

Name of the course: BIOSSTATISTICS
Course teacher: Prof. dr. sc. Tarzan Legović, R. Bošković Institute
Doctoral study: Biology
Research field associated with the course programme: biology, ecology, statistics
Type of instructions: Lectures, 10; Exercises, 10
Credit value (ECTS): 7
Expected learning outcomes: By completing the course, students will understand and be able to apply statistical methods to analyze data.
Course objectives: Sources and classification of data. Descriptive methods. Environmental indices. Probability, random variables and distributions. Testing hypotheses. ANOVA, MANOVA and ANOM. Nonparametric methods. Correlation and linear regression. Nonlinear regressions (analytical and numerical methods). Multiple regressions. Identification of parameters. Time and spatial series. Selection of statistical software.
Students activities and evaluation of student work over the course of instruction: Attendance to lectures is obligatory as well as timely submission of homework problems. Solutions to homework problems are evaluated.
Methods of monitoring quality that ensure acquisition of exit competences: Attendance to lectures is monitored as well as solution to homework problems. Exam is written and oral.
Required literature: Sharov A. Quantitative population ecology, Chapters: 2, 3 and 4. http://home.comcast.net/~sharov/PopEcol/ (Accessed: 25.02.2015) Zar, J. H.: Biostatistical Analysis, Prentice Hall, 2010. Krebs, C. J., Ecological Methodology, Addison-Wesley, 1999.
Optional literature: Legović T. and Hackenberger B. Alexandrina Statistica, Natura Aeterna, 2012 Anthony D. Statistics for health, life and social sciences, Bookboon, 2011. (bookboon.com) Legendre, J., Legendre, P.: Numerical Ecology, Elsevier, 2012. Justić, D., Legović, T., Rottini-Sandrini, L.: Trends in oxygen content 1911-1984 and occurrence of benthic mortality in the northern Adriatic Sea. Estuarine Coast. and Shelf Sci., 25, 435-445, 1987.

Name of the course: SCIENTIFIC RESEARCH METHODOLOGY

Course teacher:

Prof. Dunja Leljak-Levanić, PhD, Faculty of Science, University Zagreb, Sofia Ana Blažević, PhD, Assistant Professor, Faculty of Science, University Zagreb

Doctoral study: Biology

Research field associated with the course programme: all scientific fields

Type of instructions:

15 hours lectures; 5 hours seminars

Credit value (ECTS): 7

Expected learning outcomes:

Acquiring knowledge about the scientific method and experimental design.

Understanding the links between statistical and mathematical methods and design of experiment.

Introduction with the specificities of scientific communication, publishing the research results, availability of scientific literature, relevant data sources retrieving process and the evaluation of scientific work.

Course objectives:

Experimental design

The hypothesis or question – answer model - hypothesis, the role of hypotheses in an experimental "design"; shortcomings of hypothesis: restrictive and too general hypothesis, an alternative system of questions and answers.

Variability, replicatin, repetition, control - variability in biological research, noise of the experiment, variability , standard deviation, number of replication and repetition; role of preliminary research and prestatistic for a successful outcome of the experiment , the selection of controls , balanced and unbalanced experimental design,

Classification , sampling , aliasing - classification as a method of reducing the " noise " of the experiment; types of sampling, sample and subsamples ; controls

Ethics in research - ethics to the institution , colleagues , research ethics (how to treat human or animal experimental material)

Elements and composition of research paper

Literature referencing styles and new tools, software for citations and referencing (Endnote, Mendeley)

How to publish research results, peer review process, plagiarism

Relevant scientific information sources, bibliographic and citation databases (Web of Science, Scopus...), full-text sources

Scientific work evaluation, bibliometric and scientometric analysis, citation analysis, journal evaluation (IF, SJR, h-index etc.), peer review

Students activities and evaluation of student work over the course of instruction: Seminar

essay, practical work on data bases
Methods of monitoring quality that ensure acquisition of exit competences: written and oral form of examination
<p>Required literature: David J. Glass, M.D.: Experimental Design for Biologists Novartis Institutes for Biomedical Research, Cambridge, Massachusetts, 2007</p> <p>Ruxton, Graeme; Colegrave, Nick (2010-11-04). Experimental Design for the Life Sciences, Oxford University Press</p> <p>Wilson EB, An Introduction to Scientific Research, McGraw Hill Book Comp. Inc., New York, 1952.</p> <p>Day RA, How to Write & Publish a Scientific Paper, 3rd Ed. Oryx Press, Phoenix, New York, 1988.</p>
<p>Optional literature: Silobrčić V, Kako sastaviti, objaviti i ocijeniti znanstveno djelo, Medicinska naklada, Zagreb, 1994.</p> <p>Jokić, M. Bibliometrijski aspekti vrednovanja znanstvenog rada, Zagreb, Sveučilišna knjižara, 2005.</p> <p>Jermen, N., Letina, S., Jokić, M. Croatian scientific productivity and visibility in the field of biology measured by journals indexed in WoS 1991–2005. Periodicum biologorum, 115(2013), 1, 37-47.</p>

Name of the course: TROPHIC LEVEL AND ENERGY FLOW IN ECOSYSTEM
<p>Course teacher</p> <p>Maria Špoljar, PhD, Associate Professor, Marko Miliša, PhD, Assistant Professor, Mirela Serić Perić, PhD, Assistant Professor</p>
Doctoral study: Biology
Research field associated with the course programme: Biology, Ecology
Type of instructions: Lectures and seminar (15+5)
Credit value (ECTS): 7
<p>Expected learning outcomes:</p> <p>Acquiring the knowledge on basic laws of energy flow through ecosystems and methods for measurements of energy flow; acquiring the knowledge on trophic levels and procedures used for their analysis.</p>
<p>Course objectives:</p> <p>Basic concept of the ecosystem as inseparable unity of living and non-living matter. Organization degrees of living matter from a molecular to ecosystem level. Circulation of matter in nature. Biotic component as a basic force for circulation of matter in nature. Primary and secondary production. Nutrition types. Trophic structure and ecological pyramids. The laws of thermodynamics and energy flow in ecosystem. Conversion, conservation and utilization of energy in the ecosystems. The models of energy flow through</p>

aquatic and terrestrial ecosystems. Available food resources in ecosystems. Ecosystem eutrophication. Degradation of biocenoses and energy flow deterioration in the ecosystem. Food chains, food webs and trophic levels in the ecosystems. The concept of production and consumption of organic matter in the terrestrial, marine and freshwater communities. Primary producers, consumers and decomposers.

Seminar: Themes will be in accordance with course objectives.

Students activities and evaluation of student work over the course of instruction:

Students are expected to attend both lectures and seminars. They will be given seminar themes which they are expected to explore and submit in written form prior to exam. Students will present their themes and actively participate in discussion.

Methods of monitoring quality that ensure acquisition of exit competences:

Final evaluation will be a combination of student achievements during the course, their results and final exam.

Required literature:

Harte J 2011: Maximum Entropy and Ecology: A Theory of Abundance, Distribution, and Energetics (Oxford Series in Ecology and Evolution) Oxford University Press

Hauer FR & Lamberti GA 2007: Methods in Stream Ecology. Academic press, Elsevier Inc. Oxford.

Krebs, C.J., 1999: Ecological methodology. Ed. Claudia M. Wilson, Harper & Row Publishers, New York.

Remert, H., 1998: Oekologie. Springer- Verlag, Berlin

Optional literature:

Higashi, M., Burns, T.P., 1991: Theoretical studies of ecosystems, The network perspective. Ed. Cambridge University Press, New York.

Name of the course: ECOLOGY OF MARINE HABITATS

Course teacher: Tatjana Bakran-Petricioli, PhD, Assistant Professor, Senior Scientific Collaborator, Department of Biology, Faculty of Science, University of Zagreb

Doctoral study: Biology

Research field associated with the course programme: field – 1.01. Biology; branch – 1.01.06. General biology

Type of instructions: Lectures (10 hours), seminars (10 hours)

Credit value (ECTS): 7

Expected learning outcomes:

Students will be able to:

- Differentiate the main living communities - habitats - in the littoral zone
- Describe basic ecological processes which take place in them

- Plan and organise simple research of those communities
- Define scientific approach and use it in the research of the life in the sea
- Define endangerment of the life in the sea and justify need for its protection
- Explain the need for intra- and interdisciplinary collaboration in sea research

Course objectives:

Students will get to know ecological processes that determine structure and dynamics of populations and communities of marine benthic organisms – marine habitats. After successfully passing the exam students will be able to independently design simple research in order to better understand those processes. They will be able to observe, identify and describe patterns in nature, to develop testable hypotheses about the causes of observed patterns and design suitable empirical tests to test proposed hypotheses or to monitor a possible impact. They will also be able to evaluate how important those processes are for the management and preservation of bio-resources in the sea.

LECTURE CONTENTS:

1. Specificities of scientific work in benthic research of the Adriatic Sea.
2. Planning of sampling/experiments in laboratory and on the field.
3. Natural disturbances and dynamics of marine benthic communities.
4. Energetics of marine ecosystem.
5. Communities in the littoral area: supra- and mediolittoral communities, sea-grass meadows, communities of photophilic algae, estuaries, circalittoral communities: coralligen, marine caves, coastal detritic bottoms, mud bottoms.
6. Ecology of habitats in submerged karst in the Adriatic Sea (vruljas, marine lakes, stratified estuaries, anchihaline caves).
7. Biodiversity of benthic habitats. Changes in the Adriatic benthic communities caused by human impact (pollution – toxic substances input, heat pollution, waste dumping; nutrient salts input and eutrophication; habitat disappearance and destruction; over exploitation of marine bio-resources; import of allochthonous species; global warming, sea level rise).
8. Endangered habitats of the Adriatic Sea.
9. Management of marine bio-resources and their preservation (laws and conventions on sea protection, strategic environmental impact assessment, environmental impact assessment studies, sustainable development and is it possible, management and protection of renewable marine bio-resources, integral management of coastal areas).
10. Ecology of protected areas in the Adriatic and their management.

Seminars are thematically connected to the lectures within the same week. Literature for the seminars consists of recent scientific, review and expert papers.

