UNIVERSITY OF L'AQUILA

Department of Health, Life and Environmental Sciences

2nd Cycle Degree in ENVIRONMENTAL BIOLOGY

Laurea Magistrale in BIOLOGIA AMBIENTALE

Course Catalogue

Academic year starts the last week of September and ends the first week of June.
1st Semester - *Starting date:* last week of September, *end date*: 3rd week of January
2nd Semester - *Starting date:* last week of February, *end date:* 1st week of June
Exams Sessions: I) from last week of January to 3rd week of February, II) from 2nd week of June to end of July, III) from 1st to 3rd week of September

Comprehensive Scheme of the 2nd Cycle Degree in ENVIRONMENTAL BIOLOGY				
YEAR	**CODE**	**COURSE**	**Credits (ECTS)**	**Semester**
I	F1064	Analysis of Biodiversity and Statistical Inference	9	1
	F0259	Environmental Chemistry	6	1
	F1163	Environmental Physics and Predictive Modeling and Climate Change	12	1
	F1050	GIS and Land Planning	6	2
	F0258	Aerobiology	6	2
	F0259	Analysis of experimental data in Biology	6	2
	F1067	Experimental Course of Biodiversity Assessment with Field and Laboratory Activities	6	2
	F1070	*Work Placement*	3	1 and 2
II	F1071	Evolutionary Biology	6	1
	F1076	Conservation Biology and Biometry	6	1
	F1072	Microorganisms and Ecosystem Functioning	6	1
	F0319	Freshwater Ecology	9	2
I or II	F2F05S	*Other activities/courses*	3	1 and/or 2
	F1124	*Free choice courses*	6	1 and/or 2
II	F0103	*Thesis*	30	2
Second year for international track				
II	F1071	Evolutionary Biology	6	1
	F1076	Conservation Biology and Biometry	6	1
	F1072	Microorganisms and Ecosystem Functioning	6	1
		Stage and bibliographic report (co-tutored)	12	2
	F1124	*Free choice courses*	6	1 and/or 2
	F0103	*Experimental Thesis (co-tutored)*	30	2

Programme of "ANALISI DELLA BIODIVERSITA' E INFERENZA STATISTICA"

"ANALYSIS OF BIODIVERSITY AND STATISTICAL INFERENCE"

This course is composed of two Modules: 1) Analysis of Biodiversity, 2) Statistical Inference

F1064, compulsory

2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 1st Year, 1st Semester

Number of ECTS credits: 9 (total workload is 225 hours; 1 credit = 25 hours)

1) ANALYSIS OF BIODIVERSITY (5 ECTS)

Teacher: Paola LOMBARDO

1	Course objectives	The course main objectives are to provide a quantitative basic framework for the study and/or interpretation of environmental data at professional or post-graduate level. A primary if "indirect" objective of the course is to instill in students the ability of independent thinking on ecological and non-ecological topics, fostering constructive criticism and knowledge-based decision making as professionals and persons. The course emphasizes conceptual issues and the critical discussion of statistics-based ecological data from the published literature. Actual computation is minimal. As much of the material presented and discussed in class is in its original English version, at least some knowledge of written scientific English is required. Lectures may be partly or entirely in English, depending on the presence of international exchange students.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - types of environmental studies, their design and the importance of the experimental control; - the concepts of bio/ecological hypotheses *vs.* statistical null hypotheses (H_0) and the meaning of *p* resulting from statistical procedures to test both; - the main types of experimental/monitoring designs with emphasis on statistical inference based on (parametric) correlation/regression; - modern definition of biodiversity: (species) richness and evenness; - pros and cons of selected diversity indices; - backward (Coleman curves) and forward richness estimators (Chao2 algorithm); - biodiversity-based ecological concepts such as the effect of generalist predators on the prey community and the intermediate disturbance hypothesis. The course is organized into three main parts: 1. An *overview of statistical concepts* is provided, with an emphasis on data collection methods, mensurative *vs.* manipulative experimental/sampling designs, the importance of the experimental control, basic descriptive statistics, a detailed analysis of the simplest test formulas (χ^2, *t*-test) to understand how statistics works mathematically, the meaning and importance of the null hypothesis (H_0) and the *p* value, and the main types of experimental/ monitoring designs. 2. The *statistical techniques* of correlation and regression are described in some detail, with many examples drawn from the scientific literature. Emphasis is on the interpretation of the results for simple, linear and nonlinear correlations and regressions. Multiple and nonparametric regression also are briefly introduced. 3. Modern *definitions of biodiversity* and its main components (richness and evenness or diversity *sensu strictu*) are described and discussed. The pros and cons of selected diversity indices are discussed in detail. Backward (Coleman curves) and forward richness estimators (Chao2 algorithm) are described. Diversity-based ecological concepts such as the effect of generalist predators on the prey community and the intermediate disturbance hypothesis are illustrated with examples from the scientific literature. On successful completion of this module, the student should o have profound knowledge of how statistics assists in the interpretation of environmental data; how to express bio/ecological hypotheses and statistical hypotheses scientifically; how biodiversity is quantified, interpreted, and monitored, o have knowledge and understanding of how statistical techniques "work" in general; how ecology can be studied quantitatively and provide a solid basis for environmental studies in general; how environmental indices work; how to design a successful

