**Department of Biology**
**Josip Juraj Strossmayer University of Osijek**

# Programme of studies in Biology

Bachelor level study programme

accredited by the Ministry of Science, Education and Sports of the Republic of Croatia on 16 June 2005

Osijek, October 2020

## 1.INTRODUCTION

a) Modern society is knowledge-based, and biology i.e. the science of life, has a significant role in it. Biodiversity, recombinant DNA technology and nature protection are biological disciplines, without the knowledge of which the modern society would not be able to survive. Therefore it is easy to recognize the value of knowledge gained from a study of natural sciences. With much focus on globalization, we often forget natural processes and it is important to provide education on the importance and functioning of life. Teaching plays and important role in the process of education, and it should provide younger generations with the knowledge that will explain and protect life. Biologists, in all segments of their activity, and whatever they professional interests may be (education, science, or professional activities), are necessary in society, and can find employment in the global job market. In addition to educational and scientific institutions, there is an increasing number of private companies that conduct research or have the production for which they need the expertise of biologists. The core and optional modules are based on the results of the most recent investigations, and provide basic knowledge that will make it possible for our graduates to be competitive in the global market of knowledge.
   We are offering a 'major' programme for biologists that is comparable to many study programmes in the European Union (Universities in Wageningen, Heidelberg, Pecs), and the programme structure is agreed upon with other Croatian biology professionals. The programme also provides for vertical and horizontal student mobility.

b) The University Department of Biology was originally the Institute of Biology that was part of the Faculty of Education. Since 1977 educated teachers of biology and chemistry. Based on the Report of the committee for assessment of institutions of higher education in the Republic of Croatia, natural sciences, field biology (section 11 of the Report), we are proposing the bachelor level study programme in biology and master level study programmes in biology, biology education, and biology and chemistry education.
c) Proposed study programmes provide for the horizontal and vertical student mobility, as they are composed of 70% core modules and 30% optional modules like many European 'major + minor' study programmes, and they are comparable to similar study programmes in the Republic of Croatia.
d) Following the recommendations of the above mentioned Report of the committee for assessment of institutions of higher education in the Republic of Croatia (sections 7, 8, and 9), and since we managed to implement our plan to relocate the Institute of Biology and founded the University Department of Biology, we now have much better conditions for research and teaching, and can offer a modern programme of study in biology. Moreover, there have been considerable investments made in order to equip the labs and practicums, and such a positive trend is expected to continue.

## 2.GENERAL DESCRIPTION

2.1. PROGRAMMES OF STUDY IN BIOLOGY
Bachelor level study programme in Biology

2.2. Proposing institution: Josip Juraj Strossmayer University, Department of Biology
2.3. Duration of study.
2.4. Bachelor level study programme: 3 years (6 semesters)
Qualification awarded: BSc in biology

2.5. Admission requirements.
Applicants for the Bachelor level programme of study in biology should hold a secondary school diploma and pass an admission test.

2.6. On completion of the bachelor level study programme, graduates will be able to enrol in other master level programmes in natural sciences, field biology, or in combination with other fields. At our University, those are the master level programmes in biology, biology education, and biology and chemistry education. Graduates will also be able to enrol in other master level programmes at the Faculty of Science at Zagreb University, or at the Faculty of Science and Education at the University of Split.
On completion of the bachelor level study programme, a bachelor of biology will have the competences and skills that qualify him/her to work in labs as a laboratory technician (in the present system of secondary school education there is no school that offers this profession, which means that at the moment laboratory technicians attended agriculture, veterinary medicine, chemistry, or medical secondary schools, or studied biology, so they quickly leave such jobs), expert guards in nature parks, and similar institutions.

2.8. On completion of the bachelor level study programme the qualification awarded is

*BSc in biology*

**3. STUDY PROGRAMME DESCRIPTION PROPOSAL FOR BACHELOR LEVEL STUDY PROGRAMMES**

**3.1.** The list of obligatory and elective courses and modules with corresponding number of teaching hours and ECTS credits

**OBLIGATORY COURSES**

| **I semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| General (1) and Inorganic (1) Chemistry | | 30 | 30 | | 4 | BBO101 |
| Basic practice in General Chemistry | | | | 45 | 4 | BBO102 |
| Physical Foundations of Instrumental Methods in Biology | | 30 | | 15 | 4 | BB103 |
| Cell Biology | | 45 | | 45 | 6 | BB104 |
| Microbiology | | 30 | | 30 | 4 | BB105 |
| General Zoology | | 45 | | 45 | 6 | BB106 |
| Field Work 1 – Zoology | | | | 15 | 1 | BBO212 |
| Physical Education | | | | 30 | 1 | BBT111 |
| | **435** | **180** | **30** | **225** | **30** | |

| **II semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| Organic Chemistry 1 | | 30 | 15 | 30 | 7 | BBO207 |
| Quantitative Biology 1 | | 30 | | 15 | 4 | BBO208 |
| Human Anatomy and Histology | | 45 | | 30 | 6 | BBO209 |
| Genetics | | 30 | | 30 | 4 | BBO210 |
| Plant Anatomy | | 30 | | 30 | 4 | BBO211 |
| Plant Morphology with Field Work 1 | | 15 | | 30 | 4 | BBO213 |
| Physical Education | | | | 30 | 1 | BBT111 |
| | **390** | **180** | **15** | **195** | **30** | |

| **III semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| Invertebrates | | 30 | | 45 | 6 | BBO314 |
| Algae, Fungi and Lichens | | 45 | | 30 | 6 | BBO315 |
| Biochemistry 1 | | 30 | | 30 | 4 | BBO317 |
| General Ecology | | 30 | | | 2 | BBO318 |
| Vertebrates | | 30 | | 45 | 5 | BBO319 |
| Physical Education | | | | 30 | 1 | BBT111 |
| **Elective Courses** | **90** | | | | 6 | |
| | **345** | **165** | | **180** | **30** | |
| **IV semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
| Biochemistry 2 | | 30 | | 30 | 6 | BBO420 |
| Plant Physiology 1 | | 45 | | 45 | 7 | BBO421 |
| Cormophyte | | 30 | | 45 | 6 | BBO422 |
| Field Work 2 - Zoology | | | | 30 | 2 | BBO423 |
| Field Work 2 - Botany | | | | 30 | 2 | BBO424 |
| Physical Education | | | | 30 | 1 | BBT111 |
| **Elective Courses** | **105** | | | | 6 | |
| | **315** | **105** | | **210** | **30** | |

| **V semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| Animal Physiology 1 | | 45 | | 45 | 8 | BBO525 |
| Molecular Biology | | 30 | 15 | 30 | 6 | BBO526 |
| Plant Ecology | | 30 | | 30 | 4 | BBO527 |
| Animal Ecology | | 30 | | 30 | 4 | BBO528 |
| **Elective Courses** | **120** | | | | 8 | |
| | **285** | **135** | **15** | **135** | **30** | |

| **VI semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| Evolution | | 30 | 15 | | 5 | BBO629 |
| Zoogeography | | 30 | 15 | 15 | 6 | BBO631 |
| Geobotany | | 30 | 15 | | 5 | BBO632 |
| Field Work 3 - Zoology | | | | 30 | 2 | BBO633 |
| Field work 3 - Botany | | | | 30 | 2 | BBO634 |
| **Elective Courses** | **150** | | | | 6 | |
| Bachelor thesis | | | | | 4 | BBZR |
| | **210** | **90** | **45** | **75** | **30** | |