Students activities and evaluation of student work over the course of instruction:

- regular attendance of lectures and seminars, active participation during classes, writing homework and seminar paper, oral presentation of seminar paper in front of the colleagues, regular short written tests in the course of lectures

Note: prerequisite for enrolment of this course are attended and passed courses in: Marine Biology and/or Biological oceanography, and Methods in Marine Research (or equivalents); in case that student does not fulfil this condition she/he is obliged to take entrance colloquium in the first two months of lectures (materials for preparation will be made available)

Methods of monitoring quality that ensure acquisition of exit competences:

The final grade will be consisted of grades of the active participation in lectures, homework

and seminar paper grades, grades of the oral presentation of seminar paper, grades of short written tests in the course of lectures, and the final oral exam grade (all mentioned will be counted in the final grade)

Required literature:

- lecture presentations and materials
- selected recent review, professional and scientific articles
- selected parts of the following books (all the listed are available in laboratory):
- Bertness, MD, Gaines, SD, Hay, ME (2001) *Marine Community Ecology*, Sinauer Associates Inc. Publishers, Sunderland MA, USA
- Kaiser, MJ, Attrill, MJ, Jennings, S, Thomas, DN, Barnes, DKA, Brierley, AS, Polunin, NVC, Raffaelli, DG, Williams, PJ (2005) *Marine Ecology - Processes, Systems and Impacts*, Oxford University Press, Oxford, UK
- Mann, KH (2000) *Ecology of Coastal Waters*, Blackwell Science, Abingdon, UK
- Southwood, TRE, Henderson PA (2000) *Ecological methods*, Blackwell Science, Abingdon, UK
- Valiela, I (2006) *Global Coastal Change*, Blackwell Science, Abingdon, UK
- Bakran-Petricioli, T (2011) *Manual for determination of marine habitats in Croatia according to EU Habitats Directive (ISBN 978-953-7169-84-8)*. State Institute for Nature Protection, Zagreb, 184 pp.

Optional literature:

- Alley, M (1998) *The Craft of Scientific Writing*, Springer Verlag, New York
- Black, KD, Editor, (2001) *Environmental Impacts of Aquaculture*, Sheffield Academic Press, Sheffield, UK
- Miller, CB (2004) *Biological Oceanography*, Blackwell Publishing, Oxford, UK
- Silobrčić, V (2003) *How to write, publish and evaluate scientific paper*, Medicinska naklada, Zagreb (in Croatian)
- Quinn, GP, Keough, MJ (2002) *Experimental Design and Data Analysis for Biologists*, Cambridge University Press, Cambridge

Name of the course: ANALYSIS OF GENETIC DIVERSITY**Course teacher:**

Zlatko Liber, Associate professor, Faculty of Science, University of Zagreb
Zlatko Šatović, Full professor, Faculty of Agriculture, University of Zagreb

Doctoral study: Biology

Research field associated with the course programme: biology (1.05.); botany (1.05.02), genetics, evolution, phylogeny (1.05.06),

Type of instructions: (*lectures, practical work, seminars etc.*) **and number of hours:**

20 hours (lectures and seminars)

Credit value (ECTS): 7

Expected learning outcomes: Introduce, discuss, compare and apply molecular, statistical and computer methods for the analysis of genetic diversity which are most often used in population-genetic, molecular ecology, spatial genetic, phylogenetic, biology conservation and epigenetic researches.

Course objectives:

1. Introduction to the analysis of molecular diversity; overview of classical and molecular genetics; examples of scientific researches.
2. Genetic markers: basic molecular techniques in the analysis of genetic diversity; morphological and molecular markers; isoenzymes; molecular markers at the DNA level; randomly amplified molecular markers; molecular markers based on known sequences.
3. Descriptive statistics: informativeness of genetic markers; codominant and dominant markers; genotype and allelic frequency; polymorphism information contents; measures of intrapopulation diversity; allelic richness; observed and expected heterozygosity; fixation index; Shannon's information index; frequency of rare alleles; analysis of genetic bottleneck.
4. Measures of genetic distance: distances between populations; frequency of amplified fragments and allele frequency; distances based on evolutionary models; geometric distances; genetic distance between individuals; proportion of shared alleles distance; similarity coefficients for binary data.
5. Multivariate methods: introduction; characteristics of multivariate data; classification of multivariate methods; cluster analysis; types of trees; UPGMA and related algorithms; neighbor joining method; bootstrap method; principal component and principal coordinate methods
6. Genetic structure: Hardy-Weinberg equilibrium; Wright's F statistics; Wahlund effect; index of genetic differentiation; method according Weir and Cockerham; analysis of molecular variance; basic concept of Bayesian statistics; linkage disequilibrium; model based Bayesian analysis (STRUCTURE, BAPS).
7. Spatial and landscape genetics: spatial distribution of genetic diversity; isolation by distance; spatial autocorrelation; Moran's index; Bayesian analysis of spatial population structure (BAPS, TESS); genetic barriers; comparison of bioclimatic and genetic parameters; landscape genetics (POPS).
8. Phylogeography: impact of demographic processes on the geographical distribution of population/species; genetic genealogy; analysis of 'nested clade' vs. coalescent theory; analysis of haplotype and nucleotide diversity; neutrality test; phylogenetic networks; statistical parsimony; strict and relaxed molecular clock.
9. Adaptive genetic diversity: natural selection vs. neutral theory; genetic diversity and adaptive potential of populations/species; neutral genetic markers and markers under selection pressure; genetic drift; methods of identification of markers under selection pressure; marker deviation of overall population genetic differentiation.

10. Epigenetic diversity of natural populations: analysis of epigenetic markers (CRED-RA, MSAP); epigenetic structure of population; relationship between genetic and epigenetic diversity; impact of environmental factors, genetic bottleneck, hybridization, polyploidization and inbreeding depression on epigenetic diversity.

Students activities and evaluation of student work over the course of instruction:
Attendance of lectures, making and presentation of seminars, solving of homework exams.

Methods of monitoring quality that ensure acquisition of exit competences:

Final mark is the sum of marks of seminars, homeworks and final written exam.

Required literature:

Liber Z., Šatović, Z. 2012. Analysis of genetic diversity. Faculty of Science, Zagreb – script and lectures in PDF format

Optional literature:

Allendorf, F.W., Luikart, G.H. 2007. Conservation and the Genetics of Populations. Blackwell Publishing, Malden

Beebe, T., Rowe, G. 2008. An Introduction to Molecular Ecology: Second Edition. Oxford University Press, Oxford

Felsenstein, J. 2003. Theoretical Evolutionary Genetics. University of Washington, Department of Genetics, Seattle

Frankham, R., Ballou, J.D., Briscoe, D.A. 2002. Introduction to Conservation Genetics. Cambridge University Press, Cambridge

Gillespie, J.H. 1998. Population Genetics: A Concise Guide. The Johns Hopkins University Press, Baltimore - London

Maynard Smith, J. 1998. Evolutionary Genetics: Second Edition. Oxford University Press, Oxford

Nei, M. 1975. Molecular Population Genetics and Evolution. North-Holland Publishing Company, Amsterdam - Oxford

Templeton, A.R. 2006. Population Genetics and Microevolutionary Theory. John Wiley & Sons, Inc., Hoboken

Thompson, J.D. 2005. Plant Evolution in the Mediterranean. Oxford University Press, Oxford

Van Dyke, F. 2008. Conservation Biology: Foundations, Concepts, Applications. Second Edition. Springer Science + Business Media B.V., Springer-Verlag GmbH, Heidelberg

Weir, B.S. 1996. Genetic Data Analysis II: Methods for Discrete Population Genetic Data. Sinauer Associates, Inc. Publishers, Sunderland.

Name of the course: MOLECULAR EVOLUTION**Course teacher:**

Dr. sc. Đurđica Ugarković, Dr. sc. Branka Bruvo Mađarić, Dr. sc. Martina Podnar Lešić

Doctoral study: Biology**Research field associated with the course programme:**

Biology: evolution and genetics

Type of instructions:

lectures and seminars, 20 h (15 + 5)

Credit value (ECTS): 7**Expected learning outcomes:**

Getting novel insights into current knowledge about the evolution and organisation of eukaryotic genome, as well as about the methods of their investigation and analyses.

Course objectives:**Lectures:**

Types of genomic sequences and their organisation in the eukaryotic genome.

Evolutionary mechanisms which shape the eukaryotic genome.

Evolution of non-coding DNA.

Evolution of coding DNA (protein-coding and regulatory regions).

Molecular phylogeny and phylogeography, theory and methods of data analyses.

Bioinformatic analysis of the genome, comparative genomics.

Seminars:

Through the preparation and presentation of seminars, students get additional insight in various relevant topics in the field of molecular evolution and phylogenetics, such as:

- Evolution of the genome and chromosomes;
- Horizontal gene transfer;
- "Junk DNA": transposons, highly repetitive DNA, SINE, LINE, microsatellites, pseudogenes, NUMTs, etc.;
- Epigenetic mechanisms of gene regulation;
- Evolution of tumor genome;
- "Orphan genes";
- Phylostratigraphy;
- Molecular clock.

Students activities and evaluation of student work over the course of instruction

Attending lectures, preparation and presentation of seminar topics.

Methods of monitoring quality that ensure acquisition of exit competences:

Preparation and presentation of seminars, oral examination.

Required literature:

D. Graur, W-H. Ling (2000) Fundamentals of molecular evolution. Sinauer Associates; 2nd edition

M. Nei, S. Kumar (2000) Molecular evolution and phylogenetics. Oxford University Press, USA; 1st edition

B.G. Hall (2011) Phylogenetic trees made easy: A how-to manual. Sinauer Associates, Inc.; 4th edition

Optional literature:

J.C. Avise (2004) Molecular markers, natural history, and evolution. Sinauer Associates; 2nd edition;

J.C. Avise (2006) Evolutionary pathways in nature: A phylogenetic approach. Cambridge University Press; 1st edition;

Thalman et al. (2007) MBE;

Harrison & Langdale (2006) Plant J;

Keeling (2008) *Nat Rev Gene*;

Khalturin et al. (2009) Trends Genet.;

Domazet-Lošo et al. (2007) Trends Genet.;

Lanfear et al. (2010) TIEE;

Kramerov (2011) Heredity;

Tollervey & [Lunyak](#) (2012) [Epigenetics](#);

Huang et al. (2012) Annu Rev Genet.