		experimental or monitoring project, o understand and explain how statistical hypotheses are constructed, tested, and interpreted; the concept of statistical probability (*p*); how and why biodiversity can be studied quantitatively, o understand the pros and cons of a quantitative approach to ecology and environmental biology; understand the nuances of what is meant by "biodiversity", o demonstrate skill in quantitative ecology and an ability to read, critically interpret, and convey information on quantitative results from an experimental project or a monitoring survey, o demonstrate a critical capacity for reading, understanding, and information processing on ecological and other scientific or quantitative material, o apply a quantitative, statistics-based approach to the design and/or data interpretation of environmental projects, o - analyze and evaluate the design, results, and interpretation of other people's projects (including technical reports and published scientific work).
3	Prerequisites and learning activities	Though there are no formal prerequisites for the course, students must have a basic understanding of calculus and must be sufficiently proficient in English to read and interpret the many scientific articles that are discussed in class. The course is taught with the objective of increasing student marketability and competitiveness in the work force in environmental-based professions (environmental consultants, environmental project managers at public or private institutions; environmental surveyors, *etc.*), and/or in post-graduate education (PhD).
4	Teaching methods and language	The course is based on interactive lectures that emphasize the conceptual aspects of the topics covered. Discussion between teacher and students and among students is encouraged at any level. Language: Italian and/or English (also depending on the presence of international students). Ref. Text books: The material will be extracted from several advanced books (especially biostatistical books) and scientific articles, all in English. There is no official textbook, but students are welcome to consult the original material as desired. The course material is summarized into a ~35-page written manual ("*dispense*") in English, distributed both in hardcopy and electronic (PDF) versions during the last course sessions.
5	Assessment methods and criteria	The main assessment criterion is a final oral exam, according to the official methods of the University. Also depending on the class's response, small take-home in-term written exams at the end of each of the three course parts (or a single, larger such exam covering all the course material) will provide the basis for the course final grade. Such written exams are not compulsory but would help students test their understanding of the class material before the official oral final exam. Though discussion is encouraged at any level in and out of class, the eventual grade is individual. Active participation in class (as perceived by the teacher) may increase the final grade. Calculations are kept to a minimum, as emphasis is on conceptual aspects.
2) STATISTICAL INFERENCE (4 ECTS)		
Teacher: Piero DI CARLO		
1	Course objectives	The purpose of this module is to improve the statistical analyses skills of the students using the R programming. Beginning with basic concepts from data sampling and statistical analysis, followed by linear regressions, non-linear models, test differences between group means, multivariate analysis and, finally, an introduction to ordination. On successful completion of this module, the student should gain an exhaustive understanding of the R programming source environment, and use these abilities in statistics and R programming to solve complex problems.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Data sampling (techniques and issues, variables, reliability of the sample). Data inspection (form and distribution of data and preliminary analysis). Linear regressions, non-linear models, test differences between group means using t-tests and ANOVA test, multivariate analysis. Introduction to ordination (Principal Components Analysis). Applications using R language: build a script using R language, statistical analysis with R, plotting in R. On successful completion of this module, the student should : o have profound knowledge of the principal statistical analysis techniques, o have knowledge and understanding of R programming, o understand and explain statistical terminology and R language,

		o be able to apply the acquired knowledge to solve complex problems. o demonstrate skill to extract meaningful information from data set, o demonstrate ability to manipulate large set of data.
3	Prerequisites and learning activities	The student must have a good background in mathematics and must know the basic notions of vector and matrix algebra.
4	Teaching methods and language	Lectures, computer demonstrations. Language: Lectures are given in English upon request of non-native Italian speakers. Ref. Text books: -W.N. Venables, D.M. Smith, *An Introduction to R, free download here*: http://cran.r-project.org/doc/manuals/R-intro.html , (2011). -B. Yakir, *Introduction to Statistical Thinking (With R, Without Calculus)*, free download here: http://pluto.huji.ac.il/~msby/StatThink/index.html , (2011).
5	Assessment methods and criteria	Oral exam and problem solving using R language

