy. Zootaxa, 2010, vol.2488, str. 1–21. [COBISS.SI-ID 2229839]
JUGOVIC, Jure, PREVORČNIK, Simona, ALJANČIČ, Gregor, SKET, Boris. The atyid shrimp (Crustacea, Decapoda, Atyidae) rostrum: phylogeny versus adaptation, taxonomy versus trophic ecology. Journal of natural history, ISSN 0022-2933, 2010, vol. 44, no. 41/42, str. 2509–2533. [COBISS.SI-ID 2234703]
JUGOVIC, Jure, PREVORČNIK, Simona, BLEJEC, Andrej, SKET, Boris. Morphological differentiation in the cave shrimps Troglocaris (Crustacea: Decapoda: Atyidae) of the Dinaric karst - a consequence of geographical isolation or adaptation? Journal of zoological systematics and evolutionary research, ISSN 0947-5745, 2011, vol. 49, no. 3, str. 185–195. [COBISS.SI-ID 2344783]
JUGOVIC, Jure, JALŽIĆ, Branko, PREVORČNIK, Simona, SKET, Boris. Cave shrimps Troglocaris s. str. (Dormitzer, 1853), taxonomic revision and description of new taxa after phylogenetic and morphometric studies. Zootaxa, ISSN 1175-5326, 2012, vol. 3421, str. 1–31. [COBISS.SI-ID 2285523]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Statistična analiza bioloških podatkov
Course title:	Statistical analysis of biological data

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

Univerzitetna koda predmeta/University course code:	3781

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
10	10	20	0	5	80	5

Nosilec predmeta/Lecturer:	Andrej Blejec

Izvajalci predavanj:	Andrej Blejec
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	teoretični/theoretical

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 in pridobljenih vsaj 3 do 5 KT iz osnov statistike na predhodno končanih študijih.	General requirements. In addition, At least 3 to 5 ECTS gained in basic statistics in previously completed studies.

Vsebina:	Content (Syllabus outline):
1. Pregled osnovnih statističnih metod in njihova uporaba za analizo podatkov. Statistično preskušanje domnev. Metode proučevanja odvisnosti pojavov. 2. Osnove uporabe okolja za analizo podatkov »R«. Vrste podatkov, priprava in urejanje podatkov. Vnos in izpis podatkov, izmenjava	1. Review of basic statistical methods and their use for the analysis of data. Statistical testing of assumptions. Methods of studying the dependence of phenomena. 2. Basis of use of the environment for analysis of data »R«. Types of data, preparation and arrangement of data. Entry and extraction of

podatkov z drugimi programskimi okolji. Grafično prikazovanje podatkov. Priprava lastnih funkcij. Statistične porazdelitve in simulacija podatkov. Analiza podatkov z R. 3. Pregled metod multivariatne analize. Osnovni pojmi linearne algebre za uporabo v statistiki večdimenzionalnih podatkov. Vektorska algebra, matrike in matrični račun, pojem lastnih vrednosti in lastnih vektorjev. Statistična in geometrijska interpretacija pojmov linearne algebre. Metoda glavnih komponent, diskriminacijska analiza, faktorska analiza, razvrščanje v skupine, vizualizacija podatkov. 4. Statistično ozadje analize mikromrež. Načrt poskusa, priprava podatkov, metode za odstranjevanje šuma ozadja, normalizacija podatkov, analiza diferencialne izraženosti, grafične predstavitve in vizualizacija rezultatov, analiza omrežij, povezovanje z bazami podatkov in ontologij na svetovnem spletu. 5. Izbrane metode za analizo podatkov. Izbor posebnih metod bomo prilagajali glede na usmeritev in področje dela prijavljenih študentov.	data, exchange of data with other programme environments. Graphic presentation of data. Preparation of own functions. Statistical distribution and simulation of data. Analysis of data with R. 3. Review of methods of multivariate analysis. Basic concepts of linear algebra for use in statistics of multidimensional data. Vector algebra, matrices and matrix calculation, concept of own values and own vectors. Statistical and geometric interpretation of concepts of linear algebra. Method of main components, discrimination analysis, factorial analysis, classifying in groups, visualisation of data. 4. Statistical background to analysis of micronets. Plan of experiment, preparation of data, methods for removing background noise, normalisation of data, analysis of differential expression, graphic presentation and visualisation of results, analysis of networks, linkage with databases amd ontologies on the internet. 5. Selected methods for data analysis. The selection of special methods will be adapted to the orientation and field of work of students.

Temeljna literatura in viri/Readings:
- Whitlock, Michael C.: The analysis of biological data / Michael C. Whitlock and Dolph Schluter. - Greenwood Village, Colorado : Roberts and Company Publishers, 2009. - ISBN 978-0-9815194-0-1 - Krzanowski WJ, Principles of Multivariate Analysis, Oxford Science Publications, 1988. - Blejec, A: Introduction to R http://ablejec.nib.si/R/I2R/DOC/I2R.pdf - različni viri na svetovnem spletu.