1. COURSE DESCRIPTION – GENERAL INFORMATION			
1.1. Course teacher	Dijana Škorić	1.6. Year and semester of study	1st year
1.2. Name of the course	MOLECULAR DIVERSITY OF VIRUSES AND SUBVIRAL PATHOGENS	1.7. Credit value (ECTS)	7
1.3. Associate teachers		1.8. Type of instruction (number of hours L+S+E+e-learning)	15+5+0+0
1.4. Study programme (undergraduate, graduate, integrated)	Doctoral studies	1.9. Expected enrolment in the course	10
1.5. Status of the course	Elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1, 0%
2. COURSE DESCRIPTION			
2.1. Course objectives	Breaking the paradigm of viruses as pathogens and introducing new concepts of virosphere as a source of genetic diversity important in evolution of the living world, driving and regulating ecosystems including prokaryotic and eukaryotic systems in which they may act not only as pathogens but also as contributors to normal functioning of the host. Introducing students to the types of subviral pathogens and concepts related to them, noncoding genomes and prions as pathogenic proteins encoding information, diseases of subviral aetiology and importance of subviral and RNA world for the development of evolution and general biological concepts.		
2.2. Enrolment requirements and required entry competences for the course	Basic knowledge of molecular and cell biology, virology, genetics and population genetics. Good critical reading skills, basic molecular laboratory skills.		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Acquiring basic molecular concepts on biological entities smaller and simpler than viruses. Recognizing breakthrough findings in biology and microbiology. Changing the paradigm of viruses as pathogens. Realizing the impact of the noncoding RNAs and subviral agents on biological systems. Improving critical thinking, interpretation of published research and short oral presentations in English.		

<p>2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)</p>	<p>Getting informed on new concepts in virology and microbiology. Understanding the impact of viruses and subviral RNAs on the evolution of the living world. Grasping the vast diversity of viral and subviral pathogens. Understanding the biology of small RNA molecules and subviral pathogens. Understanding the principles underlying evolution of viruses and subviral pathogens. Introducing new trends in virology and related fields. Developing the skills of scientific results interpretation of and their public presentation.</p>		
<p>2.5. Course content broken down in detail by weekly class schedule (syllabus)</p>	<ol style="list-style-type: none"> 1. Viruses as pathogens and parasites, diversity of viral genomes and forms 2. Viruses as symbionts, horizontal gene transfer agents and ecosystem regulators 3. Definition of subviral pathogens, types of subviral pathogens (HDV, satellite viruses, satellite RNAs, viroids, prions) 4. Hypotheses on virus origins and evolution of life, the advent of giant viruses 5. Mechanisms underlying viral evolution (mutations, recombinations, rearrangements, antigenic shift and drift) 6. Genetics of viral populations, quasispecies concept, viral fitness 7. evolutionary dynamics, selection pressure types 8. Host-virus coevolution, emerging viruses 9. Diversity of satellite RNAs and viroids as RNA pathogens and symbionts, relics of RNA-world 10. Origin and evolution of Hepatitis D agent 11. Noncoding RNA diversity and biology 12. Diversity and evolution of viral and subviral pathogens and their role in developing new antiviral therapies 13, 14, 15. Students seminars on a chosen topic. 		
<p>12.1. Type of instruction</p>	<input checked="" type="checkbox"/> lectures <input checked="" type="checkbox"/> seminars and workshops <input type="checkbox"/> exercises <input type="checkbox"/> online in entirety <input type="checkbox"/> mixed e-learning <input type="checkbox"/> field work	<input checked="" type="checkbox"/> independent study <input checked="" type="checkbox"/> multimedia and the internet <input type="checkbox"/> laboratory <input type="checkbox"/> work with the mentor <input type="checkbox"/> (other)	<p>12.2. Comments:</p> <p>Guidelines are provided by lectures and recommended literature given by the teacher. The doctoral students are expected to research additional literature online themselves and prepare a short oral presentation for the seminar.</p>
<p>12.3. Student responsibilities</p>			

12.4. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course):	Class attendance	required	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	40%	(Other--describe)	
	Tests		Oral exam	60%	(Other—describe)	
	Written exam		Project		(Other—describe)	
2.1. Grading and evaluation of student work over the course of instruction and at a final exam	Lecture attendance is required. Seminar oral presentation is graded excellent if full understanding of the topic is achieved, presentation well timed and conceptually correct and readiness to discuss the topic with reasonably solid confidence is shown. Oral exam entails understanding of the main concepts given throughout the lectures and seminars including the seminars of fellow students. If full understanding is achieved with clarity in impact and applications, it is graded as excellent.					
2.2. Required literature (available at the library and via other media)	Title			Number of copies at the library	Availability via other media	
	J. Carter & W. Saunders, Virology-Principles and applications. J. Wiley& Sons, Ltd, England, 2007.			1	Yes	
	Viroids. Eds: A. Hadidi, R. Flores, J. Randles, J. S. Semancik, Science Publishers Inc., 2003.			1	Yes	
	Review and original research articles recommended by the teacher mainly available as pdfs via open access online.			0	Yes	
2.12. Optional literature (at the time of the submission of the study programme proposal)	Quasispecies: Concepts and Implications for Virology (Ed.) E. Domingo. Current Topics in Microbiology and Immunology 299, Springer, 2006. Origin and evolution od viruses (2nd Edition). Eds. E. Domingo, C. R. Parrish, J. J. Holland, Elsevier, 2008. The RNA World (3rd Edition). Eds: R. F. Gesteland, T. R. Check & J. F. Atkins, Cold Spring Harbor Laboratory Press, 2006.					
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal teacher evaluation survey.					

Name of the course: BIOLOGICAL AND HORMONAL CONTROL OF PLANT DISEASES

Course teacher

Mirna Ćurković Perica, Full Prof, University of Zagreb

Doctoral study: Biology

Research field associated with the course programme: microbiology and plant biology

Type of instructions:

practicals (8), seminar (7)

Credit value (ECTS): 6

Expected learning outcomes: The aim of the course is to familiarize students with the application of biological control and plant growth regulators in the suppression of certain plant diseases. Students will gain insight into the connection between basic biological research with applied research in agriculture and forestry. During the practicum, students will learn how to cultivate some plant pathogens *in vitro* and detect them on the molecular level. Students will learn to design and perform an experiment or research, and present their results.

Course objectives:

- Plant pathogens: fungi, bacteria and viruses
- Methods for detection of plant pathogens (serological, ELISA; different versions of PCR, nested RT, real-time PCR)
- Phytoplasmas
- The effect of plant growth regulators on phytoplasmas
- Chestnut blight
- Biological control of chestnut cancer hypovirusom
- Genetically modified plants resistant to plant pathogens

Practicals:

Cultivation of virulent and hypovirulent strains of the fungus *Cryphonectria parasitica* in the laboratory conditions and detection of hypovirus. Alternatively: Cultivation of phytoplasmas in *Catharanthus roseus* shoots grown *in vitro*, effect of auxins on phytoplasmas and molecular detection of phytoplasmas.

Students activities and evaluation of student work over the course of instruction:

Active participation in practical work in the lab that will include independent tasks and results analysis, and preparation of report.

Methods of monitoring quality that ensure acquisition of exit competences:

oral examination

Required literature:

Ambriović Ristov A. et al. Metode u molekularnoj biologiji. Institut Ruđer Bošković, 2007.
Ausubel F M. et al. Current Protocols in Molecular Biology. John Wiley and Sons, New York 1994.

Leljāk-Levanić et al. Biochemical and epigenetic changes in phytoplasma-recovered

periwinkle after indole-3-butyric acid treatment. Journal of Applied Microbiology. 109 (2010) 2069-2078

Kišpatić J. Opća fitopatologija. Fakultet poljoprivrednih znanosti Sveučilišta u Zagrebu, 1985.

Nuss DL. Hypovirulence: Mycoviruses at the fungal-plant interface. Nature Reviews. Microbiology. 3 (2005): 632-642.

Optional literature:

Agrios GN. Plant Pathology. Academic Press, San Diego, 1997 (2004).

Jelaska S. Kultura biljnih stanica i tkiva. Školska knjiga, Zagreb, 1994.

Juretić N. Osnove biljne virologije. Školska knjiga, Zagreb, 2002.

Name of the course: IMMUNOREGULATION

Course teacher

MODERATOR/LECTURER:

Asst. Prof. Alenka Gagro, MD, PhD, Research Adviser, Department of Pediatrics, Pulmology, Allergology, Immunology and Rheumatology Division, Children's Hospital Zagreb, Klaićeva 16, 10000 Zagreb

CO-LECTURERS:

1. Alma Martina Cepika, MD, PhD, Baylor Institute for Immunology Research, Dallas, USA
2. Jakov Ajduk, MD, PhD, "Sestre milosrdnice" University Hospital Center, Department of Otorhinolaryngology and Head and Neck Surgery, Zagreb, Croatia

Doctoral study: Biology

Research field associated with the course programme:

FIELD: 3.01; BRANCH: 13: immunology and immunohematology;
SCIENTIFIC PROJECT SUPPORTED BY MINISTRY OF SCIENCE, EDUCATION AND SPORTS (2006-2014): Modulation of human regulatory T cells function

Type of instructions:

lectures: 8

seminars: 4

practicals: 3

Credit value (ECTS):

Expected learning outcomes:

The course provides the basic principles and mechanisms of regulation of immunity with special emphasis on regulatory T cells. The role of regulatory cells in different experimental animal models as well as human diseases (autoimmune, autoinflammatory, allergy, tumors, infections, graft versus host reactions) will be presented. Upon completing the course, the students will accept basic knowledge of the role of regulatory cells in immunity and will be able to critically follow the recent published papers in this field. Also, the students will accept practical skills to perform laboratory methods used to determine regulatory T cells and their function by flow cytometry and *in vitro* functional assays.

Course objectives:

Lectures: Definitions of immunoregulation, immune tolerance (peripheral and central) and immunosuppression. Types of regulatory cells (natural, induced) and their markers. The role

of Th3, Tr1, Th17, Th22 and Th9 lymphocytes in immunoregulation. Animal models for investigation of immunoregulatory mechanisms. Examples of disturbed immunoregulation in human diseases. Possibilities for modulation of regulatory cells.

