UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Biološko izobraževanje**
Course title:	**Biological education**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	**biologija**	**1,2**	**1,2,3,4**
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	**biology**	**1,2**	**1,2,3,4**

Vrsta predmeta / Course type	teoretični predmet / theoretical course
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija Other study forms	Samost. delo Individ. work	ECTS
10	**20**	**15**	**/**	**/**	**80**	**5**

Nosilec predmeta / Lecturer:	Nosilec: doc.dr. Iztok Tomažič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

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 primerih spoznajo pomen in vlogo izkustvenega učenja in raziskovalnega pouka	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 about the significance and role of experience-based learning and learning through inquiry.

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.	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.

Temeljni 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 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.	Theoretical knowledge in the form of lectures; project work: (1) seminars as preparation, 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 (v %) / Weight (in %)	**Assessment:**
Ustni izpit	50 %	Oral exam
Projektno delo	50 %	Project work

Reference nosilca / izvajalcev / 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 program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	**Biologija**	**1,2**	**1,2,3,4**
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	**Biology**	**1,2**	**1,2,3,4**

Vrsta predmeta / Course type	teoretični predmet / theoretical course
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
20	**20**	**/**	**/**	**40**	**170**	**10**

Nosilec predmeta / Lecturer:	Nosilec: Alenka Gaberščik

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

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

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 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)

klimatskih sprememb na oblikovanje in funkcioniranje mikoriznih povezav.

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 uporaba orodij za modeliranje na izbranih študijskih primerih.

potential effects of climatic changes on the formation and function of mycorrhizal interactions.

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 consists of three main topics: ecosystem theory,

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.	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.

Temeljni 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:

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

Objectives and competences:

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 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.

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 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.

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

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:**

Znanje in razumevanje: **Sklop 1: Funkcionalna ekologija rastlin** Študenti spoznajo odzive rastlin na okoljske dejavnike in njihovo vlogo pri preoblikovanju in vzdrževanju stanja okolja. Razumejo pomen plastičnosti rastlinskega odziva v različnih okoljih in njegovo razvrednotenje ob "nepričakovanih" spremembah. Seznanijo se z optimiziranostjo strukture in funkcije rastline kot dela kompleksnega sistema. **Sklop 2: Ekologija vodnih rastlin** Študenti bodo prepoznali vlogo vodnih rastlin v ekosistemu, lastnosti vodnih rastlin kot bioindikatorjev. Študenti bodo poznali najpogosteje invazivne tujerodne vodne rastline in njihov invazivni potencial in grožnjo za domorodno floro. Seznanjeni bodo z najnovejšimi izsledki o sposobnost kopenskih in vodnih rastlin za privzem selena ter razlike v metabolizmu selena med vodnimi in kopenskimi rastlinami. Spoznali bodo možnost obogatitve kmetijskih rastlin s selenom in uporabo teh rastlin kot funkcijsko hrano za ljudi in živali. **Sklop 3: Vegetacija** Študenti se bodo seznanili z sodobnimi pristopi pri preučevanju vegetacije, ki jim bodo omogočili raziskovanje na tem področju in poznavanje rezultatov, ki jih je mogoče s to metodologijo doseči. Poleg tega pa bodo seznanili z možnostmi, ki jih vegetacijske raziskave vegetacije ponujajo pri opredelitev okolja posameznih živih bitij oz. za razumevanje krajine kot celote. **Sklop 4: Medvrstni odnosi** Predmet je zasnovan tako, da vzpodbuja slušatelje k raziskovalnemu razmišljanju na področju raziskav medvrstnih odnosov in njihove vpetosti v različna področja ekosistemskih raziskav. Ob tem bodo sposobni vidike biotskih interakcij vključevati v različna raziskovalna vprašanja pri uporabnih in temeljnih raziskavah, kar vzpodbuja k koncipiranju večje kompleksnosti reševanja raziskovalnih problemov. **Sklop 5: Ekologija mikorize** Študenti se bodo seznanili s delovanjem mikoriznih interakcij, razporeditvijo mikoriznih interakcij v različnih klimatskih pasovih in ekosistemih, pomenom mikoriznih interakcij na ravni združb ter potencialnimi spremembami v pojavljanju in delovanju mikoriznih interakcij zaradi klimatskih sprememb.	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** 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