**ELECTIVE COURSES**

| | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|
| Protozoa Biology | 15 | | 15 | 2 | BBZ35 |
| Phytoplankton | 15 | | 15 | 2 | BBZ36 |
| Ecophysiology of Algae | 15 | | 15 | 2 | BBZ37 |
| Ultrastructure of Cell Organelles | 15 | | 15 | 2 | BBZ38 |
| Plant Microtechnique and Microscopy | 30 | | 15 | 2 | BBZ82 |
| Experimental Biochemical Techniques | 30 | | 15 | 2 | BBZ39 |
| Insect Anatomy and Morphology | 15 | 30 | | 2 | BBZ40 |
| Hematophagous arthropods (Arthropoda) | 15 | | 15 | 2 | BBZ41 |
| Preparation and Production of Biological Collections | 15 | | 15 | 2 | BBZ42 |
| Marine Biology | 15 | 15 | | 2 | BBZ43 |
| Land Vertebrates in Croatia | 15 | 15 | | 2 | BBZ44 |
| Photosynthesis | 15 | | 15 | 2 | BBZ45 |
| Toxicology | 15 | | 15 | 2 | BBZ46 |
| Phytogeographical Characteristics of Eastern Croatia | 15 | | 15 | 2 | BBZ47 |
| Protected Animal Species | 15 | 15 | | 2 | BBZ48 |
| Genetic Engineering | 30 | | | 2 | BBO630 |
| Biology of Rodents and Insects and its Significance for Human Health | 15 | | 15 | 2 | BBZ59 |
| Experimental Animals | 15 | | 15 | 2 | BBZ62 |
| Poisonous Animals and Plants | 15 | 15 | | 2 | BBBZ51 |
| Phytobiology | 45 | 15 | 20 | 6 | BBZ60 |
| Neurobiology | 40 | 20 | 30 | 6 | BBZ61 |

**ELECTIVE COURSES: Facultative Module Chemistry**

| **III semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| General Chemistry 2 | | 30 | 15 | | 3 | K016 |
| Organic Chemistry 2 | | 30 | 15 | | 3 | K042 |
| | **90** | **60** | **30** | | | |

| **IV semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| Analytical Chemistry 1 | | 30 | | | 2 | K031 |
| Analytical Chemistry 2 | | 30 | 15 | | 2 | K032 |
| Analytical Chemistry Laboratory Practice 1 | | | | 30 | 2 | K033 |
| | **105** | **60** | **15** | **30** | | |

| **V semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| Inorganic Chemistry 2 | | 30 | 15 | | 3 | K021 |
| Organic Chemistry Laboratory Practice 2 | | | | 30 | 2 | K043 |
| Analytical Chemistry Laboratory Practice 2 and Seminar | | | 15 | 30 | 3 | K099 |
| | **120** | **30** | **30** | **60** | | |

| **VI semester** | | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|---|
| Inorganic Chemistry 3 | | 45 | 15 | | 4 | K022 |
| Inorganic Chemistry Laboratory Practice | | | | 60 | 4 | K023 |
| Elective course – Chemistry | **30** | | | | 2 | |
| | **150** | **45** | **15** | **60** | | |

**Elective courses within the Module Chemistry**

| | **L** | **S** | **P** | **ECTS** | **CODE** |
|---|---|---|---|---|---|
| Chemistry in Everyday Life | 15 | | 15 | 2 | K083 |
| Toxicology and Environmental Chemistry | 15 | 15 | | 2 | K081 |

**L - lectures**
**S - seminars**
**P - practices**

**Course teachers and associates are assigned to courses as of the academic year 2020./2021.**

## Obligatory courses

| | |
|---|---|
| **Course title** | **Algae, Fungi and Lichens** |
| **Code** | BBO315 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Melita Mihaljević |
| **Associate teachers** | Assist. Prof. Dr. Filip Stević<br>Assist. Prof. Dr. Dubravka Špoljarić Maronić |
| **Course entry requirements** | |
| **Course objective** | To teach students basics of morphology, anatomy and systematics of algae, fungi and lichens, to enable them to develop natural science literacy and awareness about protection of plant organisms and their habitats in the country and in the world. |
| **Learning outcomes** | 1. Ability to compare properties, cell structure and ecological characteristics of algae, fungi and lichens.<br>2. Ability to predict taxonomic and phylogenetic relations between individual species within groups.<br>3. Ability to determine types of algae, fungi and lichens on natural preparations by using contemporary literature.<br>4. Prediction of interactions between individual species of algae, fungi and lichens and their environment.<br>5. Development of knowledge and skills required for collecting plant material on filed and for their laboratory processing and using of data for the purpose of environmental pressure valorisation. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1.5 | Lecture | Lecture attendance and active participation | Records, evaluation | 10 | 15 |
| 1-5 | 1 | Practices | Practical classes attendance, written report containing results and conclusions of performed analyses | Records, evaluation of written report | 15 | 20 |
| 1-5 | 1.5 | Written exam | Preparation for written preliminary exam | Preliminary exam and/or written | 15 | 20 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | exam | | |
| | 1-5 | 2 | Final exam | Exam preparation | Oral exam | 20 | 45 |
| | **Total** | **6** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**
Final exam: minimum number of points refers to satisfactory performance, and maximum number of points refers to excellent performance.

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|---|---|---|---|
| **Consultation hours** | As agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 45 | 0 | 30 |

**Course content / teaching units**

Lectures:

- Introduction - general characteristics and diversity of algae
- Cell structure, anatomy and morphology of talus, reproduction and development cycles, ecology, evolution and diversity of algae according to systematic position: prokaryotic algae - Cyanobacteria/Cyanophyta; Prochlorophyta; eukaryotic algae - Euglenophyta; Cryptophyta; Dynophyta; Haptophyta; Heterokontophyta - Chloromonadophyceae, Xanthophyceae, Chrysophyceae, Bacillariophyceae, Phaeophyceae; Rhodophyta; Chlorophyta - Chlorophyceae, Zygnematophyceae, Charophyceae
- The role of algae in ecological systems
- Protection of algae species and their habitats
- Kingdom of fungi
- General features (anatomy, morphology, reproduction, developmental cycles) and systematics of groups: Myxomycota (slime mold), Phycomycota (water mold), Ascomycota (sac fungi), Basidiomycota (higher fungi)
- Identification of edible and poisonous mushrooms
- Lichen symbiosis, lichenisation; morphology, anatomy and physiology of lichens
- Ecology of lichens, distribution, specific species
- Lichens - bioindicators of air quality

Practices:

- Methods of algae sampling
- Taxonomic identification of cell structure, thallus morphology and morphology of several species from every systematic group of algae
- Algae culture (demonstration)
- Preparation of permanent algal slides
- Learning about general morphological and anatomical characteristics of fungi and lichens: Phycomycota, Ascomycota, Basidiomycota, lichenised fungi
- Determination of a representative of each systematic group within the kingdom of fungi