Practicals: Determination of regulatory T cells and immunoregulatory cytokines (IL-10, TGF-beta) by multicolor flow cytometry analysis. *In vitro* methods for examination of regulatory T cell function.

Seminars: Cellular therapy with regulatory T cells. Immunotolerance to allergens.

Students activities and evaluation of student work over the course of instruction

Active participation in all aspects of the course, including the Journal Club. Taking part in students' discussion groups, completing the seminar with independent literature topic research in the field of immunoregulation and short oral presentation of the results using the Power Point.

Methods of monitoring quality that ensure acquisition of exit competences::

Written test or presentation of project proposal in the field of immunoregulation.

Required literature:

Murphy K, Janeway's Immunobiology, 8th edition. New York: Garland Science, Taylor & Francis Group; 2011.

1. Marinic I, Gagro A, Rabatic S. Regulatory T cells. Acta Med Croatica 2006;60:447-56.
2. Ajduk J, Turkalj M, Gagro A. Regulatory T cells in children undergoing rush venom immunotherapy. Allergy Asthma Proc 2012;33:525-30.
3. Banchereau J, Pascual V, O'Garra A. From IL-2 to IL-37: the expanding spectrum of anti-inflammatory cytokines. Nat Immunol 2012;13:925-31.
4. Yuan X, Malek TR. Cellular and molecular determinants for the development of natural and induced regulatory T cells. Hum Immunol 2012;73:773-82.
5. Fujita H, Meyer N, Akdis M, Akdis CA. Mechanisms of immune tolerance to allergens. Chem Immunol Allergy 2012;96:30-8.
6. Cretney E, Kallies A, Nutt SL. Differentiation and function of Foxp3(+) effector regulatory T cells. Trends Immunol 2013;34:74-80.

Optional literature:

The most recent and relevant scientific papers in the field will be presented and discussed during seminars.

1. Miyara M, Ito Y, Sakaguchi S. TREG-cell therapies for autoimmune rheumatic diseases. Nat Rev Rheumatol 2014;10:543-51.
2. Roychoudhuri R, Eil RL, Restifo NP. The interplay of effector and regulatory T cells in cancer. Curr Opin Immunol. 2015 Feb 26;33C:101-111. doi: 10.1016/j.coi.2015.02.003. [Epub ahead of print]
3. Li Z, Li D, Tsun A, Li B. FOXP3+ regulatory T cells and their functional regulation. Cell Mol Immunol 2015; doi: 10.1038/cmi.2015.10. [Epub ahead of print]

Name of the course: CELL RESPONSE TO GENOTOXIC AGENTS

Course teacher

Anamaria Brozović, PhD, Senior Associate Scientist

Doctoral study: Biology

Research field associated with the course programme:

Biology, Molecular biology

Type of instructions (in hours)

7 lectures , 4 seminars, 4 training

Credit value (ECTS):

Expected learning outcomes:

The student's knowledge on the molecular mechanisms that are activated following the cell treatment with genotoxic agents, and molecular mechanisms that are involved in drug-resistance, along with the molecular methods which helped to resolve these mechanisms.

Course objectives:

Cell exposure to cytotoxic compounds can cause diverse harmful effects. As maintenance of genomic stability is essential for the survival of organisms, during the evolution the cells have developed numerous strictly regulated pathways to minimize these effects. The events that influence cell response can be principally divided in two groups: those that occur upstream of DNA damage, or downstream of it. Generally, the first group involves cell adhesion, activation of membrane transporters, glutathione (as the protective molecule, as well as the central molecule for redox state regulation, and modification of signalling pathways). Cells survival is supported by two signalling cascades, PI-3K/PKB and NF-kappaB cascades. In cell response to genotoxic agents DNA repair has an important role. In the cells can not repair the damage, cell death will occur (necrosis, apoptosis, autophagia). The activity of the key molecules involved in cell death (p53 family proteins, Bcl-2 family proteins, caspases, their inhibitors, inhibitors of caspases inhibitors, katepsins etc.) is very precisely regulated. The final outcome of cell exposure to certain genotoxic agent is a complex process that depends on the cell-type and cell status, as well as on the agent itself.

Briefly, in this course the cascades of events that are activated following the cell treatment with genotoxic agents will be presented that may influence the final outcome: cell adhesion, activity of cell transporters, activity of Rho GTPases, glutathione, DNA damage repair, and the activation of cells death, signaling pathways that are involved in these processes and their interaction, as well as the molecular mechanisms that are involved in drug-resistance.

Students activities and evaluation of student work over the course of instruction

Lectures attendance, participation in training, seminar work

Methods of monitoring quality that ensure acquisition of exit competences

Written and oral exam

Required literature:

1. Köberle B., Tomicic M., Usanova S., Kaina B. (2010) Cisplatin resistance: Preclinical findings and clinical implications- Review. *Biochem. Biophys. Acta*, 1806:172-182.
2. Roos W.P., Bernd K. (2013) DNA damage-induced cell death: From specific DNA lesions to the DNA damage response and apoptosis. Mini-review. *Cancer Lett.* 332:237-48.
3. Dey A., Lane D.P. , Verma C.S. (2010) Modulating the p53 pathway- Review. *Sem. Cancer Biol.* 20: 3–9.
4. Rodriguez-Nieto S., Zhivotovsky B.(2006) Role of Alterations in the Apoptotic Machinery in Sensitivity of Cancer Cells to Treatment *Current Pharmaceutical Design*, 2006, 12, 4411-4425.
5. Kelly G., Andreas Strasser (2011) The essential role of evasion from cell death in cancer. *Adv. Cancer Res.* 111: 39–96.
6. Circu M.L., Aw T.Y. (2010) Reactive oxygen species, cellular redox system and apoptosis. *Free Radic. Biol. Med.* 48: 749–762.

Optional literature:

1. Hanahan D., Weinberg R.A. (2011) Hallmarks of cancer: The next generation. *Cell* 144: 646-674.
2. Brozović, A., Majhen, D., Roje, V., Mikac, N., Jakopec, S., Fritz, G., Osmak, M., Ambriovic Ristov, A.: $\alpha V\beta 3$ integrin mediated drug resistance in human laryngeal carcinoma cells is caused by glutathione dependent elimination of drug induced reactive oxidative species. *Mol. Pharmacol.* 74 (2008) 1-9, 2008.
3. Čimbora-Zovko T., Fritz G., Mikac N., Osmak M.: Downregulation of RhoB GTPase confers resistance to cisplatin. *Cancer Lett.*, 295 (2010) 182-190.

Name of the course: GLYCOBIOLOGY

Course teacher:

Gordan Lauc, Full professor, Faculty of Pharmacy and Biochemistry

Olga Gornik, Assistant professor, Faculty of Pharmacy and Biochemistry

Doctoral study: Biology

Research field associated with the course programme: Biology, Biochemistry and Molecular Biology

Type of instructions: 6 lectures, 3 seminars, 6 practicals

Credit value (ECTS):

Expected learning outcomes: Students will receive an insight into the process of glycosylation of biomolecules as well as learn about the role of glycans in physiological and pathological processes.

Course objectives:

Over the past decade glycobiology has developed into the one of the most progressive and the most propulsive scientific disciplines. Glycosylation is essential for numerous physiological and pathophysiological processes, from embryonic development and intercellular recognition, to inflammatory processes and tumor metastasis. A recent information showed that only 0.7% of simple membrane proteins are not glycosylated or in complex with another glycoprotein. Unfortunately, despite the undoubted importance of glycosylation, as the most widespread and diverse post-translational modification, during undergraduate studies students learn very little about it at the Faculty of Science, Pharmacy and Biochemistry and the School of Medicine. This course is designed as a short recap of the basic mechanisms and roles of glycosylation in the normal organism, with emphasis on changes in glycosylation that occur in different diseases. The desire is to give students an insight into the latest findings and their application in diagnostics.

Objectives:

Lecture 1 and 2:

To get an insight into:

- glycoconjugates and their distribution in the body
- information capacity glycoconjugates, recognizing sugar-protein and sugar-sugar
- biosynthesis of glycoconjugates (N- and O-glycosylated proteins, glycolipids)

Lecture 3 and 4:

To learn about:

- key role of glycosylation during embryonic development
- physiologically normal differences in glycosylation (blood types, polymorphism of glycoforms)
- role of glycosylation in inflammatory processes (selectins, acute phase proteins, etc.).
- glycosylation of immunoglobulins and its importance in the development of disease (rheumatoid arthritis, allergy)

Lecture 5 and 6:

- diagnostic significance of glycosylation
- glycoconjugates as tumor markers
- the impact of glycosylation on the pharmacokinetics of recombinant drugs
- methods of analysis of glycosylation (HPAEC, HPLC, MS, lectins)

The newest insights about mentioned topics will also be discussed during seminars and the analytical methods will be covered by practical courses.

Students activities and evaluation of student work over the course of instruction

Beside attending lectures and practicals, students will prepare (write and orally present) seminars on the different topics from the field of glycobiology. These seminars will be evaluated.

Methods of monitoring quality that ensure acquisition of exit competences: The final

grade will be formed on the basis of seminar and oral exam.

Required literature:

Essentials of Glycobiology. 2nd edition.

Varki A, Cummings RD, Esko JD, et al., editors.

Cold Spring Harbor (NY): Cold Spring Harbor Laboratory Press; 2009.

