

## **Graduate School in Environmental Biology - syllabus**

### **Course structure**

The Institute of Environmental Sciences at the Jagiellonian University offers the Environmental Biology course as an MSc/Diploma. The aim of the Diploma stage is to provide a framework of current knowledge and skills in the field of Environmental Biology. The additional dissertation requirement for MSc candidates provides an opportunity to develop research skills through individual research projects in specific areas of Environmental Biology. The Diploma is awarded upon successful completion of taught courses. The MSc is awarded after successful completion of taught courses and the dissertation. The course starts in early October and takes 24 months (4 semesters).

First semester comprises joint core courses for all students. After successful completion of taught courses in semester I, the students choose one of three specialisations: (1) *Ecotoxicology*, (2) *Evolutionary Ecology* or (3) *Ecosystem Ecology & Biodiversity*. Each specialisation is based on 3 semesters' core courses, MSc Thesis/Research methods, seminars and individual projects. Courses are taught largely by coursework, carried out in small groups or individually with supervisors. Some material is delivered traditionally as lectures with seminars and tutorials, complemented by the use of study guides and readings, facilitating a deeper approach to learning. Some of the course material will be available online. All courses are delivered in English.

Core courses focus on the central issues involved in Environmental Biology. Courses taught within each specialisation provide an opportunity for students to either widen or deepen their field of study. The diagram below shows the organisation of the courses.

One course generally involves 30-45 hours including lecture, practical classes and individual work. All units are rated under ECTS (European Credit Transfer System). Taught courses will normally be examined by a combination of written examination and other forms of assessment (essays, projects, presentations, discussions with individual tutor). For the MSc degree a student needs to achieve 120 ECTS (60 ECTS in each year). Examinations will normally be held at the Institute of Environmental Sciences, Kraków, Poland; in some cases they can also take place online.

The dissertation (MSc thesis) forms an integral part of the MSc degree. It allows students to develop and apply research skills in a specific area of Environmental Biology. A wide range of topics and approaches within each of the three specialisations is possible and is governed by an individual tutor.

### **How To Apply**

Applicants for the MSc/Diploma course should possess a BSc or equivalent degree in a relevant subject such as ecology, environmental sciences, general biology, although we are happy to consider applicants with backgrounds in other disciplines.

1<sup>st</sup> year

Title	kind of activity	Hours / week	hours/ year	form of crediting	Credits
<b>1<sup>st</sup> Semester</b>					
<b>Introduction to Environmental Biology</b>	Lecture, classes	3	45	Test	9
<b>Statistical analysis for biologists</b>	Lecture, classes	3	45	Test	9
<b>2<sup>nd</sup> Semester</b>					
<b>Evolutionary Ecology</b>	Field course	1-week	45	Participation	9
<b>Specialisation*</b> (1) <b>Ecotoxicology</b> Toxicology, Statistics for ecotoxicologists (2) <b>Evolutionary Ecology</b> Introduction to Evolutionary Ecology (3) <b>Ecosystem Ecology &amp; Biodiversity</b> Ecology of ecosystems	Lecture, classes	2	30	Test	7
<b>1<sup>st</sup> &amp; 2<sup>nd</sup> Semester</b>					
<b>MSc Thesis/research Methods</b>	Tutoring, individual work	2	60	Participation	16
<b>Seminar</b>	Seminar	2	60	Participation	10

Required number of credits to complete 1<sup>st</sup> year: 60

2<sup>nd</sup> year

Title	kind of activity	Hours / week	hours/ year	form of crediting	Credits
<b>1<sup>st</sup> &amp; 2<sup>nd</sup> semester</b>					
<b>Specialisation*</b> (1) <b>Ecotoxicology</b> ▪ Environmental monitoring & demographic ecotoxicology ▪ Community ecotoxicology & ecosystem ecotoxicology (2) <b>Evolutionary Ecology</b> ▪ Evolution of life histories ▪ Behavioural Ecology (3) <b>Ecosystem Ecology &amp; Biodiversity</b> ▪ Ecology of biodiversity ▪ Global ecology	Lecture, classes	2	60	Test	14
<b>MSc Thesis/research Methods</b>	Tutoring, individual work	3	90	Participation	30
<b>Seminar</b>	Seminar	2	60	Participation	8
<b>2<sup>nd</sup> Semester</b>					
<b>Master thesis writing and presentation</b>	Individual work	2	30	Participation	8