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|---|---|
| **Recommended reading** | Lee R. (2008) Phycology. 4th ed. London: Cambridge University Press, London.<br>Sitte P., Ziegler H., Ehrendorfer F., Bresinsky A. (1991) Strasburger Lehrbuch der Botanik. (33. Auflage). Gustav Fischer Verlag, Stuttgart, Jena, New York.<br>Nasch T. H. III (1996) Lichen biology. Cambridge University Press.<br>Božac R. (2003) Gljive. Morfologija, sistematika, toksikologija. 5th ed. Školska knjiga, Zagreb**.** |
| **Optional reading** | Hindak F., Komarek P., Ruzicka J. (1973) Kluc na urcovanie vytrusnych rastlin. Slovenske pedagogicke nakladatelstvo, Bratislava.<br>Kirk P.M., Cannon P.F., David J.C., Stalpers J.A. (2001) Dictionary of the Fungi. 9th ed. CABI Publishing, Wallingford.<br>Riedl R. (1970) Fauna und Flora der Adria. Verlag Paul Parey, Hamburg, Berlin.<br>Wirth V. (1995) Die Flechten Baden-Württembergs 1-2 (2. Auflage). Verlag Eugen Ulmer, Stuttgart. |
| **Conditions for obtaining teacher's signature** | Attending lectures and practices and gaining a minimum of 25 points, and gaining of at least 40% of the total number of points within the preliminary exam. |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the work of each student, which makes up to 35% of the final grade. During the course, students will be taking written preliminary exams, which can be considered as a substitute for the written final exam if they achieve at least 90% of total points. Preliminary or final written exam make up 20% of the final grade, while oral exam makes up 45% of the final grade. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Periodic evaluation of students and teachers will be performed to ensure and continuously improve the quality of teaching and of the study programme. During the last week of lectures, students will be given an anonymous survey to evaluate the overall quality of the course. An analysis of students' performance at exams will be also carried out. |

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| **Course title** | **Plant Anatomy** |
| **Code** | BBO211 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | II semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Tanja Žuna Pfeiffer |
| **Associate teachers** | Assist. Prof. Dr. Dubravka Špoljarić Maronić<br>Assist. Prof. Dr. Filip Stević<br>Assoc. Prof. Dr. Melita Mihaljević<br>Nikolina Bek, assistant |
| **Course entry requirements (Preceding courses)** | Physical Foundations of Instrumental Methods in Biology (attended), Cell Biology (attended) |
| **Course objective** | To acquire knowledge about anatomical structure of plant tissues and organs. |
| **Learning outcomes** | 1. Ability to compare characteristics, structure and function of a plant cell with an animal cell.<br>2. Skills of predicting the relations between anatomical structure of plant organs and tissues and their function.<br>3. Skills to prove the presence of various compounds in plant cells and tissues by using specific reagents on fresh microscopic preparations of plant tissues.<br>4. Ability to analyse the structures that are characteristic for plant cell, tissues and organs and to develop natural science literacy. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 1 | Lecture | Critical conversation and discussion | Records related to active and independent participation in conversations and discussions | 5 | 10 |
| 1-4 | 1 | Practices | Independent production of microscopic preparations, microscopy, analysis of specific structures of some plant tissues and organs | Records related to active and independent practical work with provision of feedback | 25 | 40 |
| 1-4 | 1 | Written exam | Preparation for written exam | Written exam | 15 | 25 |
| 1-4 | 1 | Oral exam | Preparation for oral exam | Oral exam | 15 | 25 |
| **Total** | **4** | | | | **60** | **100** |

| | | | |
|---|---|---|---|
| | **Final grade:**<br>**60-70 points: grade 2 (sufficient)**<br>**71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 30 |
| **Course content / teaching units** | Lectures:<br>• Botany within biology, division of botany<br>• General characteristics of plants - development and role<br>• Organisation and function of plant cells<br>• Specificities of plant cells<br>• Types, properties and functions of plant tissues<br>• Anatomy of plant organs<br>Practices:<br>• Plant cell<br>• Properties of plant tissues<br>• Anatomical structure of plant organs | | |
| **Recommended reading** | Beck B.C. (2010) An Introduction to Plant Structure and Development. Plant Anatomy for the Twenty-First Century. 2nd ed. Cambridge University Press, UK.<br>Dickison W.C. (2000) Integrative Plant Anatomy. Academic Press, USA.<br>Lepeduš H., Cesar V. (2010) Osnove biljne histologije i anatomije vegetativnih organa. Sveučilište Josipa Jurja Strossmayera u Osijeku, Odjel za biologiju, Osijek.<br>Žuna Pfeiffer T., Krstin LJ., Štolfa I., Lovaković T., Tikas V., Lepeduš H. (2014) Praktikum iz anatomije biljaka, Sveučilište Josipa Jurja Strossmayera u Osijeku, Odjel za biologiju, Osijek. | | |
| **Optional reading** | Bačić T. (2003). Morfologija i anatomija bilja, Sveučilište Josipa Jurja Strossmayera u Osijeku, Pedagoški fakultet, Osijek.<br>Bowes G.B. (1996) A colour atlas of plant structure. Manson Publishing, London.<br>Denfer D., Ziegler H. (1988) Botanika: morfologija i fiziologija. Školska knjiga, Zagreb.<br>Domac R. (2002) Flora Hrvatske. Priručnik za određivanje bilja. 2. izd. Školska knjiga, Zagreb.<br>Moore R., Clark W.D., Stern K.R., Vodopich D. (1995). Botany. Wm. C. Brown Communications, Inc., Dubuque. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to attend lectures and practices and to participate actively in the teaching process. | | |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students take a written exam and then oral exam. The final grade is determined according to the number of points collected during the lectures and practices and the points achieved in written and oral exams. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher continuously monitors the learning process and student achievement, thus determining and adapting his/her teaching. Students have the opportunity to make oral or written comments after lectures. During the last week of lectures, students will be given an anonymous survey to evaluate the overall quality of the course. The teacher monitors the success of students at the exams. | | |

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|---|---|
| **Course title** | **Human Anatomy and Histology** |
| **Code** | BBO209 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | II semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Assist. Prof. Dr. Mirta Sudarić Bogojević |
| **Associate teachers** | Assist. Prof. Dr. Anđela Grgić<br>Assist. Prof. Dr. Anita Galir Balkić<br>Robert Mujkić, assistant |
| **Course entry requirements (Preceding courses)** | General Zoology |
| **Course objective** | To acquire knowledge about systematic organisation of human body by putting emphasis on general anatomical and histological concepts, with the aim to develop a basis for understanding physiological processes in human body and to gain skills necessary for studying of comparative anatomical human features by comparing them with other organisms on Earth. |
| **Learning outcomes** | 1. Acquired knowledge about basic anatomical and histological terminology and general principles of human body.<br>2. To determine relations between anatomical and histological structure of organs and organ systems with their function.<br>3. Skills needed for analysis of human tissues and organs by using appropriate histological preparations and anatomical models. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 1.5 | Lectures | Lecture attendance and active participation | Records related to active and independent participation in conversations and discussions | 5 | 10 |
| 1-3 | 1 | Practices | Independent microscopy, analysis of structure of human tissues and organs | Records related to active and independent practical work with provision of feedback | 20 | 25 |
| 1-3 | 2 | Written exam | Preparation for written exam | Written exam | 20 | 35 |