Sklop 6: Funkcionalna biodiverziteta Razumevanje razvoja biodiverzitete in njene vloge v delovanju ekosistemov. Izpopolnitev znanja o funkcijski vlogi nekaterih živalskih skupinah v kopenskih ekosistemih. Povezati različna biološka znanja v uporabno celoto kot osnova holističnem pristopu k trajnostnem upravljanju z okoljem. Poznavanje z dejavniki ogrožanja kopenske biodiverzitete ter načini varstvenega ukrepanja. **Sklop 7: Ekologija celinskih voda** Predvideni študijski rezultat je kandidata usposobiti za delo z obravnavanimi metodami in orodji, ki jih bo kandidat lahko uporabljal pri temeljnih in aplikativnih raziskavah združb vodnih ekosistemov. **Sklop 8: Sistemska biologija** Slušatelji bodo pridobili metodološka znanja, ki jim bodo omogočala pridobivanje novih znanj o obnašanju preučevanega ekosistema, znali bodo napovedati njegovo obnašanje in strukturirati pridobljene znanje v obliko primerno za upravljanje ekosistemov. **Sklop 9: Molekularna ekologija** Študentje bodo dobili vpogled v področje molekularne ekologije in možnosti, ki jih ponuja. Dobili bodo pregled sodobnih raziskovalnih molekularno-ekoloških metod in rešitev, ki jih ponujajo. Na ta način bodo razširili svojo paleto poznavanja raziskovalnih orodij, ki jih bodo lahko z dodatnim študijem s pridom uporabili pri svojem raziskovalnem delu.	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 (v %) / Weight (in %)	**Assessment:**
Izpitno vprašanje	100	The examination

Reference nosilca / Lecturer's references:

Prof. dr. Alenka Gaberščik

GERM, Mateja, BREZNIK, Barbara, DOLINAR, Nataša, KREFT, Ivan, GABERŠČIK, Alenka. The combined effect of water limitation and UV-B radiation on common and tartary buckwheat. Cereal research communications, ISSN 0133-3720, 2013, vol. 41, no. 1, str. 97-105, doi: 10.1556/CRC.2012.0031.

KLANČNIK, Katja, PANČIĆ, Marina, GABERŠČIK, Alenka. Leaf optical properties in amphibious plant species are affected by multiple leaf traits. Hydrobiologia, ISSN 0018-8158, 2013, 10 str., [in press].

KLANČNIK, Katja, VOGEL-MIKUŠ, Katarina, GABERŠČIK, Alenka. Silicified structures affect leaf optical properties in grasses and sedge. Journal of photochemistry and photobiology. B, Biology, ISSN 1011-1344, 2013, 10 str., [in press], doi: 10.1016/j.jphotobiol.2013.

KLANČNIK, Katja, MLINAR, Mojca, GABERŠČIK, Alenka. Heterophylly results in a variety of "spectral signatures" in aquatic plant species. Aquatic botany, ISSN 0304-3770. [Print ed.], 2012, vol. 98, issue 1, str. 20-26.

COMONT, David, GABERŠČIK, Alenka, et al. UV responses of Lolium perenne raised along a latitudinal gradient across Europe : a filtration study. Physiologia Plantarum, ISSN 0031-9317. [Print ed.], 2012, vol. 145, iss. 4, str. 604-618.

MECHORA, Špela, STIBILJ, Vekoslava, RADEŠČEK, T., GABERŠČIK, Alenka, GERM, Mateja. Impact of Se (VI) fertilization on Se concentration in different parts of red cabbage plants. International journal of food, agriculture & environment - JFAE, ISSN 1459-0255, 2011, vol. 9, no. 2, str. 357-361.

DOLINAR, Nataša, GABERŠČIK, Alenka. Mycorrhizal colonization and growth of Phragmites australis in an intermittent wetland. Aquatic botany, ISSN 0304-3770. [Print ed.], 2010, vol. 93, no. 2, str. 93-98.

GERM, Mateja, STIBILJ, Vekoslava, KREFT, Samo, GABERŠČIK, Alenka, KREFT, Ivan. Flavonoid, tannin and hypericin concentrations in the leaves of St. John-s wort (Hypericum perforatum L.) are affected by UV-B radiation levels. Food chemistry, ISSN 0308-8146. [Print ed.], 2010, issue 3, vol.122, str. 471-474.