This book has free online access at:

<http://www.ncbi.nlm.nih.gov/books/NBK1908/?term=essential%20of%20glycobiology>

Optional literature: Scientific papers in the field (students can get these in print or electronic version from lecturers)

Name of the course: MOLECULAR BASIS OF BEHAVIORAL DISORDERS

Course teacher Dubravka Hranilović, associate professor, University of Zagreb, Faculty of Science

Doctoral study: Biology

Research field associated with the course programme: neuroscience

Type of instructions: : lectures (4 hrs), seminars (4 hrs), laboratory work (7 hrs)

Credit value (ECTS): 6

Expected learning outcomes:

- to understand how molecular changes can lead to behavioral alterations
- to integrate animal model approach and population-based approach in studies of behavioral disorders
- to present the selected topic in a form of a short oral presentation
- to operate with basic molecular, statistical and behavioral methods in psychiatric genetics
- to interpret the obtained experimental results

Course objectives:

Lectures

1) Alterations in brain development and neural transmission as a basis for behavioral disorders

- electrical and chemical neurotransmission, structure and function of the synapse, disorder of the synapse at the level of synaptic proteins and their genes, development of nervous system and its alterations

2) Methods for studying genetics of complex disorders

- twin and adoption studies; association studies and linkage analysis; meta-analyses;

epigenetics; specificities of psychiatric genetics

3) The use of animal models in search for the molecular basis of behavioral disorders
- endophenotypes, behavioral testing, genotype-based approach (gene inactivation),
phenotype-based approach (QTL-analyses, directed breeding, random mutagenesis)

4) Search for the molecular basis of autism as an illustration of the mentioned approaches
- basic characteristics of the illness, psychological theories, structural and functional
anomalies of the brain, results of association and linkage studies, animal models of autism

Seminars

Within a scope of each theme, students will prepare and report on the latest discoveries,
controversies or dilemmas, based on the recent papers in the field.

Laboratory work

1) First step in genotypization: polymerase chain reaction

2) Second step in genotypization: restriction analysis and electrophoresis

3) Data analyses (chi-square tests for tendency and independence, transmission disequilibrium
test, power of the sample, corrections for multiple testing)

4) Behavioral testing (anxiety, exploratory behavior, social interaction, learning)

Students activities and evaluation of student work over the course of instruction

- students must prepare and present a seminar, engage in discussions, and perform practical
work in the lab

Methods of monitoring quality that ensure acquisition of exit competences:

- good quality of seminar, contribution to discussions following each seminar, and results of
practical work will demonstrate acquisition of exit competences

Required literature:

written material handed out before each lecture, including recent review papers in the field

Optional literature: Carlson N.R. Physiology of Behavior, 7th ed. Allyn and Bacon, Boston, 2001.

Name of the course: EXPERIMENTAL AND MOLECULAR NEUROPHARMACOLOGY

Course teacher:

Dubravka Svob Strac, PhD, Senior Research Associate, Laboratory for Molecular
Neuropharmacology, Division for Molecular Medicine, Ruder Boskovic Institute

Doctoral study: Biology

Research field associated with the course programme: Basic medical sciences:
Neuroscience

Type of instructions:

Lectures (4 hours), Practicals (5 hours), Seminars (6 hours)

Credit value (ECTS): 6

Expected learning outcomes:

The aim of the course is to explain to students, how by using different neuropsychotropic drugs, and by studying their effects and mechanisms of action, they can get valuable information about normal as well as disturbed brain neurotransmission. During the course different ways in which neuropsychotropic drugs can "repair" existing disturbances in the transmission of nerve signals will be explained. Moreover, selected experimental models and methodological approaches used in the study of neuropsychotropic drugs will be demonstrated. The examples how these medications can be used as a useful "tool" in neurobiological research will be presented.

Course objectives:

Lectures:

- Action of neuropsychotropic drugs used in the treatment of various neurotransmission disorders, which can lead to a variety of neurological and psychiatric diseases
- Different CNS levels and ways in which neuropsychotropic drugs can "repair" specific neurotransmission disorder, and how the application of neuropsychotropic drugs has enabled certain important discoveries in neurobiology (examples of selected diseases and drugs)
- How by using neuropsychotropic drugs in various experimental approaches in vitro and in vivo, numerous structural, morphological, functional, biochemical, molecular, developmental, and any other information on CNS could be obtained
- The use of pharmacological manipulation to cause and/or distinguish different behaviors
- Various pharmacological models of neuropsychiatric and neurodegenerative diseases (schizophrenia, depression, anxiety, addiction, Parkinson's and Alzheimer's disease, epilepsy, etc.), and their use in order to elucidate biochemical/molecular mechanisms associated with a specific behaviors, development and etiology of different disorders, as well as to test potential new drugs

Seminars:

Each student will present some of the latest scientific paper from this area

Practicals:

- work with selected cell models in neurobiology (culture of neurons, recombinant receptors), treatment of cells with drugs, monitoring changes following in vitro administration of drugs (e.g. morphology and cell proliferation, expression of messenger RNA and proteins, etc.)
- in vivo application of neuropsychotropic drugs and presentation of certain behavioral tests used to determine different drug effects (locomotor activity, rota-rod, Porsolt test, Marble test, etc.)
- radioligand binding method which by using radiolabeled drugs can obtain much information on neurotransmitter receptors (number, affinity, function, etc.) in the brain

Students activities and evaluation of student work over the course of instruction:

Regular class attendance, preparation and presentation of seminar work, practicals attendance, active participation in discussions

Methods of monitoring quality that ensure acquisition of exit competences:

Seminar work and oral exam

Required literature:

Working material which will be distributed to students before each lecture

Optional literature:

Lackovic Z. Neurotransmitori u zdravlju i bolesti. Medicinski fakultet Sveucilišta u Zagrebu, Zagreb, 1994.

Katzung BG. Temeljna i klinicka farmakologija. Medicinska naklada, Zagreb, 11. izdanje, 2011. (Katzung's - Basic and Clinical Pharmacology 12th edition (2012))

Selected review papers from the latest scientific literature

Name of the course: HUMAN CELL CULTIVATION TECHNIQUES IN DIAGNOSTICS OF CHROMOSOMAL AND GENETIC DISEASES

Course teacher

Feodora Stipoljev, B.Sc. Molecular Biology, Assist. Prof.

Department of Medical biology and Genetics

Faculty of Medicine, University of Osijek, Croatia

Doctoral study: Biology

Research field associated with the course programme:

biomedical sciences: biomedicine and healthcare

scientific field: basic medical sciences

branch: genomics and proteomics

Type of instructions:

lectures (5 hours)

practicals (5 hours)

seminars (5 hours)

Credit value (ECTS): 6

Expected learning outcomes: Aim of this course is to get introduce to students with the general principles and commonly used cultivation techniques of human cells for diagnostic purposes. Techniques of classical and molecular cytogenetics, and the recent information about of new progress in use of cultivation techniques in clinical praxis will be explained. This course is mainly planned as a practical work of students, where they will obtain basic skills of using techniques of prenatal and postnatal diagnosis in routine work. Students are engaged to critically analyze fundamental postulates of cytogenetics.

Course objectives:

Lectures:

Diagnostic possibilities of using different fetal cells in prenatal diagnosis (2P)

Postnatal diagnosis of chromosomal disorders: detection of microdeletion, and microduplication syndromes; the use of molecular cytogenetics in diagnostic protocols for infertility problems (2P)

Diagnostic cultivation techniques in multifetal pregnancies (1P)

Seminars:

Cultivation protocols for peripheral blood, amniotic fluid and spontaneous abortions (2S)
Preimplantation diagnostics and the isolation of fetal DNA from maternal blood (1S)

Preparation of seminar work: students will prepare seminar work on the requested theme and present as the oral power point presentation (2S)

Practicals:

Estimation of risk of having a child with chromosomal and genetic disease, types and mechanisms of inheritance (2V)

Introduction to the work of the cytogenetic laboratory , the techniques of cell cultivation, preparation of karyotype, and the interpretation of results (3V)

Students activities and evaluation of student work over the course of instruction

attendance to lectures, seminars, and practicals is prerequisite for the exam, active participation in practicals

Methods of monitoring quality that ensure acquisition of exit competences:

oral presentation of the requested seminar work

Required literature:

1. Michael Connor, Malcolm Ferguson-Smith. Essential medical genetics. Blackwell Science 2011 (6th edition).
2. R.J. McKinlay Gardner, Grant R. Sutherland. Chromosome abnormalities and genetic counseling. Oxford University Press 2011 (4th edition).

Optional literature:

O:J: Miller, E. Therman. Human chromosomes. Springer-Verlag New York 2001 (4th edition).

Name of the course: IMMUNOBIOLOGY OF STRESS**Course teacher**

Course coordinators: Katja Gotovac, PhD, research scientist, Genera, Zagreb; Anđelko Vidović, MD, PhD, research scientist, University Hospital Dubrava, Zagreb

Associates: Andrea Jambrošić- Sakoman, MD, University Hospital Dubrava, Zagreb; Ela Kosor Krnčić, PhD, Hospira, Zagreb; Krešo Bendelja, PhD, University of Zagreb

Doctoral study: Biology**Research field associated with the course programme:**

Field: basic medical sciences, Branch: immunology

Type of instructions:

lectures (6), seminars (5), practicals (2)

Credit value (ECTS): 6**Expected learning outcomes:**

Understanding the role of immune system in homeostasis maintenance through functional interactions with nervous and endocrine systems. Understanding stress-related neuroendocrine-immune interactions.

Course objectives:

Concepts of the immune system (danger and integrity models); Molecular aspects of stress (cellular stress, "heat shock" proteins, modulation of the immune response); Types of stressors (physical, psychosocial, acute, chronic) and stress response; Physiological mechanisms of the stress response: the effect of stress on the immune system (recirculation of immune cells, Th1/Th2 balance, effector functions – phagocytosis, cytotoxicity, humoral and cell-mediated immune responses to vaccination, platelet activation), the effect of stress on the autonomic nervous system (heart rate, blood pressure, skin conductance, respiratory rate, body temperature), the effect of stress on the central nervous system (sickness behavior, the role of cytokines); The concept of allostasis and allostatic load: reactivity of the stress response, pathological effects of stress (cardiovascular, autoimmune, malignant, and psychiatric diseases)

Students activities and evaluation of student work over the course of instruction

Attending lectures and active participation in seminars and practical courses.

Methods of monitoring quality that ensure acquisition of exit competences:

Multiple choice-test

Required literature:

M. Boranić i sur.: Psihoneuroimunologija, Školska knjiga, Zagreb, 2007.

Optional literature:

Psychoneuroimmunology, Volume 1 and 2. Ader R, Felten DL, Cohen N (eds) Third Edition, Academic Press 2001.

Sabioncello A, Gotovac K, Vidović A, Gagro A, Markotić A, Rabatić S, Dekaris D: The immune system under stress. Period biol 106:317-323, 2004.