Programme of "CHIMICA DELL'AMBIENTE" "*ENVIRONMENTAL CHEMISTRY*"		
F0259, Compulsory 2nd Cycle in ENVIRONMENTAL BIOLOGY, 1st Year, 1st Semester		
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)		
Teacher: Fabrizio RUGGIERI		
1	Course objectives	The aim of the course in environmental chemistry is to give students a thorough understanding of the natural and anthropogenic process that occur on nature. Knowledge of these processes is necessary to understand the balance in ecosystems, and to manage the risks associated with anthropogenic activities.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: General information on toxic organic molecules (pesticides, dioxins, dibenzofurans, polychlorinated biphenyls, polycyclic aromatic hydrocarbons), indices of toxicity, biodegradation of chlorinated pesticides, dioxins and PCBs in the environment. Water cycle, Aquatic systems and carbonate-bicarbonate equilibrium, degradation of silicates and pyrite. Phosphates, dissolved oxygen, pH and pE in environmental systems. Solubility of aluminum and iron in aquatic systems. Construction and interpretation of the pH and pE diagrams. Anaerobic decomposition of organic matter. Potable water, removal of colloids systems, disinfection systems and wastewater treatment. Use of photocatalysts in advanced oxidation systems. Nitrogen compounds and nitrogen cycle. Biogeochemical cycles, colloidal particles and clay minerals. Role of sediments in the processes of adsorption, cation exchange capacity, adsorption isotherms. Heavy metals in the environment (Mercury, Lead, Cadmium, Arsenic, Chromium), natural and anthropogenic sources, speciation of metals in different environmental compartments. Treatment and disposal of municipal waste. Disposal of toxic waste. Techniques for remediation of contaminated soils. On successful completion of this module the student should o have profound knowledge of chemical process in the environment; o have knowledge and understanding of human activity on the environment and related changes; o be able to explain the natural and anthropogenic chemical process in environment; o demonstrate skill in evaluation of environmental problems and ability to explain them; o demonstrate capacity for reading and understand other texts on related topics. o be able to apply the acquired knowledge to concrete cases as occurring in the professional life; o demonstrate concern on environmental issues; o be able to work in team; o demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notions of Inorganic and Organic Chemistry.
4	Teaching methods and language	Lectures. Language: Italian Ref. Text books: -Colin Baird, Michael Cann *"Chimica Ambientale"*, Zanichelli Editore, 2013.

		-Stanley E. Manahan *"Chimica dell'ambiente",* Casa Editrice Piccin, 2000.
5	Assessment methods and criteria	Oral exam

Programme of "FISICA AMBIENTALE E MODELLI PREDITTIVI E CAMBIAMENTI CLIMATICI" *"ENVIRONMENTAL PHYSICS AND PREDICTIVE MODELING AND CLIMATE CHANGE"* **This Course is composed of two Modules: 1) Environmental Physics, 2) Predictive Modeling and Climate Change**		
F1163, Compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 1st year, 1st semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credits =25 hours)		
1) ENVIRONMENTAL PHYSICS (6 ECTS)		
Teacher: Giovanni PITARI		
1	Course objectives	The course is finalized to give the student a comprehensive introduction to atmospheric and ocean dynamics and links to the carbon cycle and other global biogeochemical cycles.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: -Introduction to atmospherics dynamics and thermodynamics. -Atmospheric boundary layer dynamics. -Ocean-atmosphere coupling. Ekman circulation. -Gyre circulation models. -Global thermoaline circulation and climate change impact. -Bio-geo-chemical carbon, sulphur and nitrogen cycles. On successful completion of this module, the student should: o have good knowledge of processes driving the large scale atmospheric and ocean circulation and their coupling, o understand and explain the role of biological and dynamical processes in the global carbon cycle, o be able to apply knowledge and understanding of atmosphere-ocean dynamics on biological, physical and chemical processes driving the carbon cycle and other global biogeochemical cycles, o be able to analyse data and make informed judgments on process driving the climate change and climate feedbacks on atmosphere – ocean coupling, o have capacity to communicate the results of their studies in the course with written tests and reports, o demonstrate capacity for estimating the role of different processes driving the climate change, o demonstrate capacity for reading and understanding other texts on related topics for a continuous learning in Environmental Physics.
3	Prerequisites and learning activities	The student must follow in parallel the course "Environmental Chemistry".
4	Teaching methods and language	Introductive lectures to atmospheric and ocean dynamics and their coupling. Language: Lectures (or summaries) are given in English upon request of non-native Italian speakers. Text books: -Jacob D. J.: *Introduction to Atmospheric Chemistry*, Princeton University Press, 1999. -Open University Course Team: *Ocean Circulation*, Butterworth – Heinemann, 2001.
5	Assessment methods and criteria	Periodic written tests and final oral exam.
2) PREDICTIVE MODELING AND CLIMATE CHANGE (6 ECTS)		
Teacher: Gianluca REDAELLI		
1	Course objectives	The course is finalized to give the student a comprehensive introduction to modeling techniques for atmospheric processes and to the mechanisms of global climate change
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the Module include: - Principal approaches to the modeling of atmospheric processes. - Introductions to methods of solving the equations for atmospheric chemistry - Chemistry of stratospheric and tropospheric Ozone and its interaction with climate.