GERM, Mateja, STIBILJ, Vekoslava, KREFT, Samo, GABERŠČIK, Alenka, PAJK, Franja, KREFT, Ivan. Selenium concentration in St. John`s wort (Hypericum perforatum l.) herb after foliar spraying of young plants under different UV-B radiation levels. Food chemistry, ISSN 0308-8146. [Print ed.], 2009, issue 2, vol. 117, str. 204-206.

KRŽIČ, Nina, PONGRAC, Paula, REGVAR, Marjana, GABERŠČIK, Alenka. Photon-harvesting efficiency and arbuscular mycorrhiza in amphibious plants. Photosyntetica, ISSN 0300-3604, 2009, vol. 47, no. 1, str. 61-67.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Fiziologija in morfologija – integrativni pristop**
Course title:	**Physiology and Morphology - an Integrative Approach**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	**Biologija**	**1,2**	**1,2,3,4**
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	**Biology**	**1,2**	**1,2,3,4**

Vrsta predmeta / Course type	Temeljni predmet / Basic subject
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
20	**30**	**/**	**/**	**10**	**190**	**10**

Nosilec predmeta / Lecturer:	Nosilec: prof. dr. Marko Kreft

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

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

Vsebina:	**Content (Syllabus outline):**

Predmet obravnava zgradbo in delovanje živih organizmov na več ravneh biološke organizacije in pri tem povezuje številne vede in področja raziskav, ki obravnavajo zgradbo in delovanje živali, človeka in rastlin: morfologijo in anatomijo, histologijo, etologijo, nevroznanost, kemijo, biomehaniko, fiziko, inženirstvo. Nedavni napredek v molekulski biologiji, vključno z 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.	The course provides knowledge of the form and function of living organisms at levels of biological organization of animals, humans, and plants 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 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.

Temeljni 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

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 živih večceličnih organizmih.	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 living multicellular organisms.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Predviden študijski rezultat je nadgraditi in povezati znanje s področja fiziologije, anatomije, morfologije, etologije in uporaba novega znanja za razumevanje delovanja organizmov pod vplivom biotskih in abiotskih dejavnikov.	Knowledge and understanding: 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 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. Del z rastlinsko tematiko koordinira prof. dr. Marjana Regvar, del z živalsko tematiko koordinira prof. dr. Marko Kreft.	Lectures, workshops with seminars, lab presentations in cooperation with invited lecturers. The course is adjusted to the research field of the student. Plant related topics are coordinated by prof. dr. Marjana Regvar, animal related topics are coordinated by prof. dr. Marko Kreft.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit iz tem predavanj	**50%**	Written examination
Predstavitev individualnega projekta	**50%**	Project presentation

Reference nosilca / Lecturer's references:

prof. dr. Marko Kreft

RITUPER, Boštjan, CHOWDHURY HAQUE, Helena, JORGAČEVSKI, Jernej, COORSSEN, Jens R., KREFT, Marko, ZOREC, Robert. Cholesterol-mediated membrane surface area dynamics in neuroendocrine cells. Biochimica et biophysica acta. Molecular and cell biology of lipids, ISSN 1388-1981, Jul. 2013, vol. 1831, iss. 7, str. 1228-1238

FLAŠKER, Ajda, JORGAČEVSKI, Jernej, COSTA CALEJO, Ana-Isabel, KREFT, Marko, ZOREC, Robert. Vesicle size determines unitary exocytic properties and their sensitivity to sphingosine. Molecular and cellular endocrinology, ISSN 0303-7207. [Print ed.], 2013, vol. 376, iss. 1/2, str. 136-147,

PREBIL, Mateja, CHOWDHURY HAQUE, Helena, ZOREC, Robert, KREFT, Marko. Changes in cytosolic glucose level in ATP stimulated live astrocytes. Biochemical and biophysical research

communications, ISSN 0006-291X, 2011, vol. 405, issue. 2, str. 308-313, doi: 10.1016/j.bbrc.2011.01.035.

KREFT, Marko, BERDEN ZRIMEC, Maja, ZRIMEC, Alexis, ERDANI-KREFT, Mateja, KREFT, Ivan, KREFT, Samo. Pumpkin fruit, seed and oil yield is independent of fruit or seed photosynthesis. Journal of Agricultural Science, ISSN 0021-8596, 2011, vol. 149, issue 6, str. 753-760, ilustr., doi: 10.1017/S0021859611000372.