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<tr><td></td><td>
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<tr><td>1-3</td><td>1.5</td><td>Oral exam</td><td>Preparation for oral exam</td><td>Oral exam</td><td>15</td><td>30</td></tr>
<tr><td>Total</td><td>6</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
</table>
Final grade:<br>Od 60-70 points: grade 2 (sufficient)<br>Od 71-80 points: grade 3 (good)<br>81-90 points: grade 4 (very good)<br>Od 91-100 points: grade 5 (excellent)
</td></tr>
<tr><td>Consultation hours</td><td>Schedule of consultation hours will be defined with students.</td></tr>
<tr><td>Teaching</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Practices</th></tr>
<tr><td>45</td><td>0</td><td>30</td></tr>
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<tr><td>Course content / teaching units</td><td>
<ul>
<li>General principles of tissue structure, types and their characteristics</li>
<li>Techniques for making histological preparations</li>
<li>Macroscopic structure of human body, topography, body cavity system and anatomical terminology</li>
<li>Basics of histological and anatomical structure of organ systems: skeletal system, joints, muscular system, vascular and lymphatic system, respiratory system, digestive system, nervous system, sensory system, excretory system, endocrine system, reproductive system</li>
<li>Analysis of structures of tissues, organs and organ systems based on histological preparations, i.e. on anatomical models</li>
</ul>
</td></tr>
<tr><td>Recommended reading</td><td>Junqueira L.C. (1995) Osnove histologije. Školska knjiga, Zagreb.<br>Keros P., Pećina M., Ivančić-Košuta M. (1999) Temelji anatomije čovjeka. Medicinska biblioteka, Zagreb.<br>Sobotta J. (2004) Histološki atlas. Naklada slap, Zagreb.<br>Sobbota J. (2007) Atlas anatomije čovjeka. Naklada slap, Zagreb.</td></tr>
<tr><td>Optional reading</td><td>Jalšovec D. (2005) Sustavna i topografska anatomija čovjeka. Školska knjiga, Zagreb.<br>Krmpotić-Nemanić J. (1993) Anatomija čovjeka. Medicinska naklada, Zagreb.<br>Marušić A., Krmpotić-Nemanić J. (2001) Anatomija čovjeka. Medicinska naklada, Zagreb.</td></tr>
<tr><td>Conditions for obtaining teacher's signature</td><td>Students are obliged to attend lectures and practices, to participate in lectures actively and to fulfil all assignments within the course.</td></tr>
<tr><td>Exam passing procedure</td><td>Students pass the written exam within five preliminary exams, after which they take the oral exam. The final grade is determined based on the number of points achieved during the course as of the defined criteria.</td></tr>
<tr><td>Main language of instruction; other languages</td><td>Croatian language</td></tr>
<tr><td>Method of monitoring the quality and efficiency of teaching</td><td>During the course, the teacher continuously monitors the learning process and student achievement, thus determining and adapting his/her teaching. After the course, the teacher conducts an anonymous survey among students to evaluate their subjective impression about the teaching quality.</td></tr>
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|---|---|
| **Course title** | **Animal Physiology 1** |
| **Code** | BBO525 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 8 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Branimir Hackenberger Kutuzović |
| **Associate teachers** | Assoc. Prof. Dr. Davorka Hackenberger Kutuzović<br>Assoc. Prof. Dr. Sandra Ečimović<br>Assist. Prof. Dr. Olga Jovanović Glavaš |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To understand basic physiological processes of animal organisms and to compare them systematically at cellular and organic, i.e. integrative level by overviewing all classes and orders of the animal kingdom and putting emphasis on comparative details within individual phyla, classes and orders. |
| **Learning outcomes** | 1. Reviewed basic concepts of general physiology (homeostasis, negative and positive feedback, diffusion, osmosis, isoosmotic and isotonic solution, Na/K pump ratio, buffers and acid-base balance, etc.).<br>2. Analysed basic physiological processes in animal organisms.<br>3. Explained physiological principles of organ system functioning - nervous systems and senses, endocrine systems, muscles, blood and immune system, heart, circulatory systems, respiration and gas exchange, ionic, osmotic and acid-base balance, digestion and metabolism, reproduction.<br>4. Developed skills related to handling with laboratory animals and equipment, by applying modern ethical principles required for working in scientific and professional teams involved in research into physiology.<br>5. Developed digital skills for using computer simulations to analyse physiological processes.<br>6. Ability to valorise scientific research (experiment design, implementation, quantitative data processing and conclusion making) by studying available scientific literature. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 2 | Lecture | Lecture attendance and active participation | Records related to attendance and activity | 5 | 10 |
| 4-5 | 2 | Practices | Practical classes attendance and active participation | Records related to attendance and activity | 15 | 30 |
| 1-6 | 3 | Written exam | Preparation for written exam | Written exam | 15 | 30 |
| 1-6 | 1 | Oral exam | Preparation for oral exam | Oral exam | 15 | 30 |
| **Total** | **8** | | | | **50** | **100** |

<table>
<tr><td></td><td colspan="3">Final grade:<br>50.1-62.5 points: grade 2 (sufficient)<br>62.6-75 points: grade 3 (good)<br>75.1-87.5 points: grade 4 (very good)<br>87.6-100 points: grade 5 (excellent)</td></tr>
<tr><td>Consultation hours</td><td colspan="3">By appointment.</td></tr>
<tr><td>Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>Hours - total</td><td>45</td><td>0</td><td>45</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">Lectures:<ul><li>The concept of physiology and it brief historical development</li><li>Homeostasis</li><li>Fundamentals of control and feedback mechanisms</li><li>Fundamentals of cellular physiology</li><li>Communication between cells and tissues</li><li>Receiving stimuli from the environment</li><li>Nervous systems</li><li>Endocrine systems</li><li>Sensory systems</li><li>Muscular systems</li><li>Circulation systems</li><li>Cardiac physiology and hemodynamics</li><li>Breathing and gas exchange</li><li>Ionic, osmotic and acid-base balance</li><li>Digestion</li><li>Skeletal systems</li><li>Movement in the environment</li><li>Energy of movement</li><li>Reproduction</li><li>Reproductive hormones</li><li>Pheromones</li></ul>Practices:<ul><li>Fundamentals of handling animals in physiological practicum</li><li>Laboratory animals (mice, rats)</li><li>Handling with animals</li><li>Animal maintenance</li><li>Highly-related strains</li><li>Techniques for administering substances to laboratory animals</li><li>Anaesthesia, analgesia</li><li>Preparation of blood smears for differential blood count</li><li>Differential blood count</li><li>Bleeding and clotting time</li><li>Leukocyte and erythrocyte counting</li><li>Calculation of haematological indices (MCV, MCH, MCHC)</li><li>Erythrocyte osmotic resistance</li><li>Behaviour of erythrocytes in solutions of different tonicity (osmotic pressure)</li><li>Blood pressure (3-minute step test)</li><li>Computer simulations: nerve impulse; substance transfer across the cell membrane; muscles; heart; kidney; buffers and acid-base balance; breathing; digestion; the influence of thyroid hormones on metabolism; insulin and diabetes</li></ul></td></tr>
</table>

| | |
|---|---|
| **Recommended reading** | Hill R.W., Wyse G.A., Anderson M. (2012) Animal Physiology. Sinauer Associates, Inc., Massachusetts U.S.A.<br>Moyes C.D., Schulte P.M. (2007) Principles of Animal Physiology, Pearson. |
| **Optional reading** | Paul J.R. (2001) Physiologie der Tiere, Thieme, Stuttgart.<br>Randall D., Burggren W., French K. (2002) Eckert Animal Physiology – Mechanisms and Adaptation, W. H. Freeman and Company, New York. |
| **Conditions for obtaining teacher's signature** | Regular attendance at lectures, successfully completed practices, preparation and presentation of a scientific essay. |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass written exam. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade. |
| **Main language of instruction; other languages** | Croatian language, English language |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. |