Required number of credits to complete 2<sup>nd</sup> year: 60

\* optional specialisations of student's choice

## **Courses aims and objectives**

### **Joined-core courses**

#### **Introduction to Environmental Biology** - Prof. Ryszard Laskowski

**Hours:** 45 h (30 h Lecture + 15 h classes)

**Content:** This is the first, overview course in the graduate program offered by the Institute of Environmental Sciences. Its aim is to let the students with various backgrounds to reach a common level of understanding in environmental biology. During the course the students will learn fundamentals of environmental biology and will have an opportunity to get familiar with specializations offered to graduate students at the Institute. This is the 45-hour course, consisting of several blocks of lectures and classes dedicated to different aspects of environmental biology: (1) Introduction to graduate program in Environmental Biology, (2) Physiological Ecology and Bioenergetics, (3) Population Ecology, (4) Community Ecology, (5) Ecosystem Ecology, (6) Evolutionary Ecology, (7) Environmental Education.

#### **Statistical analysis for biologists II** - Paweł Koteja, Assoc. Prof.

**Hours:** 45 (30 h L + 15 h demonstration)

**Content:** An intermediate level course for students who are already familiar with basic statistical concepts. Introduction to General Linear Model (GLM) and Ordinary Least Squares (OLS) estimation. Simple and multiple linear regression, analysis of variance (ANOVA) and covariance (ANCOVA). Fixed, random, and mixed effects models. Experimental design: simple, nested, factorial, randomized blocks, cross-nested and repeated measures designs. Multiple comparisons. Analysis of correlation. Introduction to computer-intensive methods: bootstrap and randomization tests.

#### **Evolutionary Ecology - field course** - Mariusz Cichoń, Assoc. Prof.

**Hours:** one week – 45 h

**Content:** This is a practical course in evolutionary ecology in which students will practice research skills in planning and conducting experimental studies, data analysis, writing and evaluating research reports. It will take place in the field station in the Gorce Mountains. During the course students will perform at least one short research project concerning chosen, well defined scientific problem within a scope of evolutionary ecology. It will start with preparing a study proposal. Then, the study will be conducted in the field. After adequate data processing and statistical analyses a study report will be written. Students taking part in the course will evaluate the proposals and study reports of other participants. Projects will be discussed at all stages of their development during everyday seminars.

#### **MSc. Thesis/Research Methods**

**Content:** The four-semester project focused on selected research topic within each specialisation governed by individual supervisor, fulfils requirements for MSc diploma thesis of the Jagiellonian University and most European Universities.

#### **Seminar**

Paralleled with chosen specialisation's topics. Aims at presentation of individual projects' results, accustoming students with techniques of research presentation (oral, posters, discussion) and current trends in environmental biology.

#### **Individual projects**

**Content:** aims at acquainting students with experimental (laboratory and field) tools and methods of environmental biology as well as self-study (reading etc.) supervised by individual supervisor and teaching staff.

## **SPECIALISATIONS:**

### ***I. Ecotoxicology***

**Co-ordinator:** Prof. Ryszard Laskowski

**Content:** The ecotoxicology course is one of the specialized graduate courses offered by the Institute of Environmental Sciences. Like all other courses, this one also consists of a block of specialized lectures, tutoring, experimental work and preparing the M.Sc. thesis. The lectures are directed in this case to the study of ecotoxicology – the science about effects of toxic chemicals on organisms, populations, communities and ecosystems. The block consists of the following topics:

#### **Toxicology & Statistics for ecotoxicologists**

**Hours:** 30 (20 h lectures, 10 h classes)

**Content:** Toxicology (nutritional and xenobiotic chemicals, biochemistry of toxic chemicals, physiology and toxicology, ecotoxicological genetics, most important groups of toxic chemicals). Statistics for ecotoxicologists (specificity of toxicological and ecotoxicological data analysis, specialized statistical methods: life tables and survival analysis, logistic and probit analysis).