BANDMANN, Vera, KREFT, Marko, HOMANN, Ulrike. Modes of exocytotic and endocytotic events in tobacco BY-2 protoplasts. Molecular Plant, ISSN 1674-2052, 2011, vol. 4, issue 2, str. 241-251, graf. prikazi, doi: 10.1093/mp/ssq072.

ERDANI-KREFT, Mateja, ROMIH, Rok, KREFT, Marko, JEZERNIK, Kristijan. Endocytotic activity of bladder superficial urothelial cells is inversely related to their differentiation stage. Differentiation, ISSN 0301-4681, 2009, letn. 77, št. 1, str. 48-59, doi: 10.1016/j.diff.2008.09.011.

GABRIJEL, Mateja, BERGANT MARUŠIČ, Martina, KREFT, Marko, JERAS, Matjaž, ZOREC, Robert. Fused late endocytic compartments and immunostimulatory capacity of dendritic-tumor cell hybridomas. The journal of membrane biology, ISSN 0022-2631, 2009, letn. 229, št. 1, str. 11-18, doi: 10.1007/s00232-009-9171-7.

DARIOS, Frédéric, WASSER, Catherine, SHAKIRZYANOVA, Anastasia, GINIATULLIN, Artur, JORGAČEVSKI, Jernej, KREFT, Marko, ZOREC, Robert, et al. Sphingosine facilitates SNARE complex assembly and activates synaptic vesicle exocytosis. Neuron, ISSN 0896-6273, 2009, letn. 62, str. 683-694, doi: 10.1016/j.neuron.2009.04.024.

POTOKAR, Maja, VARDJAN, Nina, STENOVEC, Matjaž, GABRIJEL, Mateja, TRKOV, Saša, JORGAČEVSKI, Jernej, KREFT, Marko, ZOREC, Robert. Astrocytic vesicle mobility in health and disease. International journal of molecular sciences, ISSN 1661-6596, 2013, vol. 14, iss. 6, str. 11238-11258, ilustr., doi: 10.3390/ijms140611238.

KREFT, Marko, BAK, Lasse K, WAAGEPETERSEN, Helle S, SCHOUSBOE, Arne. Aspects of astrocyte energy metabolism, amino acid neurotransmitter homoeostasis and metabolic compartmentation. ASN neuro, ISSN 1759-0914, 2012, vol. 4, iss. 3, str. 187-199. http://www.asnneuro.org/an/004/an004e086.htm, doi: 10.1042/AN20120007.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Geografski informacijski sistemi kot raziskovalno orodje v biologiji in varstvu narave**
Course title:	**Geographic information systems as a research tool for biology and nature conservation**

Študijski program in stopnja Study programme and level	**Študijska smer Study field**	**Letnik Academic year**	**Semester Semester**
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	**Biologija**	**1,2**	**1,2,3,4**
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	**Biology**	**1,2**	**1,2,3,4**

Vrsta predmeta / Course type	teoretični predmet / theoretical course
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	**Seminar Seminar**	**Vaje Tutorial**	**Klinične vaje work**	**Druge oblike študija**	**Samost. delo Individ. work**	**ECTS**
10	**10**	**20**	**/**	**/**	**85 ur**	**5**

Nosilec predmeta / Lecturer:	Nosilec: doc. dr. Maja Zagmajster

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski ali angleški – v dogovoru s študenti Slovene / English – in agreement with the students
	Vaje / Tutorial:	slovenski / angleški – v dogovoru s študenti Slovene / English – in agreement with the students

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
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. 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.	Displaying spatial data: coordinate systems, geographic projections, georeferencing. Data management and spatial databases. 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

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

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminar	**100%**	Seminar

Reference nosilca / izvajalcev / 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.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Interakcije nukleinskih kislin in proteinov**
Course title:	**Protein-nucleic acid interaction**

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	**Biologija**	**1,2**	**1,2,3,4**
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	**Biology**	**1,2**	**1,2,3,4**

Vrsta predmeta / Course type	teoretični predmet / theoretical course
Univerzitetna koda predmeta / University course code:	

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
10	**15**	**10**	**/**	**5**	**85**	**5**