| | |
|---|---|
| **Course title** | **Invertebrates** |
| **Code** | BBO314 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Dubravka Čerba |
| **Associate teachers** | Assist. Prof. Dr. Anita Galir Balkić<br>Barbara Vlaičević, Ph.D. |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about basics of evolution, systematics, anatomy, morphology and diversity of invertebrates and to enable students to develop natural science literacy. |
| **Learning outcomes** | 1. Explained concepts of systematics and taxonomy of invertebrates and understanding of progress of these disciplines within various scientific branches of biology.<br>2. Developed ability to independently apply appropriate methods of handling organisms and dissecting invertebrates in order to collect all necessary information by avoiding unnecessary sacrifice of organisms.<br>3. Skills to connect and critically assess the importance of different anatomical, morphological and physiological characteristics of terrestrial and aquatic invertebrates, and their adaptation to specific habitat, feeding, survival strategies and reproductive performance.<br>4. Explained relation between anatomical and morphological characteristics of invertebrates and their position in trophic levels of different ecosystems.<br>5. Developed ability to use independently the keys for determination of invertebrates and to distinguish the representatives of different classes and orders of invertebrates. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1,3,4,5 | 1 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 2-5 | 1.5 | Practices | Anatomical section and determination of representatives of different invertebrates | Analysis of practical work with provision of feedback | 15 | 20 |
| 1-5 | 2 | Written exam | Preparation for written exam | Written exam | 20 | 35 |
| 1-5 | 1.5 | Oral exam | Preparation for oral exam | Oral exam | 20 | 35 |
| **Total** | **6** | | | | **60** | **100** |

| | | | |
|---|---|---|---|
| | **Final grade:**<br>**60-70 points: grade 2 (sufficient)**<br>**71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 45 |
| **Course content / teaching units** | Lectures:<br>• General characteristics of Protozoa<br>• Anatomical and morphological characteristics of Porifera<br>• Anatomical and morphological characteristics of Cnidaria<br>• Anatomical and morphological characteristics of Platodes with special reference to Neodermata<br>• Phylum Aschelminthes as of the new findings<br>• Phylum Mollusca - anatomical and morphological changes connected with the way of life<br>• Comparative review of Polychaeta and Clitellata<br>• Characteristics of Arthropoda considering the tagmatization processes<br>• Amandibulata and Mandibulata – anatomical and morphological characteristics considering the types of habitat, with special emphasis on parasitic arthropods;<br>• Insecta - adaptive radiation, morphology and anatomy<br>• Echinodermata – radially symmetrical Deuterostomia with bilaterally symmetrical larva and variable connective tissue<br>Practices:<br>• Protozoa – functional constitution, movement, feeding and reproduction; Spongia – anatomical and morphological characteristics of exclusively aquatic organisms (aquiferous system)<br>• Cnidaria – diploblastic, primary radially symmetric planctonic and nektonic organisms<br>• Platodes – comparative overview of anatomical and morphological characteristics considering the way of life (free-living, external and exclusively internal parasites)<br>• Aschelminthes – the variety of constitution and functions<br>• Mollusca – comparative anatomy and morphology of the aquatic and terrestrial representatives, with special emphasis on Cephalopoda as exclusively marine predators<br>• Annelida – comparative anatomy and morphology of polychaetes, oligochaetes and hirudineans<br>• Arthropoda – similarities and differences in the outer constitution of scorpions, spiders and mites; Entomostraca and Malacostraca, and insects<br>• Echinodermata – basic plan of the constitution and inner functional constitution, comparatively: Crinoidea, Asteroidea, Ophiuroidea, Echinoidea and Holothuroidea. | | |
| **Recommended reading** | Habdija I., Primc Habdija B., Radanović I., Špoljar M., Matoničkin Kepčija R., Vujčić K., S., Miliša M., Ostojić A., Sertić Perić M. (2011) Protista - Protozoa - Metazoa- Invertebrata: Strukture i funkcije. Alfa d.d., Zagreb.<br>Radanović I., Miliša M. (ed.) (2004) Protista-Protozoa i Metazoa-Invertebrata: funkcionalna građa i praktikum. Meridijani, Samobor. | | |
| **Optional reading** | Ruppert E. E., Fox R. S., Barnes R. D. (2004) Invertebrate Zoology. A functional evolutionary approach. 7th ed. Thomson Brooks/Cole. | | |

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| **Conditions for obtaining teacher's signature** | Students are obliged to participate actively in lectures and to complete the work diaries related to practices. |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass written exam. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. |

| | |
|---|---|
| **Course title** | **Biochemistry 1** |
| **Code** | BBO317 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Assist. Prof. Dr. Rosemary Vuković |
| **Associate teachers** | Ana Vuković, assistant |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about the basic principles of biochemical processes in the body and about their relations with physiological functions; relations between the structure of biological macromolecules and their role, mechanisms of enzymatic catalysis and regulation of their activity, dynamics and regulation of nucleic acid and protein synthesis. To develop students' skills required for experimental work, such as selecting and applying of biochemical methods and techniques, collecting, analysing and interpreting results by using relevant scientific literature. |
| **Learning outcomes** | 1. Explained basic principles of biochemical processes in the body, and their connection with physiological functions.<br>2. Knowledge about the structure of biological molecules and ability to predict their characteristics, mutual interaction and role in the organisation and functioning of cellular processes.<br>3. Ability to predict the course of biochemical reactions under defined conditions, as well as the influence of specific compounds on the speed of enzymatically catalysed reactions.<br>4. Ability to compare different mechanisms of enzymatic catalysis, as well as mechanisms of their activity regulation.<br>5. Ability to determine the relations between inheritance and the structure of genes and DNA, as well as DNA, RNA and protein synthesis mechanisms.<br>6. Ability to compare and select appropriate biochemical techniques for analysis and purification of proteins and other macromolecules, as well as for testing of scientific hypothesis and successful researching. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-6 | 1 | Lecture | Critical conversation and discussion | Records related to active participation in lectures | 5 | 10 |
| 1-4, 6 | 1 | Practices | Independent performance of tasks and experimental exercises, data collection and analysis; commenting | Monitoring of students' work on experimental tasks; Work diary; Presentation and interpretation of | 25 | 40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | and discussing the obtained results. | results; Preliminary exams | | |
| | 1-6 | 1.5 | Written exam | Preparation for written exam | Written exam | 10 | 20 |
| | 1-6 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 20 | 30 |
| | **Total** | **4** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | Two hours a week according to schedule defined at the beginning of the academic year and additional consultation hours as agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 30 |

**Course content / teaching units**

Lectures:

- Introduction to biochemistry, chemical bonds in macromolecules, noncovalent interactions, entropy and thermodynamics laws
- Protein composition and structure
- Research into proteins and proteomes
- Methods and techniques of researching proteins
- Myoglobin and haemoglobin
- Enzymes and enzyme kinetics
- Enzymes: Catalytic strategies
- Enzymes: Regulation strategies
- Genetic information, structure and function of DNA
- DNA replication, repair and recombination
- RNA synthesis (transcription) and RNA processing
- Protein synthesis (translation)
- Control of gene expression

Practices:

- Buffers
- Ionization properties of amino acid
- Reaction time course
- Influence of pH, temperature and enzyme concentration on the speed of enzymatically catalysed reaction
- Determination of kinetic parameters $K_m$ and $V_{max}$
- Influence of effectors (inhibitors and activators) on the speed of enzymatically catalysed reactions
- Haemoglobin electrophoresis
- Determination of protein concentration
- Determination of enzyme activity
- Isoenzymes

**Recommended reading**

Berg J.M., Tymoczko J.L., Gatto G.J., Stryer L. (2019) Biochemistry (9th edition). Macmillian International Higher Education, New York.
Stryer L., Berg J., Tymoczko J. (2013) Biokemija (6. izdanje, 1. hrvatsko). Školska knjiga, Zagreb.