		- The Climate System and its components. - Mechanisms of global climate change - Energy balance models On successful completion of this module, the student should: o Have good knowledge of processes driving the climate changes and of the techniques used for their numerical modeling, o Know and understand the mechanisms of global climate change, o Understand and explain the role of chemistry and energy balances in the global climate changes, o Demonstrate capacity for estimating the role of different processes driving the climate change, o Be able to analyse and interpret the process driving the climate change and climate feedbacks on atmosphere and on the modeling techniques used to study them, o Be able to communicate the results of their studies in the course with written/oral presentations, o Develop capacities to read and understand other texts for a continuous learning in Atmospheric Modelling.
3	Prerequisites and learning activities	The student must follow in parallel the course "Environmental Physics".
4	Teaching methods and language	Lectures on the topics of the course. Use of simple atmospheric computer models. Language: Lectures (or summaries) are given in English upon request of non-native Italian speakers. Text books: - Jacobson M. Z., *Fundamentals of Atmospheric Modeling*, Cambridge University Press, 1999 - Jacob D. J.: *Introduction to Atmospheric Chemistry*, Princeton University Press, 1999 - AA. VV., IPCC *Third Assessment Report - Climate Change* 2001.
5	Assessment methods and criteria	Final oral exam.

Programme of "SISTEMI INFORMATIVI TERRITORIALI E PIANIFICAZIONE" ***"GIS AND LAND PLANNING"***		
F1050, Compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 1st year, 2nd semester**		
Number of ECTS credits: 6 (total workload is 150 hours; 1 credit = 25 hours)		
Teacher: Bernardino ROMANO		
1	Course objectives	Land planning encompassing various disciplines, which seek to order and regulate land use in an efficient way, thus preventing land-use conflicts. For achieving these goals several tools, like GIS techniques, are used.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of this Module include: - The environment sustainability: Principles and criteria, - The compulsory evaluation procedures, - Techniques and Methods of evaluation, Agenda XXI, - Landscape Evaluation, - European Landscape Convention, - Urban Codes and landscape Plans, - Ecosystem interference evaluation of settlements, - Ecosystem approach to land planning, - Indicators and indexes of environment value, vulnerability and risk, - Technical tools, GIS: use and applications, - Use and application of specific software open source. On successful completion of this Module the student should o Acquire knowledge and understanding of environmental and urban legislation; tools and techniques for territorial analysis; o be able to apply knowledge and understanding in GIS software technical laboratory; inspection and visit on natural areas and settlement districts;

		o be able to make exercises and experimentation on real territorial cases with specific indicators; o Be able to communicate knowledge and understanding: technical proofs, PPT presentation, bibliography and scientific documents; o Acquire capacities for continuous learning by reading scientific literature, dedicate Website.
3	Prerequisites and learning activities	Basic knowledge on geography and mapping concept.
4	Teaching methods and language	Lectures, team work, exercises, PC laboratory Language: Italian Ref. Text books: -Romano B., *Ambiente e Piano?* ,Andromeda Ed., 2005. -Battisti C., Romano B., *Frammentazione e connettività, dall'analisi ecologica alla pianificazione ambientale*. Città Studi Torino, 2007.
5	Assessment methods and criteria	GIS Technical proof and oral exam

Programme of "AEROBIOLOGIA" ***"AEROBIOLOGY"***		
F0258, Compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 1nd Year, 2st Semester**		
Number of credits: ECTS 6 (workload is 150 hours; 1 credit = 25 hours)		
Teacher: Loretta Giuseppina PACE		
1	Course objectives	The goal of this course is to provide the students with scientific bases of the Aerobiology and skills for the application of a correct methodology in monitoring of pollen and spores. On successful completion of this module, the student is expected to have knowledge of aerodynamics, influence of environment on pollen and spore dispersals, modeling dispersal of aeroallergens, determination of pollen and fungal spore amount in the air, indoor and outdoor air quality, epidemics and pandemics of airborne diseases, use of epidemiological investigations in disease control. Special emphasis will be give to practical sessions covering aspects like operation of volumetric traps and sampling processing, pollen and fungal spore identification by optical microscopy or laboratory management of protocols. investigate the relationship between pollen in the atmosphere and the occurrence of respiratory disease including allergic responses, hay fever and asthma Investigate the potential shifts occurring in flowering seasons of major pollen (and allergy) producing plants with respect to current and future climate change
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: -Aerodynamics and dispersal of airborne particles (pollen, fungal spores). -Sampling technologies of bioaerosol and aeroallergens. -Pollen biology, structure, function, morphology. -Fungal spores: production and release. -Microscopic techniques in aerobiology. -Statistical techniques applied to aerobiology. -Plant taxonomy and identification. -The European Pollen Information system and the European Allergen Network. On successful completion of this module the student should o have profound knowledge of Aerobiological studies; o be able to explain the relevant aerobiological monitoring techniques using appropriate scientific language; o demonstrate capacity for reading and understand scientific texts on related topics; o be able to apply the acquired knowledge to concrete cases as occurring in the professional life; o be able to investigate the relationship between pollen in the atmosphere and the occurrence of respiratory disease including allergic responses, hay fever and asthma; o be able to investigate the potential shifts occurring in flowering seasons of major pollen (and allergy) producing plants with respect to current and future climate change;