Nosilec predmeta / Lecturer:	Nosilec:doc. dr. Matej Butala

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
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) 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).	(ii) Characteristics of the DNA/RNA binding proteins (Thermal diffusion/electrostatic 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) 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).	(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) Študije kinetike interakcij proteinov in nukleinskih kislin (uporaba površinske plazmonske resonance ter MST; konstanta hitrosti asociacije, disociacije, študija kooperativnosti).	(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) Vizualizacija, lokalizacija interakcij nukleinskih kislin in proteinov *in vitro* ter *in vivo* (označevanje molekul; fluorescentna, dekonvolucijska, elektronska mikroskopija).	(v) Visualization and localisation of protein-nucleic acids complexes *in vitro* and *in vivo* (labeling of molecules; fluorescent, deconvolution, electron microscopy).
(vi) Biotehnološka uporabnost (proteinski inženiring, urejanje genomov evkariontov s sistemom CRISPR-Cas9, izgradnja logičnih vezij, tehnologija Nanopore).	(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).

Temeljni 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 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.	(i) To understand the molecular mechanisms that enable the cytosolic and the membrane 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. Motiviranje študentov za iskanje in razumevanje novejših člankov. Praksa v laboratoriju in demonstracija metod. Teoretična zasnova nove metode, orodja.	Lectures using the modern presentation software. Video conferences. 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 (v %) / Weight (in %)	Assessment:
Kolokvij in izpit se opravljata po zaključenih laboratorijskih vajah, predavanjih in individualnemu delu v pisni obliki.	Kolokvij / tutorial: 100% Izpit / exam 70%; seminar 30%	Examination after finished laboratory practice, individual work and lectures will be in written format.

Reference nosilca / izvajalcev / 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.

KOVAČIČ, Lidija, PAULIČ, Nejc, LEONARDI, Adrijana, HODNIK, Vesna, ANDERLUH, Gregor, PODLESEK, Zdravko, ŽGUR-BERTOK, Darja, KRIŽAJ, Igor, **BUTALA, Matej**. Structural insight into LexA-RecA interaction. *Nucleic acids research*, 2013, vol. 42, issue 21, str. 9901-9910.

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.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Molekulska in sistemska biologija**
Course title:	**Molecular and systems biolology**

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	**Biologija**	**1,2**	**1,2,3,4**
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	**Biology**	**1,2**	**1,2,3,4**

Vrsta predmeta / Course type	teoretični predmet / theoretical course
Univerzitetna koda predmeta / University course code:	

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
20	**20**	**/**	**/**	**20**	**190**	**10**

Nosilec predmeta / Lecturer:	Nosilec: prof. dr. Nina Gunde – Cimerman

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
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 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	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, 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). Presentation of the regulatory networking of RNA, which is likely to have important impact

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.	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.

Temeljni 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.

Članki/Papers:

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.

4. Baggio LL, Drucker DJ. Biology of incretins: GLP-1 and GIP. Gastroenterology. 2007 May;132(6):2131-57.
5. Zinman B. Newer insulin analogs: advances in basal insulin replacement. Diabetes Obes Metab 2013;15(Suppl. 1):6–10.
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:

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,

Objectives and competences:

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

- poznavanje različnih nekodirajočih RNA (mikroRNA, snoRNA in lncRNA) molekul in ter razumevanje njihovega delovanja na različnih nivojih regulacije izražanja genov, - 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.	conditions, - learning about the complex world of non-coding RNA molecules (microRNA, snoRNA and lncRNA) and their multilevel role in the expression of genes, - 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	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

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, 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.	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, 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 (v %) / Weight (in %)	**Assessment:**
- oddaja rešene problemske naloge - sodelovanje na journal club-ih - aktivna udeležba na znanstvenih srečanjih.	40 20 40	- presentation of problem solution, - participation at journal clubs, - active participation at scientific meetings.