| | |
|---|---|
| **Optional reading** | Alberts B., Johnson A., Lewis J., Raff M., Roberts K., Walter P. (2008) Molecular Biology of the Cell (5. izdanje). Garland Science, New York.<br>Harperova ilustrirana biokemija; 28. izdanje, Medicinska naklada 2011.<br>Nelson D.L., Cox M.M. (2013) Lehninger Principles of Biochemistry (6th edition). W. H. Freeman & Co, New York.<br>Voet D., Voet J.G. (2011) Biochemistry (4th edition). Wiley, New York.<br>Original scientific papers and review papers |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After the course, students take a written exam and then oral exam. During the semester, students can take three preliminary exams and substitute them for the written exam if passing each preliminary exam with more than 60% of the total number of points. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher continuously evaluates student achievement, and gives students the opportunity to make oral or written comments. After the course, students are given a survey in which they give their subjective opinion about quality and organisation of teaching, all with the aim to improve future teaching. |

| | |
|---|---|
| **Course title** | **Biochemistry 2** |
| **Code** | BBO420 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Assist. Prof. Dr. Senka Blažetić |
| **Associate teachers** | Ana Vuković, assistant |
| **Course entry requirements (Preceding courses)** | General Chemistry (1) and Inorganic Chemistry (1) (attended), Organic Chemistry 1 (attended), Cell Biology (attended), Physical Foundations of Instrumental Methods in Biology (attended), Biochemistry 1 (passed exam) |
| **Course objective** | To understand the basic principles related to metabolism of organisms at different stages of development and the importance of preserving homeostasis. |
| **Learning outcomes** | 1. Ability to compare processes of degradation and biosynthesis in living cells.<br>2. Ability to comprehend energy changes in cellular metabolic processes of organisms at different development stages.<br>3. Ability to explain complex regulatory metabolic mechanisms, the activity of which is necessary to maintain homeostasis.<br>4. Ability to compare different types of biomolecules (carbohydrates, proteins and fats).<br>5. Ability to predict the causes of metabolic diseases and possible options for regaining of homeostasis.<br>6. Skills for integration of appropriate biochemical techniques required in scientific research related to biochemistry. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 10 | 15 |
| 1-6 | 1.5 | Practices | Independent performance of experimental tasks, data collection and analysis | Records, evaluation of initial preliminary exam, monitoring of experimental work progress; work diary | 15 | 25 |
| 1-6 | 1.5 | Written exam | Preparation for written exam | Written exam | 10 | 25 |
| 1-6 | 1.5 | Oral exam | Preparation for oral exam | Oral exam | 15 | 35 |
| **Total** | **6** | | | | **50** | **100** |

| | | | |
|---|---|---|---|
| | **Final grade:**<br>**50.1-62.5 points: grade 2 (sufficient)**<br>**62.6-75 points: grade 3 (good)**<br>**75.1-87.5 points: grade 4 (very good)**<br>**87.6-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 30 |
| **Course content / teaching units** | • General overview of metabolism, catabolism and anabolism, regulation of metabolism<br>• Carbohydrate metabolism: transport of glucose into cells, glycolysis, gluconeogenesis, pentose-phosphate pathway, metabolism of disaccharides and polysaccharides (glycogen - glycogenesis and glycogenolysis, and starch)<br>• Metabolic energy production: citric acid cycle and oxidative phosphorylation<br>• Fat metabolism: triacylglycerol, phospholipids and cholesterol.<br>• Degradation (ß-oxidation) and synthesis of fatty acids, synthesis of phospholipids, ceramides and gangliosides, synthesis of cholesterol and cholesterol-derived compounds (steroid hormones, bile salts, vitamin D)<br>• Degradation of amino acids and urea synthesis, synthesis of amino acids and cofactors, mobilisation of nitrogen from air for incorporation into biomolecules, complex regulation of the enzyme glutamine synthetase<br>• Biosynthesis and degradation of purine and pyrimidine nucleotides<br>• Integration of metabolism<br>• Biochemical methods of analysis: isolation and analysis of proteins (homogenisation, spectrophotometric determination of concentration and activity of different proteins - enzymes, electrophoresis, gel-filtration) | | |
| **Recommended reading** | Berg J. M., Tymoczko J. L., Stryer L. (2013) Biokemija, prijevod 6.-tog izdanja iz 2007. god. (Freeman & Comp., New York). Školska knjiga, Zagreb.<br>Has-Schön E. (2002) Biokemijske teme - Oksidacijska fosforilacija. Sveučilište J. J. Strossmayera, Pedagoški fakultet Osijek, elektronički udžbenik. http://bcs.whfreeman.com/biochem6 http://www.whfreeman.com/biochem5<br>Has-Schön E. (2003) Biokemijske teme – Metabolizam ugljikohidrata. Sveučilište J. J. Strossmayera, Pedagoški fakultet Osijek, elektronički udžbenik. | | |
| **Optional reading** | Devlin T.M. (ed.) (2010) Textbook of Biochemistry with Clinical Correlations, 7th ed. J.Wiley & Sons Inc., New York.<br>Garrett R.G., Grisham C.M. (2010) Biochemistry. Brooks/Cole, Cengage Learning, Boston, USA.<br>Holme D.J., Peck H. (1998) Analytical Biochemistry, 3rd ed. Addison Wesley Longman Ltd., New York.<br>Mathews C.K., Van Holde K.E., Ahern K.G. (2012) Biochemistry, 4th ed. Prentice Hall.<br>Nelson D.L., Cox M.M. (2012) Lehninger Principles of Biochemistry, 6th ed. W.H. Freeman, New York.<br>Wilson K., Walker J. (1997) Principles and Techniques of Practical Biochemistry, 4th ed. Cambridge University Press, Cambridge.<br>Voet D., Voet J.G. (2011) Biochemistry, 4th ed. J.Wiley & Sons Inc., New York. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass final written exam, which can be divided into two preliminary written exams. Points gained at written and oral exam are | | |

| | |
|---|---|
| | added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade. |
| **Main language of instruction; other languages** | Croatian language, English language |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. |

| | |
|---|---|
| **Course title** | **Cell Biology** |
| **Code** | BBO104 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | I semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Vera Cesar<br>Assoc. Prof. Dr. Davorka Hackenberger Kutuzović |
| **Associate teachers** | Assist. Prof. Dr. Jasenka Antunović Dunić<br>Assist. Prof. Dr. Lidija Begović<br>Assist. Prof. Dr. Selma Mlinarić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about structure and function of the cell. Within practices, students will obtain skills required for independent work that comprises understanding and visualisation of cellular processes. |
| **Learning outcomes** | 1. Knowledge about basic scientific findings related to the structure and function of cells in the living world.<br>2. Understanding the principles of dynamic connection between structures and their functioning in the cell.<br>3. Ability to analyse findings about the continuity of cellular processes.<br>4. Ability to analyse cell structures on independently prepared microscopic slides and developed scientific literacy.<br>5. Supported development of professional knowledge by using laboratory techniques and instrumental methods. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1 - 4 | 1.5 | Lecture | Critical conversation and discussion | Records related to active and independent participation in conversations and discussions | 6 | 10 |
| 1, 4, 5 | 1.5 | Practices | Independent production of microscopic preparations, microscopy and analysis of preparations; engagement in laboratory activities | Records related to active and independent practical work | 24 | 40 |
| 1 - 5 | 2 | Written exam | Preparation for written exam | Practice-based assessment; Written exam | 25 | 30 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 - 5 | 1 | Oral exam | Preparation for oral exam | Oral exam | 5 | 20 |
| | **Total** | **6** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 45 | 0 | 45 |