		o be able to interact with others in a constructive manner, even when dealing with difficult issues; o demonstrate capacity to be critical and self-critical;
3	Prerequisites and learning activities	The student must know the basic notion on the reproduction of plants and pollen formation.
4	Teaching methods and language	Lectures. Language: Italian Ref. Text books: -Feliziani V., *Pollini di interesse allergologico, guida al loro riconoscimento*, Masson Italia, 1986. -Riccardo Bottelli et al., *I Pollini e la Pollinosi*, Piccin Editore-Padova, 1982. Paolo Mandrioli, Paul Comtois, Vincenzo Levizzani, *Methods in Aerobiology*, Pitagora Editrice Bologna,1998 Christopher S. Cox, Christopher M. Wathes, *Bioaerosols Handbook*, CRC , 1995.
5	Assessment methods and criteria	Oral exam, recognition of pollens by optical microscope.

Programme of "ANALISI DEI DATI SPERIMENTALI IN BIOLOGIA" ***"ANALYSIS OF EXPERIMENTAL DATA IN BIOLOGY"***		
F1073, Compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 2nd Year, 2nd Semester**		
Number of ECTS credits: 6 (total workload is 150 hours; 1 credit = 25 hours)		
Teacher: Anna Rita FRATTAROLI		
1	Course objectives	The goal of this course is to provide the students with scientific bases of the integrated analysis of plant biodiversity from the level of populations to the landscape and their applications to territory management.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: -Plant biodiversity of the Earth, Europe, and Italy. -Study of the flora. The species wealth of the territory. The distribution areas: typologies, their description and dynamics. Endemism, relicts, vicariance. -Chorotypes. Autocthonous and exotic species; invasive species. The chorotypes as environmental indicators. -Floristic divisions of the Earth. Floristic kingdoms. Floristic regions of the Holarctik kingdom. -History of the flora. The Tertiary. The Quaternary glaciations and post-glaciation. Origin and evolution of the Italian flora. Peculiarities and uniqueness of the central Apennine flora. -The vegetation. Concepts and methods of study. Historic outline. Techniques of sampling and analysis of data in the study of the vegetation. -The phytosociological method. The plant associations. Phytosociological *relevés*. Structural studies. Data analysis. Phytosociological tables. The characteristic, differential and associated species. Classification and ordering of the vegetation. Syntaxonomy. Integrated phytosociology. Syndynamics. Serial and chain contacts. Vegetation series. -The territorial hierarchical classification. Problems of scale. Landscape units. -Zones and belts of vegetation. Present and potential vegetation. The vegetation zones and belts in Italy, in Europe, and in the world. -Thematic cartography. Geobotanical maps: floristic, phytogeographical and vegetation maps. Geographical information system (GIS) methodologies in geobotanical cartography. On successful completion of this module the student should o have profound knowledge of plant biodiversity and geobotanical maps, o understand the physiology of the plant landscape systems of the territory, o have knowledge and understanding of environment assessment methodologies, o be able to apply the methodologies learnt for the study of the floristic and vegetation diversity, o be able to explain the relevant techniques for integrated analysis of the plant biodiversity from the level of populations to the landscape using appropriate scientific language, o demonstrate skills in analytical evaluation and ability to address the phytosociological method and GIS methodologies and their applications to environmental management, o demonstrate capacity for reading and understanding other texts on related topics,

		o be able to apply the acquired knowledge to concrete cases as occurring in the professional life, o demonstrate concern to plant biodiversity, plant ecology and management, o be able to work in team showing commitment to tasks and responsibilities, o demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notion of Plant Biology and Ecology
4	Teaching methods and language	Lectures. Language: Italian Ref. Text books -Davide Ubaldi, *Flora, fitocenosi e ambiente*, CLUEB, Bologna, 1992. -Sandro Pignatti, *Ecologia del Paesaggio*, UTET, Torino, 2001. -Franco Pedrotti, *Cartografia geobotanica*, Pitagora Editrice Bologna, 1998. -Handouts and articles distributed by the teacher.
5	Assessment methods and criteria	Oral exam