Reference nosilca / Lecturer's references:

Nina Gunde –Cimerman

1. TKAVC, Rok, AUSEC, Luka, OREN, Aharon, GUNDE-CIMERMAN, Nina. Bacteria associated with Artemia spp. along the salinity gradient of the solar salterns at Eilat (Israel). *FEMS Microbiology Ecology*, ISSN 1574-6941. [Online ed.], 2011, vol. 77, str. 310-321, doi: 10.1111/j.1574-6941.2011.01112.x. [COBISS.SI-ID 4025464]
2. TKAVC, Rok, GOSTINČAR, Cene, TURK, Martina, VISSCHER, Pieter T., OREN, Aharon, GUNDE-CIMERMAN, Nina. Bacterial communities in the 'petola' microbial mat from the

Sečovlje salterns (Slovenia). *FEMS microbiology, ecology*, ISSN 0168-6496, 2011, vol. 75, issue 1, str. 48-62, doi: 10.1111/j.1574-6941.2010.00985.x. [COBISS.SI-ID 2313295]
3. TURK, Martina, PLEMENITAŠ, Ana, GUNDE-CIMERMAN, Nina. Extremophilic yeasts : plasma-membrane fluidity as determinant of stress tolerance. *Fungal biology*, ISSN 1878-6146, 2011, vol. 115, no. 10, str. 950-958. http://dx.doi.org/10.1016/j.funbio.2011.04.006, doi: 10.1016/j.funbio.2011.04.006. [COBISS.SI-ID 2442319]
4. LENASSI, Metka, ZAJC, Janja, GOSTINČAR, Cene, GORJAN, Alenka, GUNDE-CIMERMAN, Nina, PLEMENITAŠ, Ana. Adaptation of the glycerol-3-phosphate dehydrogenase Gpd1 to high salinities in the extremely halotolerant Hortaea werneckii and halophilic Wallemia ichthyophaga. *Fungal biology*, ISSN 1878-6146, 2011, vol. 115, issue 10, str. 959-970. http://dx.doi.org/10.1016/j.funbio.2011.04.001, doi: 10.1016/j.funbio.2011.04.001. [COBISS.SI-ID 2396495]
5. FETTICH, Martin, LENASSI, Metka, VERANIČ, Peter, GUNDE-CIMERMAN, Nina, PLEMENITAŠ, Ana. Identification and characterization of putative osmosensors, HwSho1A and HwSho1B, from the extremely halotolerant black yeast Hortaea werneckii. *Fungal genetics and biology*, ISSN 1087-1845, 2011, vol. 48, issue 5, str. 475-484, doi: 10.1016/j.fgb.2011.01.011. [COBISS.SI-ID 28077785]
6. SEPČIĆ, Kristina, ZALAR, Polona, GUNDE-CIMERMAN, Nina. Low water activity induces the production of bioactive metabolites in halophilic and halotolerant fungi. *Marine drugs*, ISSN 1660-3397, 2011, vol. 9, issue 1, str. 43-58, doi: 10.3390/md9010043. [COBISS.SI-ID 2320719]
7. GOSTINČAR, Cene, TURK, Martina, PLEMENITAŠ, Ana, GUNDE-CIMERMAN, Nina. The expressions of [delta]9-,[delta]12-desaturases and an elongase by the extremely halotolerant Hortaea werneckii are salt dependent. *FEMS yeast research*, ISSN 1567-1356. [Print ed.], 2009, vol. 9, issue 2, str. 247-256, doi: 10.1111/j.1567-1364.2009.00481. [COBISS.SI-ID 25392345]
8. GOSTINČAR, Cene, TURK, Martina, TRBUHA, Tina, VAUPOTIČ, Tomaž, PLEMENITAŠ, Ana, GUNDE-CIMERMAN, Nina. Expression of fatty-acid-modifying enzymes in the halotolerant black yeast Aureobasidium pullulans (de Bary) G. Arnaud under salt stress. *Studies in mycology*, ISSN 0166-0616, 2008, letn. 61, str. 51-59, doi: 10.3114/sim2008.61.04. [COBISS.SI-ID 25205465]
9. VAUPOTIČ, Tomaž, VERANIČ, Peter, PETROVIČ, Uroš, GUNDE-CIMERMAN, Nina, PLEMENITAŠ, Ana. HMG-CoA reductase is regulated by environmental salinity and its activity is essential for halotolerance in halophilic fungi. *Studies in mycology*, ISSN 0166-0616, 2008, letn. 61, str. 61-66, doi: 10.3114/sim.2008.61.05. [COBISS.SI-ID 25205977]
10. PLEMENITAŠ, Ana, VAUPOTIČ, Tomaž, LENASSI, Metka, KOGEJ, Tina, GUNDE-CIMERMAN, Nina. Adaptation of extremely halotolerant black yeast Hortaea werneckii to increased osmolarity : a molecular perspective at a glance. *Studies in mycology*, ISSN 0166-0616, 2008, letn. 61, str. 67-75, doi: 10.3114/sim2008.61.06. [COBISS.SI-ID 25205721]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Sistematska in evolucijska biologija
Course title:	Systematic and Evolutionary Biology