Other selected most recent reviews.

Name of the course: ECOLOGY AND TAXONOMY OF MARINE PHYTOPLANKTON

Course teacher:

Zrinka Ljubešić, PhD, Associate Professor, University of Zagreb, Faculty of Science

Doctoral study: Biology

Research field associated with the course programme: Biology, Ecology

Type of instructions:

Lectures, seminars, exercise I SATI NASTAVE: (7+8+0)

Credit value (ECTS):**Expected learning outcomes:**

1. Associate the structure of organisms, their evolutionary course of development, and the systematic affiliation with their physiological functions and the flow of energy in the sea.
2. Apply scientific methods according to the set hypotheses and conceived experimental design for resolving problems in oceanography
3. Analyze the position and role of phytoplankton in the biosphere and their role in processes of cycling of biogenic elements.
4. Use various devices, measurement instruments and optical aids in research methods in biology when planning and implementing routine analyses, experiments, research and projects.

Course objectives:

Biology, anatomy and taxonomy of phytoplankton.

Methods and tools in taxonomy.

Phytoplankton community structure, spatial and temporal distribution of phytoplankton.

Methods in the field work, planning and setting up hypotheses.

The role of phytoplankton in trophic, regeneration and biogeochemical interactions in the

<p>environment. The role of phytoplankton in production of organic matter, microbiological loop.</p> <p>Abundance, biomass, primary production.</p> <p>Analytical methods and ecological interpretation. Graphical and statistical tools in data management.</p> <p>Environmental parameters (physical, chemical and biological) controlling phytoplankton ecology and taxonomy phytoplankton.</p> <p>Phytoplankton and eutrophication</p> <p>Case studies</p>
<p>Students activities and evaluation of student work over the course of instruction:</p> <p>Actively involved in lectures and seminars, homework, practical exercise.</p>
<p>Methods of monitoring quality that ensure acquisition of exit competences:</p> <p>oral exam, written report</p>
<p>Required literature:</p> <p>Kirchman, D.L., 2000: Microbial ecology of the oceans. Wiley-Liss, New York.</p> <p>Livingston, R.J., 2001: Eutrophication processes in coastal systems. Origin and succession of plankton.</p> <p>Viličić, D. 2014: Ecology and composition of phytoplankton in the Adriatic Sea., Koeltz Scientific Books, Koenigstein, Germany.</p>
<p>Optional literature:</p> <p>Recent scientific papers</p>

<p>Name of the course: BIOLOGICAL CLASSIFICATION OF FRESHWATERS, DISTRIBUTION AND FUNCTIONAL ORGANIZATION OF COMMUNITIES</p>
<p>Course teacher: Biserka Primc, PhD, Full Professor; Ines Radanović, PhD, Associate Professor; Renata Matoničkin Kepčija, PhD, Associate Professor, Maria Špoljar, PhD, Associate Professor</p> <p>Faculty of Science, University of Zagreb</p>
<p>Doctoral study: Biology</p>
<p>Research field associated with the course programme: Biology, Ecology</p>
<p>Type of instructions: Seminar and practicum (5+10)</p>
<p>Credit value (ECTS): 6</p>

Expected learning outcomes:

Acquiring knowledge on freshwater communities, their diversity, ecology and functional organization. Applying methods for determination of functional feeding structure and their horizontal and vertical changes in lotic and lentic freshwaters.

Course objectives: Geological, hydrological and climatic parameters in evolution of biodiversity in the aquatic ecosystems. The origin of freshwater animals. Number of species in European limnofauna. Permanent and temporal fauna of freshwaters. Primary, secondary and tertiary ecological parameters influencing spatial distribution and seasonal fluctuations in qualitative and quantitative composition of the aquatic communities. The complexity of functional organization of communities and ecological determination of their spatial and temporal changes in longitudinal profile of running and stagnant waters. The gradient of spatial changes of physical, chemical and biocenological parameters in running and stagnant waters. Alochtonous and autochtonous food resources. Functional feeding groups of primary consumers; herbivorous and detritivorous in running waters: shredders, scrapers and collectors; in stagnant waters: detritivores, bacterivores, filterers of different size fractions of nanophytoplankton and net phytoplankton. Predators. Predation pressure as an ecological determination of community composition.

Students activities and evaluation of student work over the course of instruction

Students are expected to attend instructions. They will be given questions and problems which they are expected to solve and submit in written form prior to exam. During the practical work, students will be given different samples for the analysis, upon which they will be expected to discuss the results.

Methods of monitoring quality that ensure acquisition of exit competences:

Final evaluation will be a combination of student achievements during the course, their results and final exam.

Required literature:

Dodds, W. K., 2002: Freshwater Ecology. Concepts and Environmental Applications. Academic Press, San Diego.

Hauer, F. R., Lamberti, G. A. 2006: Methods in Stream Ecology, Academic Press, San Diego.

Kalff, J., 2002: Limnoecology. Inland Water Ecosystems. Prentice Hall, New Jersey.

Lampert, W., Sommer, U., 2007: Limnology: The Ecology of Lakes and Streams. Oxford

Optional literature:

Recent scientific articles (depending on seminar themes)

Name of the course: ALGAE IN BIOLOGICAL VALORISATION OF FRESHWATER ECOSYSTEMS

Course teacher:

Prof. Anđelka Plenković-Moraj, PhD

University of Zagreb, Faculty of Science, Department of Biology

Doctoral study: Biology

Research field associated with the course programme

Ecology and taxonomy of phytoplankton, phytobenthos, and periphyton communities in freshwater ecosystems

Type of instructions:

Lectures 10 hours, Seminar work 5 hours

Lectures

1. Preparation and organization of fieldwork and laboratory analyzes for the purpose of research of algae in lotic and lentic biotopes - 2 hours
2. Trophic categories and their role in food webs, energy flow and cycling of matter, composition, abundance, biomass, distribution and biocenotic diversity - 4 hours
3. The implementation of Croatian indicator system (HRIS)/practical application of HRIS, the Water Framework Directive - 4 hours

Seminars:

1. Introduction and work with measuring instruments used in limnological surveys, sampling methods and procedures for laboratory processing of the material - 4 hours
2. Application of software for results analysis (Grapher, Surfer, Primer, PC-ORD, Statistica, and similar) - 2 hours
3. Setting problem task, processing of samples, statistical analysis, interpretation of results - 2 hours

Credit value (ECTS): 6

Expected learning outcomes:

- (i) development of new practical skills that represent the foundation for a successful upgrade in future research,
- (ii) understanding and practical application of intraspecific and interspecies interrelationships of algae and other organisms in different types of freshwaters and understanding of biogeochemical processes at all higher trophic levels
- (iii) gaining experience in independent reasoning in the field of ecology,
- (iv) advancement of scientific thinking and critical appraisal,
- (v) follow modern concepts in biology in general, awareness about the diversity and variability of organisms.
- (vi) obtaining a broader picture of the structure and dynamics of algae as a response to environmental conditions in aquatic ecosystems
- (vii) the independence in the laboratory, experience in planning and execution of research with experience in interaction in scientifically complex environment

Course objectives:

Scientific, research and professional education of highly educated students for their independent mastery: the modern principles of taxonomic classification and identification of freshwater algae, understanding and interpretation of the spatial and temporal distribution, the importance of the algae in the ecosystems and human life. Active preparation and active participation for lectures and practical as well as independent work, students will master the practical knowledge. To develop the student's ability to set up, understand and creatively solve problem tasks, principles and theories, identifying and applicability of measurement principles in practice, independence and creativity in practical and generic skills related to the

field of work. Gaining experience in the planning, setting up and performing laboratory experiments, data processing and statistical analysis of the results and the interpretation thereof. The aim of the course is to provide a broad training in identification and ecology of all freshwater algal groups, with the emphasis on more common algae and those used for monitoring. Related topics, such as practical techniques, aspects of monitoring and implications of the EC Water Framework Directive, will be introduced into the course. This course will also address the needs of aquaculturists, fishery biologists, research students, conservationists, contract agency staff and others with an interest in identifying freshwater and terrestrial algae.

Students activities and evaluation of student work over the course

Minute papers, Problem sets, , Cooperative exams, Written and oral assignments

Required literature:

1. Lampert W., Sommer U., 2007: Limnoecology - The Ecology of Lakes and Streams (2nd Edition). Oxford University Press.
2. Gupta RK & Pandey VD.2007: Advances in Applied Phycology, Daya Publish house.
3. Ognjanova-Rumenova N & Manoylov K, 2006: Advances in Phycological Studies, Pensoft Publishers, St. Kliment Ohridski University Press, Sofia.Moscow

Optional literature:

Significantly depends on students' doctoral thesis topic. Available (Central Biological Library) biology books of Environmental Sciences as well as selected science papers in field of algology.

4. Barry J. F. Biggs & Cathy Kilroy2000. Stream Periphyton - Monitoring Manual, NIWA, Christchurch, Christchurch, New Zealand
5. Wetzel R. G., 2001. Limnology – lake and river ecosystems (3rd Edition). Academic Press. A Harcourt Science and Technology Company. London

Name of the course: INVASIVE SPECIES OF FRESHWATER INVERTEBRATES**AUTHORS OF COURSE PROGRAMME:**

Assistant Professor, Jasna Lajtner, PhD, Division of Biology, Faculty of Science, University of Zagreb

Associate Professor, Ivana Maguire, PhD, Division of Biology, Faculty of Science, University of Zagreb

FIELD:

Biology, Ecology, Zoology

TEACHING TECHNIQUES:

Lectures: 0

Exercises: 10

Seminar: 5

COURSE AIMS:

Aim of the course is to enable students to gain knowledge on freshwater invasive invertebrates as well as get acquainted with invasive species ecological and socio-economic impacts.

Through conducting a small assignment students will learn how to plan and perform a project independently, and afterwards will present results and conclusions of the research to other attendees of the course through seminar/workshop.

COURSE PROGRAMME:

Autochthonous species, allochthonous species, invasive species, cryptic species. Historical overview. Spreading vectors. Ecological impacts. Socio-economic impacts. Invasive species of molluscs. Invasive species of freshwater crayfish. Invasive species of other invertebrates. The invasive species control and management methods. Law regulations.