**Course content / teaching units**

Lectures:

- Chemical composition of cell
- Overview plan of cellular organization: protocytes, eucites. Cell compartmentisation
- Organisation and chemistry of biomembranes
- Forms of transport through the biomembrane
- Cytoskeleton
- Structure and function of the interphase nucleus: chromosomes, DNA and genes
- Control of gene expression
- Cell cycle
- Replication
- Transcription
- Mitosis and endomitosis
- Meiosis and crossing-over
- Endoplasmic reticulum, ribosomes and protein biosynthesis
- Golgi system, lysosomes, peroxisomes, glyoxisomes, vacuoles
- Mitochondria: ultrastructure and function. Cellular energy
- Plastids and plastid pigments
- Chloroplast ultrastructure and photosynthesis
- Cell differentiation, growth control and cancer
- Cellular immunity

Practices:

- Use of a light microscope: ocular and object micrometer
- Resolution power and usage of immersion lens
- Usage of stereomicroscope and photodocumentation
- Protocites and eucites
- Biomembranes: vital staining, borderline plasmolysis. Interphase core
- Mitosis. Production of cytological preparations
- Endomitosis
- Mitotic activity: calculation of mitotic index
- Meiosis. Crossing-over
- Plastids: chromoplasts, leucoplasts, etioplasts
- Chloroplasts and photosynthetic pigments
- Usage of a fluorescent microscope
- Chloroplast isolation
- Electrophoretic separation of proteins

**Recommended reading**

Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P. (2015) Molecular biology of the cell. 6th ed. Garland Science, Taylor & Francis Group, New York.

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| | Cooper G.M., Hausman R.E. (2010) Stanica – molekularni pristup. Peto izdanje. (Editor of Croatian edition: Lauc, G.) Medicinska naklada, Zagreb.<br>Lepeduš H., Cesar V. (2010) Osnove biljne histologije i anatomije vegetativnih organa. Sveučilište J. J. Strossmayera u Osijeku, Odjel za biologiju, Osijek.<br>Murray R. K., Bender D.A., Botham K.M., Kennelly P.J., Rodwell V.W., Weil P.A. (2011) Harperova ilustrirana biokemija. 28. izdanje. (Editors of Croatian edition: Lovrić J., Sertić J.) Medicinska naklada, Zagreb. |
| **Optional reading** | Ambriović Ristov A. (2007) Metode u molekularnoj biologiji. Institut Ruđer Bošković, Zagreb.<br>Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. (2013) Campbell biology. 10th ed. Pearson - Benjamin Cummings, San Francisco.<br>Rubbi C.P. (1994) Light microscopy: essential data. John Wiley & Sons, Chicester - New York.<br>Voet D., Voet J.G., Pratt C.W. (2016) Fundamentals of Biochemistry: Life at the Molecular Level 5th ed. John Wiley & Sons, Inc. New York. |
| **Conditions for obtaining teacher's signature** | Students are obliged to attend lectures and practices, to participate in lectures actively and to fulfil all assignments within the course. |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. The final grade is determined according to the number of points collected during the lectures and practices and the points achieved in written and oral exams. |
| **Main language of instruction; other languages** | Croatian language, English language |
| **Method of monitoring the quality and efficiency of teaching** | Carrying out a survey among students and giving them a possibility to give a written review after a lecture or exam.<br>Monitoring of student success at preliminary and final exams.<br>Carrying out a uniform University Student Survey. |

| | |
|---|---|
| **Course title** | **Plant Ecology** |
| **Code** | BBO527 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V winter semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Janja Horvatić |
| **Associate teachers** | Aleksandra Kočić, Ph.D.<br>Vera Tikas, expert advisor |
| **Course entry requirements (Preceding courses)** | Plant Anatomy, Plant Morphology with Field Work, General Ecology, Cormophyte |
| **Course objective** | To teach students about interactions between plants and about environmental influence on the life strategies of Cormophyte. To develop students' skills to analyse and predict the influence of environmental factors on the distribution of plants and plant communities. |
| **Learning outcomes** | 1. Ability to analyse the influence of abiotic and biotic factors on plants, and on their adjustment capabilities.<br>2. Ability to make connection between ecological factors and the distribution of plants and plant communities.<br>3. Ability to analyse life strategies of Cormophyte for survival of unfavourable seasons.<br>4. Ability to predict the consequences of anthropogenic impact on the environment.<br>5. Ability to use different laboratory techniques to examine how water regime of the habitat and physical and chemical properties of the soil influence composition and structure of selected phytocenoses. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1 | Lecture | Lecture attendance and active participation | Records related to active participation in conversations and discussions | 5 | 10 |
| 3,5 | 1 | Practices | Performance at experimental task, preparation of the final report, performance at preliminary exam | Monitoring of student activities and results | 10 | 20 |
| 1-5 | 1 | Written exam | Preparation for written exam | Written exam | 20 | 40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1-5 | 1 | Oral exam | Preparation for oral exam | Oral exam | 15 | 30 |
| | Total | **4** | | | | **50** | **100** |

**Final grade:**
**50-69.9 points: grade 2 (sufficient)**
**70-79.9 points: grade 3 (good)**
**80-89.9 points: grade 4 (very good)**
**90-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 30 |
| **Course content / teaching units** | Lectures:<br>• Plant ecology, definition and basic concepts<br>• Ecological factors and their influence on life and distribution of plants and plant communities<br>• Abiotic factors: climate, light, water and moisture, precipitation, wind, soil, physical and chemical properties of soil, geological background<br>• Biotic factors: symbiosis, parasitism, competition, bonds between plants and animals<br>• Anthropogenic impact<br>• Phytocenosis as a productive component of ecosystems<br>• Vegetation<br>• Primary and secondary biocenoses<br>• Successions<br>Practices:<br>• Determination of physical and chemical properties of different soil samples<br>• Microclimatic characteristics of phytocenosis habitats<br>• Water regime of habitats and plants<br>• Analysis of the composition and structure of selected phytocenoses | | |
| **Recommended reading** | Gračanin M., Ilijanić LJ. (1977) Uvod u ekologiju bilja. Školska knjiga, Zagreb.<br>Gurevitch J., Scheiner S.M., Fox G.A. (2006) Ecology of Plants. 2nd edition. Sinauer Associates Inc., US.<br>Topić J., Vukelić J. (2009) Priručnik za određivanje kopnenih staništa u Hrvatskoj prema Direktivi o staništima EU. Državni zavod za zaštitu prirode, Zagreb. | | |
| **Optional reading** | Crawley J.M. (1997) Plant Ecology. Blackwell Science.<br>Vukelić J., Mikac S., Baričević D., Bakšić D., Rosavec R. (2008) Šumska staništa i šumske zajednice u Hrvatskoj. Nacionalna ekološka mreža. Državni zavod za zaštitu prirode, Zagreb.<br>Zaninović K., Gajić-Čapka M., Perčec Tadić M., Vučetić M. (ed.) (2008) Klimatski atlas Hrvatske: 1961.-1990.: 1971.-2000. Državni hidrometeorološki zavod, Zagreb.<br>Šegota T., Filipčić A. (1996) Klimatologija za geografe. Školska knjiga, Zagreb. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Before taking oral exam, students have to pass written exam, which can be taken as a whole or split into two preliminary exams. The final grade is determined according to the number of points for student's performance and the points achieved in written and oral exams. | | |