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	**Biologija**	**1,2**	**1,2,3,4**
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	**Biology**	**1,2**	**1,2,3,4**

Vrsta predmeta / Course type	teoretični predmet / theoretical course
Univerzitetna koda predmeta / University course code:	

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
20	**10**	**/**	**/**	**30**	**190**	**10**

Nosilec predmeta / Lecturer:	Nosilec: Peter Trontelj

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

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

Temeljni 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 (v %) / Weight (in %)	**Assessment:**
Seminarji in aktivnosti na strokovnih srečanjih in delavnicah	100	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

Kuntner, M., Arnedo, M. A., Trontelj, P., Lokovšek, T., & Agnarsson, I. (2013). A molecular phylogeny of nephilid spiders: Evolutionary history of a model lineage. Molecular phylogenetics …, 69(3), 961–979. Retrieved from http://www.sciencedirect.com/science/article/pii/S1055790313002480

Protas, M., Trontelj, P., & Patel, N. (2011). Genetic basis of eye and pigment loss in the cave crustacean, Asellus aquaticus. Proceedings of the National Academy of Sciences USA, 108(14), 5702–5707. doi:10.1073/pnas.1013850108/-/DCSupplemental.www.pnas.org/cgi/doi/10.1073/pnas.1013850108

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(5), 1009–1018. doi:10.1007/s10592-013-0491-x

Skrbinšek, T, Jelenčič, M., Waits, L. P., Potočnik, H., Kos, I., & Trontelj, P. (2012). Using a reference population yardstick to calibrate and compare genetic diversity reported in different studies: an example from the brown bear. Heredity, 109(5), 299–305. doi:10.1038/hdy.2012.42

Skrbinšek, Tomaž, Jelenčič, M., Waits, L., Kos, I., Jerina, K., & Trontelj, P. (2012). Monitoring the effective population size of a brown bear (Ursus arctos) population using new single-sample approaches. Molecular Ecology, 21(4), 862–75. doi:10.1111/j.1365-294X.2011.05423.x

Trontelj, P., Blejec, A., & Fišer, C. (2012). Ecomorphological Convergence of Cave Communities. Evolution, 66(12), 3852–3865. doi:10.1111/j.1558-5646.2012.01734.x

Trontelj, P., Douady, C. J., Fišer, C., Gibert, J., Gorički, Š., Lefébure, T., … Zakšek, V. (2009). A molecular test for cryptic diversity in ground water: how large are the ranges of macro-stygobionts? Freshwater Biology, 54(4), 727–744. doi:10.1111/j.1365-2427.2007.01877.x

Trontelj, P., & Fišer, C. (2009). Perspectives: Cryptic species diversity should not be trivialised. Systematics and Biodiversity, 7(1), 1–3. doi:10.1017/S1477200008002909

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
Turjak, M., & Trontelj, P. (2012). A method for measuring support for synapomorphy using character state distributions on phylogenetic trees. Cladistics, 28, 627–638. doi:10.1111/j.1096-0031.2012.00403.x

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Statistična analiza bioloških podatkov
Course title:	Statistical analysis of biological data

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	**Biologija**	**1,2**	**1,2,3,4**
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	**Biology**	**1,2**	**1,2,3,4**

Vrsta predmeta / Course type	Izbirni predmet / Elective subject
Univerzitetna koda predmeta / University course code:	

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
10	**10**	**20**	**/**	**5**	**80**	**5**

Nosilec predmeta / Lecturer:	Nosilec: prof. dr. Andrej Blejec

Jeziki / Languages:	**Predavanja / Lectures:**	**slovenski** **Slovene**
	Vaje / Tutorial:	**slovenski** **Slovene**

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

Temeljni 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 (v %) / Weight (in %)	**Assessment:**
- ustni/pisni izpit - praktično delo v računalnici	90 % 10 %	- oral/written exam - Practical work in the lab

Reference nosilca / izvajalcev / 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]