STUDENTS' ACTIVITIES AND THEIR EVALUATION:

Regular attending, conducting a small assignment and writing a seminar.

Students will be evaluated on the base of mean value of grades of written exam, seminar and project assignment. Oral exam would be carried out if candidates would like to improve their final grade.

OBLIGATORY LITERATURE:

- Leppäkoski, E., Gollasch S., Olenin, S. (2003): Invasive aquatic species of Europe. Distribution, impacts and management. Kluwer Academic Publishers. Dordrecht, 583 str.

SUPPLEMENTARY LITERATURE:

- Lockwood, J., Hoopes, M., Marchetti, M. (2006): Invasion Ecology. Blackwell Publishing Limited, London. 304 str.
- [Mooney](#), H. A., [Mack](#) R. N., [McNeely](#), J. A. [Neville](#), L. E., [Schei](#), P. J., [Waage](#), J. K., (2005): Invasive Alien Species: A New Synthesis. Island Press, Washington D.C., 368 str.
- [Ruiz](#), G. M., [Carlton](#), J. (2005): Invasive Species: Vectors And Management Strategies. Island Press. Washington D.C., 484 str.
- [Sax](#), D.F., [Stachowicz](#), J.J., [Gaines](#) S.D. (2005): Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates Inc. Sunderland, 495 str.
- Elton, C. (2000): The Ecology of Invasions by Animals and Plants. University of

Chicago Press, Chicago, 196 str.

- [Mooney](#), H., [Richard J. Hobbs](#), R. J. (2000): Invasive Species in a Changing World. Island Press. Washington D.C., 384 str.
- Internet pages:
 - <http://www.issg.org/>
 - <http://nas.er.usgs.gov/>
 - <http://www.zin.ru/rbic/>
 - <http://www.daisie.ceh.ac.uk/>

Name of the course: BIOLOGICAL WASTEWATER TREATMENT

Course teacher:

Assoc. Prof. Dr. Jasna Hrenović, University of Zagreb
Faculty of Science

Doctoral study: Biology

Research field associated with the course programme: microbiology

Type of instructions:

Lecture and seminar (5+10)

Credit value (ECTS): 7

Expected learning outcomes: have insight into the existence of different kinds of wastewater and the need for their treatment; identify wastewater that can be biologically treated; recognize the role of microorganisms in the wastewater treatment; handle the important factors that could disrupt the process of biological wastewater treatment.

Course objectives: Types of biological wastewater treatment. The causes of the fall of the effectiveness of biological wastewater treatment. Removal of nutrients in biological wastewater treatment plants. Bioaugmentation.

Students activities and evaluation of student work over the course of instruction:

Attending lectures and seminar work.

Methods of monitoring quality that ensure acquisition of exit competences: Rating of the seminar and oral exam.

Required literature: (*navesti detaljne podatke o izdavaču i godini izdanja, voditi računa o tome da obavezna literatura mora biti dostupna studentima i što je moguće novijeg datuma*): Henze M., van Loosdrecht M.C.M., Ekama G.A., Brdjanovic D. (2008): Biological wastewater treatment. IWA Publishing, London.
Tedeschi S. (1997): Zaštita voda. HDGI, Zagreb.

Optional literature:

Articles from professional and scientific journals.

Bitton G. (2005): Wastewater microbiology. John Wiley & Sons, Inc., New Jersey.

Ramadori R. (1987): Biological phosphate removal from wastewaters. Pergamon Press, Oxford.

Seviour R, Nielsen P.H. (2010): Microbial ecology of activated sludge. IWA Publishing, London.

Wong T.W. (2009): Handbook of Zeolites: Structure, Properties and Applications. Nova Science Publishers, Inc, Hauppauge NY, SAD.

Name of the course: ECOLOGICAL MODELLING
Course teacher: Prof. dr. sc. Tarzan Legović, R. Bošković Institute
Doctoral study: Biology
Research field associated with the course programme: biology, ecology.
Type of instructions: Lectures, 8; Exercises, 7
Credit value (ECTS): 6
Expected learning outcomes: By completing the course, students will understand how ecological models are created and why are they used.
Course objectives: Dynamics of an isolated population in peaceful, periodic and stochastic environment. Malthus and Verhulst laws. Proportional harvesting and quota. Maximum sustainable yield. Occurrence and control of chaos in population dynamics. Prey-predator systems. Principle of Volterra. Food chains. Cycling of matter. Selected food webs. Consequences of harvesting and eutrophication. Population invasion into space. Elements of population control. Applications.
Students activities and evaluation of student work over the course of instruction: Attendance to lectures is obligatory as well as timely submission of homework problems. Solutions to homework problems are evaluated.
Methods of monitoring quality that ensure acquisition of exit competences: Attendance to lectures is monitored as well as solution to homework problems. Exam is written and oral.
Required literature: Sharov A. Quantitative population ecology, Chapters: 1, 5 to 13. http://home.comcast.net/~sharov/PopEcol/ (Accessed: 25.02.2015). Edelstein-Keshet, L., Mathematical Models in Biology, SIAM, 2005.
Optional literature: Kott, M., Elements of Mathematical Ecology, Cambridge Univ. Press, 2001. Murray J. D., Mathematical Biology, Springer, 2004.

Name of the course: ANTHROPOLOGY - HUMAN BIOLOGICAL VARIATION**INSTRUCTORS:**

Professor Nina Smolej Narančić Professor Tatjana Škarić-Jurić, Natalija Novokmet, Ph.D., Assistant professor Saša Missoni, Matea Zajc Petranović, PhD, Scientific Associate

DOCTORAL STUDY: Biology**MAIN SCIENTIFIC FIELD AND SUB-FIELD:** Anthropology, Biological Anthropology**COURSE FORMAT:** lectures - 4 hours; seminars - 11 hours**ECTS POINTS:** 6

COURSE DESCRIPTION: The course reviews anthropological approaches to the study of human biological variation. Emphasis is placed on understanding the principles of research into genetic and environmental origins of human phenotypic variation throughout the life cycle. Selected research examples typical for complex phenotypes' analyses are highlighted which gives students an overview of analytical techniques that are most appropriate for analyses of complex biological traits. Dilemmas in interpretation of novel scientific anthropological information and the need for holistic analytical approach as the most successful in contemporary anthropology are discussed.

COURSE CONTENT:

1. Biological anthropology.

Holistic analytical approach in anthropology; the aim of contemporary study of biological variation among human populations: possibilities and limitations.

2. Growth and development.

Evolution of human life cycle; principles of human growth; stages in the life cycle; growth and development variation in living human populations; population differences in rate of growth; differences in growth between boys and girls; population variation in skeletal, dental, and sexual maturation.

3. Human Aging.

Aging theories; aging and evolution; aging as the consequence of natural selection; life expectancy and demographic structure of populations; difference between biological and chronological age; genetic basis of aging; lifestyle and aging; definition of health and disease; aging or disease; definition and selection of phenotype in genetic research.

4. Biocultural interactions in contemporary populations.

Biological and biocultural traits and their inter-population diversity; genetic, environmental and cultural interactions in population differences; body proportions, adaptive value of body size and secular trends in human populations.

5. Environmental factors influencing human phenotypic variation.

Human adaptation, plasticity and variation: adaptability – biological and behavioral adaptations; acclimatization; nutrition, altitude, climate, migration and urbanization;

socio-economic status; men-environment interaction.

6. Human genetic variability.

Quantitative vs. qualitative traits; quantitative phenotype variability; 'ecolabile' and 'ecostabile' traits; evolutionary aspect of human quantitative variation; genetic determination of quantitative (complex) phenotypes; population studies (isolates, population stratification), family studies; gene-environment correlation and interaction; epistasis and pleiotropy.

STUDENT'S OBLIGATIONS

Attendance at lectures and active participation at seminars, preparation of a seminar in-class report at the assigned topic

EXAMINATION

Class presentation of the seminar report, oral exam

REQUIRED TEXTS

1. Relethford, J. (2006) *The Human Species – An Introduction to Biological Anthropology*. Mayfield Publ. Comp., Mountain View, California.
2. Rudan, P. (2004) *Human Population Biology (Introduction to Anthropology)*, supplementary material to the lectures, Croatian Anthropological Society – internal edition, Zagreb.
3. Bogin, B. (1999) *Patterns of Human Growth*. Cambridge University Press, Cambridge, UK
4. Hartl, D.L. (2000) *A Primer of Population Genetics*. Sinauer Associates Inc., Sunderland, Massachusetts.
5. Frisancho, R.F. (2007) *Human adaptation and Accomodation*. The University of Michigan Press, Ann Arbor, USA.

SUPPLEMENTARY TEXTS

1. Selected scientific articles related to the topics of interest
2. Selected book chapters

Name of the course: ORGANIZATION, FUNCTION AND MECHANISMS OF PLANT GENOME EVOLUTION

Course teacher

Prof.dr.sc. Višnja Besendorfer

Doctoral study: Biology

Research field associated with the course programme: Molecular Genetics, Evolution, Plant Sciences

Type of instructions:

Lectures: 2 h

Practicals: 8 h

Seminars: 5 h

Credit value (ECTS):

Expected learning outcomes:

Understanding the principles of speciation at molecular and cytogenetic level.

Learn how to utilize modern molecular and cytogenetic techniques in the study of plant genome evolution and speciation.

Course objectives:

Processes of speciation and adaptation are accompanied with considerable restructuring of plant genomes which can be studied through the changes in structure and function of the genome at the level of DNA sequences and chromosome behaviour. Structural chromosome aberrations (deletions, duplications, translocations, inversions) and changes in chromosome number (aneuploidy, polyploidy) are involved in the speciation, while changes in DNA sequence structure could be connected with processes of adaptation. Ribosomal RNA (rRNA) genes and repetitive DNA (satellite DNA, transposable elements) represent regions on chromosome with high potential for structural rearrangements. Comparative analysis at molecular and cytogenetic level enable monitoring of genome changes that associate with speciation. Processes like homologous recombination and transposon-mediated sequence transposition could lead to dramatic qualitative and quantitative differences in distribution and organization of various DNA sequences in the genome. Therefore, study of position, structure and activity of different genome sequences could give an overview on evolutionary processes that are going on at inter- and intraspecies level. The goal of this course is to introduce to the students a new research approaches in the field of biosystematics.