Programme of **"CORSO SPERIMENTALE DI ANALISI DELLA BIODIVERSITÀ CON ATTIVITÀ DI CAMPO E LABORATORIO"** ***"EXPERIMENTAL COURSE OF BIODIVERSITY ASSESSMENT WITH FIELD AND LABORATORY ACTIVITIES"***		
F1067, compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 1st Year, 2nd Semester**		
Number of ECTS credits: 6 (total workload is 150 hours; 1 credit = 25 hours)		
Teacher: Diana Maria Paola GALASSI		
1	Course objectives	The course have the following main objectives: - To introduce the students to the practical concerns of species distribution across different habitat types; - To select the most appropriate monitoring procedures by analyzing all the ones used and known; - To acquire skills in "reading" the environment under different spatial scales, from the landscape scale to the microhabitat scale - To put the knowledge acquired into practice by coupling sampling procedures and species identification and counting in a policy context (e.g. Directive 60/2000/CE; Directive 118/2006/EC, Habitat Directive, etc. - To translate operational activities on the field and in the laboratory in an environmental impact assessment scoring, by integrating the biodiversity response to the presence of hazard centers, farming, wastewater and industry discharges, urbanization, man-induced habitat alterations. - To make students aware of the step by step - protocol procedures required to be confident with inherent professional and scientific activities.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: -Measuring biological diversity, general framework. Setting the objectives. Freshwater invertebrate biodiversity: legislation at EU and national levels. -Sampling methodology: putting theory into practice. Description, selection and application of uniform sampling, stratified sampling, random sampling, stratified random sampling, systematic sampling. -Key-stone structure concept in assessing habitat heterogeneity. Field activity (selected environments: hyporheic zone, epibenthic layers of streambed sediments, springwaters, caves). -Biodiversity assessment by species or species-group taxonomic identifications. -Selection of appropriate sampling devices. Sampling procedures. Laboratorial activity: sorting, storing counting and identification of sampled species. The spatial and temporal scales of biodiversity measurements. The ecological and the historical scales and their role in shaping species richness and diversity.

		-The taxonomic diversity and implications in biomonitoring. -Biodiversity sampling on the field with different sampling devices and under different pressures and impacts. -Practice in sorting, counting, analyzing invertebrate fauna -Basic statistical analyses for assessing patterns of species distribution at different spatial scales. - Capacity building to write a technical report in English and in Italian, following an articulation in aim of the work, how the work must be correctly performed, data analysis, critical discussion of the results obtained, how the results may be correctly addressed to environmental impact assessment. For the successful completion of this module the student must reach the following results: o high level knowledge and understanding of the biodiversity sampling protocols and species identification with special emphasis to invertebrates o ability to apply knowledge and understanding following a *practical agenda* in order to efficiently translate theory into practice in biodiversity assessment for the evaluation of the environmental quality and for biodiversity conservation issues. o high-level skills in biodiversity monitoring and assessments in order to develop a self-critical choice of the best procedure to be adopted in environmental situations also different from the ones analyzed in the study cases during the course. o capacity to extrapolate and apply what is learned to concrete cases as occurring in professional or in research activity being able to defend their position. o development of critical view in determining the causes of variance in performance of the different methodologies analyzed and then adopted for biodiversity assessment, the reason behind corrective actions chosen, and on the on field and lab activities that worked well and those that did not. o development of fine communication skills in both oral and written reports, including a very good scientific English understanding.
3	Prerequisites and learning activities	General knowledge of systematic zoology, botany, fundamental ecology, descriptive statistics, English language (intermediate/high level)
4	Teaching methods and language	Lectures and field and laboratory activities Language: Italian or English Ref. Text books: -Scientific papers and EEA reports. -Power point presentations given during classes. -Elzinga et al., *Monitoring plants and animal populations*. Blackwell Science, 2001. -*Guide C.N.R. monografiche al riconoscimento della fauna acquatica a invertebrati*. -Hauer F.R. & Lamberti G.A., *Methods in stream ecology*, Elsevier, 2007. -Gibert J. et al., *Groundwater Ecology*, Academic Press, 1994. -Silk N. & Ciruna K., *Freshwater Biodiversity Conservation*, Island press, Washington D.C. 2005. -Magurran A.E. & B.J. McGill, *Biological Diversity. Frontiers in Measurement and Assessment*, Oxford University press, 2011. - FP7 Project – GENESIS available at: http://www.bioforsk.no/ikbViewer/page/prosjekt/hovedtema?p_dimension_id=16858&p_menu_id=16904&p_sub_id=16859&p_dim2=16860
5	Assessment methods and criteria	Evaluation of a written report with summary in English language, which must have the typical structure of a scientific paper. Power Point oral presentation.

Programme of "BIOLOGIA EVOLUTIVA" ***"EVOLUTIONARY BIOLOGY"***		
F1071, Compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 2nd Year, 1st Semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credit=25 hours)		
Teacher: Anna M.G. POMA		
1	Course objectives	The goal of this course is to provide the students with the basis of the genetic aspects of biological evolution and address the main fields of study of modern evolutionary genetics
2	Course content and	Topics of the module include:

	Learning outcomes (Dublin descriptors)	-Elements of General Genetics (the pattern of inheritance, inheritance of single genes; Mendel; the gene interaction; the basic principles of chromosomes mapping; the nature of DNA and its replication; gene and chromosomal mutations). -Genetic variation and its modulation. -Genetic structure of populations. Phenotypic, genotypic, allelic frequencies. The Hardy-Weinberg equilibrium. The heterozygosis. -The forces of evolution, mutation, migration, selection, genetic drift. Analysis of mitochondrial DNA and the study of inter-individual variation. -Evolution of genes and characters. Mechanisms of genome evolution. Centromeres, neocentromeres and evolution. -Practical exercises will be done by the students as laboratory experience (ancient-DNA extraction). On successful completion of this module the student should o have knowledge of human and comparative evolutionary genetics, o have knowledge and understanding of the fundaments of the genes and genomes and their evolution, o be able to explain the fundaments of heredity and evolutionary genetics, o demonstrate skill in finding connections and ability to perform genetic analysis and quantitative genetics applied to evolutionary biology, o -demonstrate capacity in explaining the most significant scientific experiments that deal with the genetic basis of evolution, o be able to apply the acquired knowledge to concrete cases as occurring in the professional life, o demonstrate concern for health, well-being, safety and environment, o be able to work in team showing commitment to tasks and responsibilities, o demonstrate capacity for reading and understanding other texts on related topics. o demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notion of Cell Biology, Plant Biology, Zoology and Biochemistry
4	Teaching methods and language	Lectures Language: Italian; laboratory experience (ancient-DNA extraction), available to be done in English. Ref. Text books: -Griffiths A.J.F. et al., *Genetica: principi di analisi formale*, 7^ ed., Zanichelli, 2013. -Russell P. J., *I-Genetica,* Edit. EdiSES, 2007. -Hartwell L.H., *Genetica: dall'analisi formale alla genomica*, McGrawHill, 2004. -D.J. Futuyma, *L'evoluzione,* Zanichelli, 2008.
5	Assessment methods and criteria	Oral exam.

Programme of "BIOLOGIA DELLA CONSERVAZIONE E BIOMETRIA" ***"CONSERVATION BIOLOGY AND BIOMETRY"***		
F1076, Compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 2nd Year, 1st Semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credit = 25 hours)		
Teacher: Maurizio BIONDI		
1	Course objectives	1. To inspire and encourage an interest in conservation biogeography and statistical analysis of environmental data . 2. To acquaint students with the modern methods of conservation biology. 3. To make students aware of the various disciplines encompassed by the field of zoology, botany, biogeography and ecology and to encourage them to pursue those areas that interest them through further reading and coursework. 4. To encourage the development of a interdisciplinary approach to promote better study and test-taking skills necessary for this course.
	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Methods and aims of the biogeographical approach. Biogeography in the modern evolutionary biology and the environmental conservation. Geographical distribution in time and in space. Ecological and dynamic zoogeography. Faunas and islands. Mac Arthur and Wilson

		equilibrium theory of island biogeography. How continental drift and glaciations affected the geographical distribution in animals. Refugial areas and areas of endemism. Zoogeographical regions. Methodological aspects of the analyses in Biogeography. Zoogeography and animal conservation. Hot-spots and cold-spots. Flag, key and umbrella species. Problem of the alien species. Vertebrates as useful tool for environmental conservation. Italian fauna: origin, distribution and peculiarities. Basic concepts of the biometrical analysis. Data-bases and tools of analysis. Statistical approach to biogeographical analysis and environmental quality assessment. Statistics and taxonomy. On successful completion of this module the student will be able: o To understand the importance of the biodiversity and its conservation. o To study comparative structure and function of the different organ systems and their physiological importance in relation to habit and habitat of the organism, with special regard to the reproductive strategies. o To have advanced knowledge on different aspects of biogeography such as ecological and historical biogeography, multivariate statistical methods applied to biological conservation, endemism and areas of endemism. o To have adequate knowledge for pursuing advance studies in various fields of conservation biology by research.
3	Prerequisites and learning activities	The student must have basic notion of animal and plant biology, ecology and statistics
4	Teaching methods and language	Lectures. *Language:* Italian or English Ref. Text books: -Ladle R. J. & Whittaker R. J., *Conservation Biogeography*, Wiley-Blackwell, 2011. -Pough F.H., Janis C.M., Heiser J.B., *Zoologia dei vertebrati*, Casa Editrice Ambrosiana, 2011. -Primack R.B. & Boitani L., *Biologia della Conservazione*, Zanichelli, 2013. -Zunino M.E. & Zullini A., *Biogeografia. La dimensione spaziale dell'evoluzione* , Seconda edizione. Casa Editrice Ambrosiana, 2004.
5	Assessment methods and criteria	Oral exam

Programme of "MICROORGANISMI E FUNZIONAMENTO DEGLI ECOSISTEMI" ***"MICROORGANISMS AND ECOSYSTEM FUNCTIONING"***		
F1072, Compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 2nd Year, 1st Semester**		
Number of ECTS credits: 6 (total workload is 150 hours; 1 credit = 25 hours)		
Teacher: Maddalena DEL GALLO		
1	Course objectives	The course gives advanced knowledge of the role of microorganisms in the different Earth ecosystems and of their use in environmental pollution and environmental recovery. Aim of the course is giving to the students an advanced knowledge on microbiology and to provide them with the basis for understanding the role of microorganisms in the functioning of the ecosystems. At the end of the course the student should be able to analyze the role of microorganisms in a given environment and must be able to design a utilization of microorganisms in the recovery of a degraded ecosystem.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: - Introduction to genetics and, in particular, methods of molecular biology applied to the study of different environments. - The biogeochemical cycles and the role played by microorganisms in them: Carbon cycle, with particular emphasis on the role of humus as tank and CO_2 capture. Nitrogen cycle, with particular emphasis on biological nitrogen fixation and its potential applications in agriculture. Sulfur cycle, Phosphorus cycle, minor cycles: the role of microorganisms in the recycling of matter. - Microorganisms in water, soil and air; Gaia Hypothesis and implications for future policy development; the role and use of microorganisms in agriculture: environmentally friendly and with less impact agriculture. - Role of microorganisms in the bioremediation of pollution caused by man and his