Cilji in kompetence:	Objectives and competences:
Študent nadgradi poznavanje statističnih metod z zahtevnejšimi metodami, ki jih bo potreboval pri raziskovalnem delu. Poudarek je na konceptualnem razumevanju metod, primernosti metod za različne probleme in samostojni analizi podatkov s pomočjo sodobne programske opreme (R). .	The student builds on understanding of statistical methods with more demanding methods required in research work. The stress is on conceptual understanding of methods, comparability of methods for various problems and independent analysis of data with the aid of up-to-date software (R).

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Študent se usposobi za čim bolj samostojno izbiro ustrezne metode in analize problema, s katerim se vsebinsko ukvarja. Dosežena znanja mu pomagajo pri komunikaciji s strokovnjaki statističnih strok ter pri primerni vključitvi statističnih rezultatov v poročila in znanstvene članke	Knowledge and understanding: The student is trained for as independent as possible selection of suitable methods and analysis of problems with which he or she is dealing. The achieved knowledge will help him or her in communication with statistical experts and with suitable inclusion of statistical results in reports and scientific articles.

Metode poučevanja in učenja:	Learning and teaching methods:
- predavanja, - laboratorijske vaje, - konzultacije, - seminarske naloge	- lectures - work in computer lab - consultations - seminar

Načini ocenjevanja:	Delež/Weight	Assessment:
- ustni/pisni izpit	90,00 %	- oral/written exam
- praktično delo v računalnici	10,00 %	- Practical work in the lab

Reference nosilca/Lecturer's references:

1. FIŠER, Cene, BLEJEC, Andrej, TRONTELJ, Peter. Niche-based mechanisms operating within extreme habitats : a case study of subterranean amphipod communities. Biology letters, ISSN 1744-9561, 2012, vol. 8, no. 4, str. 578-581, doi: 10.1098/rsbl.2012.0125. [COBISS.SI-ID 2554447]

2. ROUYAR, Angela, PARTY, Virginie, PREŠERN, Janez, BLEJEC, Andrej, RENOU, Michel. A general odorant background affects the coding of pheromone stimulus intermittency in specialist olfactory receptor neurones. PloS one, ISSN 1932-6203, 2011, vol. 6, no. 10, str. e26443-1-e26443-13. http://www.plosone.org/article/info:doi/10.1371/journal.pone.0026443, doi: 10.1371/journal.pone.0026443. [COBISS.SI-ID 1156703]

3. BAEBLER, Špela, STARE, Katja, KOVAČ, Maja, BLEJEC, Andrej, PREZELJ, Nina, STARE, Tjaša, KOGOVŠEK, Polona, POMPE NOVAK, Maruša, ROSAHL, S., RAVNIKAR, Maja, GRUDEN, Kristina. Dynamics of responses in compatible potato - potato virus Y interaction are modulated by salicylic acid. PloS one, ISSN 1932-6203, 2011, vol. 6, issue 12, str. 1-12. http://dx.doi.org/10.1371/journal.pone.0029009, doi: 10.1371/journal.pone.0029009. [COBISS.SI-ID 2492751]

4. ŠUŠTAR VOZLIČ, Jelka, ROSTOHAR, Katja, BLEJEC, Andrej, KOZJAK, Petra, ČERGAN, Zoran, MEGLIČ, Vladimir. Development of sampling approaches for the determination of the presence of genetically modified organisms at the field level. Analytical and bioanalytical chemistry, ISSN 1618-2642, 2010, vol. 396, iss. 6, str. 2031-2041, doi: 10.1007/s00216-009-3406-4. [COBISS.SI-ID 3210344]

5. PAPAZOVA, Nina, ZHANG, David, GRUDEN, Kristina, VOJVODA, Jana, YANG, Litao, BUH GAŠPARIČ, Meti, BLEJEC, Andrej, FOUILLOUX, Stephane, DE LOOSE, Marc, TAVERNIERS, Isabel. Evaluation of the reliability of maize reference assays for GMO quantification. Analytical and

bioanalytical chemistry, ISSN 1618-2642, 2010, vol. 396, no. 6, str. 2189-2201. http://dx.doi.org/10.1007/s00216-009-3386-4, doi: 10.1007/s00216-009-3386-4. [COBISS.SI-ID 2163791]

6. ROTTER, Ana, KRALJ NOVAK, Petra, BAEBLER, Špela, TOPLAK, Nataša, BLEJEC, Andrej, LAVRAČ, Nada, GRUDEN, Kristina. Gene expression data analysis using closed itemset mining for labeled data. Omics. , ISSN 1536-2310, 2010, vol. 14, no. 2, str. 177-186. http://dx.doi.org/10.1089=omi.2009.0126, doi: 10.1089=omi.2009.0126. [COBISS.SI-ID 2210383]