1. Organization of plant genome at chromosome and molecular level – structural chromosome aberrations and changes in chromosome
2. Structure and organization of repetitive DNA (rDNA, satellite DNA, transposon elements)
3. Practical: isolation and cloning of repetitive DNA, sequence analysis, hybridization, fluorescent in situ hybridization, bioinformatics sequence analysis.

Students activities and evaluation of student work over the course of instruction:

The students will be actively involved in the course through writing and oral presentation of research in the field based on the recent scientific papers and practical work.

Methods of monitoring quality that ensure acquisition of exit competences:

Seminar presentation – written and oral

Required literature:

Levine DA (2002) The role of chromosomal change in plant evolution. Oxford Series in Ecology and Evolution. Oxford University Press, Oxford

Leitch IJ 2012. Plant genome diversity. Vol. 1. Springer

Leitch IJ 2012. Plant genome diversity. Vol. 2. Springer

Optional literature:

Schwarzacher T, Heslop-Harrison JS. (2000). Practical in situ hybridization. Oxford Bios, Oxford
Relevantni znanstveni članci.

Name of the course: MOLECULAR BASIS OF GENE THERAPY

Course teacher: Andreja Ambriović Ristov, PhD, Senior Scientist, Ruđer Bošković Institute; Dragomira Majhen, PhD, Research Associate, Ruđer Bošković Institute

Doctoral study: Biology

Research field associated with the course programme: Natural Sciences, Biology

Type of instructions: : 10 hours lectures, 5 hours seminars

Credit value (ECTS): 7

Expected learning outcomes:

Students will learn types of diseases that might be treatable by gene therapy, the basic principals of genetic manipulation using viral and nonviral vectors and its associated risks and challenges.

Course objectives:

1. Introduce students to the molecular biology and life cycles of different types of viruses which are used as vectors in gene therapy.
2. Introducing students to the construction of viral vectors, their advantages and disadvantages in gene therapy. Introduction to non-viral methods of gene transfer, their advantages and disadvantages in gene therapy application.
3. Introduction to gene therapy target diseases and short overview of clinical trials results.

Course content:

Lectures:

Introduction: Principles of gene therapy. (2 hours)

Molecular biology of retroviruses, principles of vector construction. (2 hours)

Molecular biology adenoviruses, principles of vector construction. (2 hours)

Molecular Biology of adeno - associated and herpes viruses, principles of vector construction. (1 hour)

<p>Principles vector vaccination. (1 hour)</p> <p>Principles of tumor gene therapy. (1 hour)</p> <p>Non-viral gene transfer. (1 hour)</p> <p><u>Seminars:</u></p> <p>Gene therapy clinical trials using retrovirus, adenovirus and adeno-associated viruses, as well as non-viral gene transfer. Ethics in gene therapy. (5 hours)</p>
<p>Students activities and evaluation of student work over the course of instruction</p> <p>Attending the course, preparing seminar on selected topic.</p>
<p>Methods of monitoring quality that ensure acquisition of exit competences:</p> <p>Oral exam</p>
<p>Required literature:</p> <p>Majhen D., Ambriović-Ristov A.: Adenoviral vectors - how to use them in cancer gene therapy. <i>Virus Research</i>, 119: 121-133, 2006.</p> <p>Majhen D., Calderon H., Chandra N., Fajardo C.A., Rajan A., Alemany R., Custers J.: Adenovirus-based vaccines for fighting infectious diseases and cancer: progress in the field. <i>Human Gene Therapy</i>, 25(4):301-17, 2014.</p> <p>Wirth T, Ylä-Herttuala S.: "Gene Therapy Used in Cancer Treatment." <i>Biomedicines</i> 2, no. 2: 149-162, 2014.</p> <p>Ambriović Ristov A. Brozović A., Bruvo Mađarić B., Četković H., Herak Bosnar M., Hranilović D., Katušić Hećimović S., Meštrović Radan N., Mihaljević S., Slade N., Vujaklija D (ur.): <i>Metode u molekularnoj biologiji</i>. Institut Ruđer Bošković, 2007.</p> <p>Schultz B.R., Chamberlain J.S.: Recombinant Adeno-associated Virus Transduction and Integration, <i>Molecular Therapy</i>, 16(7): 1189–1199, 2008.</p> <p>Kotterman M.A., Schaffer D.V.: Engineering adeno-associated viruses for clinical gene therapy. <i>Nature Reviews Genetics</i>.15(7):445-51, 2014.</p> <p>Yi Y., Noh M.J., Lee K.H.: Current Advances in Retroviral Gene Therapy, <i>Current Gene Therapy</i>, 11: 218-228, 2011.</p> <p>Emeagi P.U., Goyvaerts C., Maenhout S., Pen J., Thielemans K., Breckpot K.: Lentiviral vectors: a versatile tool to fight cancer. <i>Current Molecular Medicine</i>. 13(4):602-25, 2013.</p> <p>Pichon C., Billiet L., Midoux P.: Chemical vectors for gene delivery: uptake and intracellular Trafficking, <i>Current Opinion in Biotechnology</i>, 21:640–645, 2010.</p>
<p>Optional literature:</p> <p>Selection from the latest scientific publications regarding gene therapy field.</p>

Name of the course: MOLECULAR DIAGNOSTICS OF NEOPLASMS

Course teacher Petra Korać, assistant professor, University of Zagreb, Faculty of Science

Doctoral study: Biology

Research field associated with the course programme: biomedicine, tumor biology, molecular pathology

Type of instructions:

lectures (5 hrs), seminars (5 hrs), practicals (5 hrs)

Credit value (ECTS): 6

Expected learning outcomes:

- 1) Explain mechanisms of neoplasm development
- 2) Use methods that are the most reliable for detection of certain aberrations based on the understanding of disease mechanism
- 3) Discuss ethical issues in specific biomedical fields

Course objectives:

Objectives:

- 1) to teach molecular basis of disease development and connect it with terms „diagnostic test“, „biomarker“ and „disease classification“
- 2) to explain concepts of molecular pathology studies and application of their results in diagnostics
- 3) to explain laboratory methods used in everyday practice as a part of diagnostics, prognostics and therapy

Lectures

- 1) General mechanisms of neoplasm development with emphasis on haematological malignancies:
 - genetic and epigenetic aberrations in tumor development, B-cell lymphoma development, lymphoma classification, translational research (2 hrs lectures)
- 2) Methods in biomedicine:
 - FISH, FICTION, immunohistochemistry, PCR, qRT-PCR, methylation status evaluation, RFLP (1 hr lecture)
- 3) Concept of neoplasm development research:
 - detailed classification based on aberrations in tumour cell genomes/detecting key aberration that is responsible for transformation, biomarker analysis, use of results from basic research in

diagnostics (1 hr lecture)

4) Impact of Human Genome Project on diagnostics, ethical considerations, possibility for developing new, earlier diagnostic tests (1 hr lecture)

Seminars:

Each student prepares a seminar about selected topic from the routinely used diagnostic methods based on disease development mechanisms. (5 hrs)

Practicals

After the lectures all student participate in solving cases making their own protocols for diagnostic procedures, selecting methods and analysing results that are prepared from practice. (5 hrs)

Students activities and evaluation of student work over the course of instruction

attending lectures, preparing seminars, solving cases from everyday practice, oral exam

Methods of monitoring quality that ensure acquisition of exit competences:

seminars, oral exam

Required literature:

material given during lectures

Optional literature:

Swerdlow S.H., Campo E., Harris N.L., Jaffe E.S, Pileri S.A., Stein H., Thiele J , Vardima J.w. (Eds.), WHO Classification of Tumours of Haematopoietic and Lymphoid Tissues, IARC: Lyon, 2008.

Küppers Ralf. Mechanism of B-cell Lymphoma Pathogenesis. Nature Rev. Cancer. 2005: 5:251-262.

van Dongen JJ, Langerak AW, Brüggemann M, Evans PA, Hummel M, Lavender FL, Delabesse E, Davi F, Schuurin E, García-Sanz R, van Krieken JH, Droese J, González D, Bastard C, White HE, Spaargaren M, González M, Parreira A, Smith JL, Morgan GJ, Kneba M, Macintyre EA. Design and standardization of PCR primers and protocols for detection of clonal immunoglobulin and T-cell receptor gene recombinations in suspect lymphoproliferations: report of the BIOMED-2 Concerted Action BMH4-CT98-3936. Leukemia. 2003;17(12):2257-317.

Hans CP, Weisenburger DD, Greiner TC, Gascoyne RD, Delabie J, Ott G, Müller-Hermelink HK, Campo E, Braziel RM, Jaffe ES, Pan Z, Farinha P, Smith LM, Falini B, Banham

AH, Rosenwald A, Staudt LM, Connors JM, Armitage JO, Chan WC. Confirmation of the molecular classification of diffuse large B-cell lymphoma by immunohistochemistry using a tissue microarray. *Blood*. 2004 Jan 1;103(1):275-82.

Horn H, Ziepert M, Becher C, Barth TF, Bernd HW, Feller AC, Klapper W, Hummel M, Stein H, Hansmann ML, Schmelter C, Möller P, Cogliatti S, Pfreundschuh M, Schmitz N, Trümper L, Siebert R, Loeffler M, Rosenwald A, Ott G; German High-Grade Non-Hodgkin Lymphoma Study Group. MYC status in concert with BCL2 and BCL6 expression predicts outcome in diffuse large B-cell lymphoma. *Blood*. 2013;121(12):2253-63.

Enjuanes A, Albero R, Clot G, Navarro A, Beà S, Pinyol M, Martín-Subero JI, Klapper W, Staudt LM, Jaffe ES, Rimsza L, Braziel RM, Delabie J, Cook JR, Tubbs RR, Gascoyne R, Connors JM, Weisenburger DD, Greiner TC, Chan WC, López-Guillermo A, Rosenwald A, Ott G, Campo E, Jares P. Genome-wide methylation analyses identify a subset of mantle cell lymphoma with a high number of methylated CpGs and aggressive clinicopathological features. *Int J Cancer*. 2013 Jun 10. doi: 10.1002/ijc.28321.