		presence. - Cycling of matter in special environments such as caves, oceanic hydrothermal vents, etc. - Analysis of some specific environments. For the successful completion of this module the student must reach the following results: o high-level knowledge and understanding of the structure and function of different ecosystems; o capacity to extrapolate and apply what is learned to concrete cases as occurring in professional or in research activity; o capacity to make informed judgments and ability to defend their position; o development of communication skills in both oral and written reports, including a very good scientific English understanding.
3	Prerequisites and learning activities	Good knowledge of general microbiology, elements of genetics and molecular biology.
4	Teaching methods and language	Teaching method: Lectures, home work. Language: Italian or English Ref. Text books: P. Barbieri, G. Bestetti, E. Galli, D. Zannoni, *Microbiologia ambientale ed elementi di ecologia microbica*, ed. CEA, 2008. -Biavati B., Sorlini C., *Microbiologia Agroambientale*, CEA, 2008. -Atlas R.M. and Bartha R., *Microbial Ecology*, Benjamin Cummings ed., 1997., -Lecture notes. Power point presentations given by the lecturer.
5	Assessment methods and criteria	A written paper on the role of microorganisms on a chosen environment, or oral examination

Programme of "ECOLOGIA E BIOMONITORAGGIO DELLE ACQUE INTERNE" ***"FRESHWATER ECOLOGY"*** ***This course, for the incoming and outgoing students enrolled in the International Track, is changed in*** ***"STAGE AND BIBLIOGRAPHIC REPORT"*** **Composed by two Modules: 1) Freshwater Ecology, 2)Free choice module within an agreed list**		
F1076, Compulsory **2nd Cycle Degree in ENVIRONMENTAL BIOLOGY, 2nd Year, 2nd Semester**		
Number of ECTS credits of "freshwater Ecology": 9 (workload is 225 hours; 1 credit = 25 hours) **Number of ECTS credits for "Stage and bibliographic Report": 12 (workload is 300 hours; 1 credit = 25 hours)**		
1) FRESHWATER ECOLOGY (9 ECTS)		
Teacher: Antonio DI SABATINO		
1	Course objectives	The Module is mainly focused on providing the students with knowledge and capacities i) to examine the relationships between freshwater organisms and their environment, ii) to analyze the physical, chemical, and biological factors that govern inland waters such as lakes, streams, and springs, and iii) to highlight interactions between human needs and water resources and discuss these challenges and opportunities in conservation and management. Applications of specific concepts will be illustrated and discussed in a series of case studies. Lab exercises and field trips will help the students to apply ecological concepts to aquatic systems and to understand the impacts of human activities on freshwater ecosystems. Special emphasis will be given to the analysis and applications of new methods and standard procedures in freshwater biomonitoring program, following the implementation of the 2000/60 EC Directive.
	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Running waters, lakes, springs, abiotic parameters, freshwater biota, biotic interactions, energy inputs and flows, natural and human disturbance, human alterations of freshwater resources, global changes, ecosystem services, case studies, experimental design and data analysis, biomonitoring. Biological Quality Elements BQE (Macroinvertebrates, Diatoms, Fish, Macrophytes), reference sites and reference conditions, EQR (Ecological Quality Ratio), multimetric indices, ecological status, chemical status.

		At the completion of the course, students should: o have a profound knowledge of the physical, chemical, and biological characteristics of inland waters, o understand how human activities affect aquatic ecosystems and explain how these changes affect society, o be able to analyze temporal and spatial changes that occur in aquatic environments, o be able to make a hypothesis, design simple experiments, analyze data and interpret results, o demonstrate skill in freshwater biomonitoring and ability to apply methods and indices, o have capacity for reading and understanding other texts on related issues, o demonstrate concern to ecosystem services, natural capital and sustainable development.
3	Prerequisites and learning activities	The student must know the basic principles of General Ecology and Data Analysis
4	Teaching methods and language	Lectures, Lab. work and exercises, field trips Language: Italian, PPT slides mostly in English Text books: -J. D. Allan & Maria M. Castillo, *Stream Ecology, Structure and function of running waters,* 2nd edition. Springer, 2007. -R. G. Wetzel, *Limnology,* Third edition, Academic Press, 2001. -Bettinetti, Crosa, Galassi, *Ecologia delle Acque Interne*, Città-Studi Ed., 2007. -Fenoglio, S. Bo,T., *Lineamenti di Ecologia Fluviale*, Città-Studi Ed., 2009.
5	Assessment methods and criteria	Oral exam