#### **Environmental monitoring & Demographic ecotoxicology**

**Hours:** 30 (20 h lectures, 10 h classes)

**Content:** Environmental monitoring (bioindicators and biomarkers, anthropogenic pollution in Poland and Europe, etc.). Demographic ecotoxicology (sensitivity and resistance to toxicants, population-level consequences of toxic effects in organisms, demographic methods in ecotoxicology, local extinctions, ecotoxicology and competition, species-level bioassays, ecotoxicological measures of toxicity).

#### **Community ecotoxicology & Ecosystem ecotoxicology**

**Hours:** 30 (14 h lectures + 16 h classes)

**Content:** Community ecotoxicology (effects of toxicants on species richness and diversity, trophic-chain effects, species sensitivity distributions, keystone species in ecotoxicology). Ecosystem ecotoxicology (major ecosystem processes endangered by pollution, effects of toxic chemicals on organic matter decomposition, primary productivity and pollution, the history of novel forest decline, eutrophication).

### ***II. Evolutionary Ecology***

**Co-ordinator:** Mariusz Cichoń, Assoc. Prof.

#### **Introduction to Evolutionary Ecology**

**Hours:** 30 h

**Content:** Basic concepts of the theory of evolution. Mechanisms of natural selection, genetic drift, migration and their evolutionary consequences. The role of constraints in evolution. Relation of fitness and adaptation to the process of natural selection. Origin and maintenance of genetic variation (mutations, gene flow, genetic polymorphism, genetic drift and genetic recombinations), speciation and extinctions. Major transitions in evolution.

#### **Evolution of life histories**

**Hours:** 30 h

**Content:** Description of variation in life history strategies observed in various organisms living in natural populations. Evolution of body size, timing of reproduction and longevity. Evolution of

reproductive patterns. The concept of trade-off and evolutionary constraints. The potential evolutionary mechanisms and the role of environmental variability underlying variation in life histories.

### **Behavioural Ecology**

**Hours:** 30 h

**Content:** The course focuses on the interplay between ecology, behaviour and evolution. The role of sexual selection in shaping observed diversity of living forms. Evolution of sexual reproduction, and mating systems. Diversity of sexual characters, processes of mate choice and mate competition. Evolution of parental care and evolution of brood parasitism. The biological processes underlying aggressive behaviours, cooperation, biological altruism and other behavioural

### ***III. Ecosystem ecology and Biodiversity***

**Co-ordinator:** Prof. January Weiner

#### **Ecology of ecosystems**

**Hours:** Lectures 15 h, 4 half-day field trips (demonstrations).

**Content:** ecosystem metabolism, matter cycling, trophic webs. Terrestrial systems: forests, grasslands; soils, primary producers, decomposers; aquatic systems: lakes, rivers, marine; stratification and sedimentation. Overview of terrestrial and aquatic systems, temperate zone and beyond (arctic, tropical).

#### **Ecology of biodiversity**

**Hours:** 15 h, 4 field trips (demonstrations)

**Content:** Biological diversity. Community structure. Species interactions (competition, predation, parasitism). Coevolution. Community assembly and secondary succession. Diversity patterns in local scale. Global changes in diversity. Diversity protection.

#### **Global ecology**

**Hours:** Lectures 15 hr; seminars (individual readings) 15 hr.

**Content:** Biosphere as a global ecosystem. Biogeochemistry (global scale). Spatial patterns (climate productivity, diversity; biomes vs. biogeography). Temporal patterns, palaeoecology: global change (climate, biogeochemistry, biodiversity). Ecosystem vs. superorganism. Sustainability of the biosphere. Human impact.