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|---|---|
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. |

| | |
|---|---|
| **Course title** | **Animal Ecology** |
| **Code** | BBO528 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V winter semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Stjepan Krčmar |
| **Associate teachers** | Assist. Prof. Dr. Alma Mikuška<br>Assist. Prof. Dr. Goran Vignjević<br>Assist. Prof. Dr. Barbara Vlaičević |
| **Course entry requirements (Preceding courses)** | General Ecology |
| **Course objective** | To enable students to judge, analyse and determine the effects of abiotic factors on animal organisms, and to assess the role of biotic factors. Gaining of basic knowledge about the population ecology, the living community, and the ecological system as functional and dynamic form found in nature. |
| **Learning outcomes** | 1. Ability to analyse living conditions and to understand the concept of ecological factors, ecological valence, habitat, ecological niches, ability to compare elements of population, to determine the factors of movement of animal populations, and to present the structural characteristics of the living community.<br>2. Skills required to evaluate the effect of abiotic factors (climatic, edaphic) on animal organisms and on their distribution.<br>3. Skills required to analyse biotic factors: neutrality, competition, mutualism, commensalism, parasitism, amensalism and predation.<br>4. Skills required to analyse the basic categories of relations between the constituents of the ecosystem, land to make links between the creation and decomposition of organic matter and the energy flow in the ecosystem.<br>5. Ability to determine the factors of succession in the ecological system. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1 | Lecture | Lecture attendance and active participation | Records and evaluation | 15 | 25 |
| 1-3 | 1 | Practices | Practical classes attendance and active participation | Records and evaluation of task performance | 15 | 25 |
| 1-5 | 1 | Exam | Preparation for written exam | Written exam | 15 | 25 |
| 1-5 | 1 | Final exam | Preparation for final exam | Oral exam | 15 | 25 |
| **Total** | **4** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**

| | | | |
|---|---|---|---|
| | **71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | Regular consultation hours will be scheduled after being agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 30 |
| **Course content / teaching units** | Lectures:<br>• Living conditions and the concept of ecological factors (abiotic and biotic)<br>• Ecological valence, habitat, life form, ecological niche<br>• Climatic and edaphic factors and their impact on animal organisms<br>• Analysis and comparison of biotic factors<br>• Population ecology, living community and structural characteristics of living community, nutrition relations in living community<br>• Analysis of ecological systems, substances and energies in an ecological system<br>• Successions and transformations of the ecosystem, grouping and classification of ecosystems<br>Practices:<br>• Climate graph, bioclimatic graph, stage hydrograph<br>• Analysis of the qualitative composition of ichthyofauna in the Kopački Rit Nature Park<br>• Analysis of nesting bird population density in the Kopački Rit Nature Park<br>• Analysis of *Capreolus capreolus* L. deer population density<br>• Predation<br>• Analysis of the diet of *Tyto alba* (Scopoli) owl<br>• Analysis of migration of some bird populations<br>• UTM mapping | | |
| **Recommended reading** | Aber J. D., Melillo J.M. (2001) Terrestrial Ecosystems. Second edition. Harcourt Academic Press, San Diego, CA, USA.<br>Krčmar S., Hackenberger K.D. (2008) Nastavni tekst predavanja iz predmeta Ekologija životinja.<br>Price W.P. (1997) Insect Ecology. J. Wiley & Sons. Inc., New York. | | |
| **Optional reading** | Chapin F.S. III, Matson P.A., Mooney H.A. (2002) Principles of Terrestrial Ecosystem Ecology. Springer, New York, USA.<br>Lambert M., Williams J. (1988) Animal ecology, Franklin Watts. | | |
| **Conditions for obtaining teacher's signature** | Regular lecture and practice attendance. | | |
| **Exam passing procedure** | During lectures and practices, the teacher monitors and evaluates performance of each student, which refers to 50% of the final grade. Passing of final written exam refers to 25% of the final grade, and passing of final oral exam refers to the remaining 25% of the final grade. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form | | |

| | |
|---|---|
| **Course title** | **Evolution** |
| **Code** | BBO629 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 5 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Dubravka Čerba |
| **Associate teachers** | Barbara Vlaičević, Ph.D. |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To understand the basic concepts and principles of biological and chemical evolution. To develop scientific literacy that will allow understanding of more complex processes which affect evolution. |
| **Learning outcomes** | 1. Explained climatic and geological changes that occurred during geological periods and affected chemical and biological evolution.<br>2. Linking mechanisms that lead to evolutionary changes, by putting emphasis on the importance of changes in the environment, i.e. on the influence of natural selection.<br>3. Ability to assess the importance of anatomy, morphology and physiology of organisms as indicators of evolutionary relationships and adaptations to habitats, and to determine the importance of fossils and other evidence of evolution.<br>4. Ability to compare, evaluate and rank findings in the field of botany and zoology and to connect them with the causes and consequences of increased structural complexity, from simple animal organisms to the species *Homo sapiens*, or from photosynthetic organisms to Angiosperm. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 1.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 10 | 20 |
| 1-4 | 1.5 | Seminar | Solving of exercises independently, practical work. Flipped classroom. | Monitoring of student performance at interpreting and solving of exercises | 15 | 30 |
| 1-4 | 1 | Written exam | Preparation for written exam | Written exam | 20 | 30 |
| 1-4 | 1 | Oral exam | Preparation for oral exam | Oral exam | 15 | 20 |
| **Total** | **5** | | | | **60** | **100** |

| | | | |
|---|---|---|---|
| | **Final grade:**<br>**60-70 points: grade 2 (sufficient)**<br>**71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 15 | |
| **Course content / teaching units** | • Definition of the terms: evolution, microevolution and macroevolution<br>• Mechanisms of evolution: adaptations, heredity and variations, natural selection, mutations and genetic drift. Geographical variations of species, speciation, extinction of species<br>• Evolutionary ecology: competition, ecological niches, classification of interspecies interactions. Comparative and experimental adaptation models. Interspecies interaction, isolation mechanisms<br>• Gene frequency in a population. Heredity and sources of genetic variability.<br>• Darwin and selection (Impact of selection in the population. Sexual selection and sexual competition)<br>• Evidence of evolution: biogeography, comparative anatomy, comparative embryology, molecular biology; fossil age dating methods, fossilization processes, fossils as a proof of evolution<br>• The origin of the universe and the solar system, the origin of the planet Earth. Overview of geological periods, land distribution, continental floating, tectonic disturbances and climate change<br>• Chemical and biological evolution<br>• Evolution of unicellular and multicellular organisms<br>• Geological periods - climatic conditions, geological past and evolution of biota<br>• The evolution of man | | |
| **Recommended reading** | Hall B.K., Hallgrimsson B. (2008) Strickberger's Evolution. Jones and Bartlett Publishers, Canada.<br>Janković I., Karavanić I. (2009) Osvit čovječanstva. Početci našega biološkog i kulturnog razvoja. Školska knjiga, Zagreb.<br>Karavanić I. (2009) Život neadnedertalca. Školska knjiga, Zagreb. | | |
| **Optional reading** | Mayr E. (1998) To je biologija. Znanost o živom svijetu. Dom svijet, HPM, Zagreb.<br>Parker S., Bernor R.L. (ed.) (1996) Fossils. The practical guide to paleontology. Greenwich Editions. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass written exam. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

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|---|---|
| **Course title** | **Physical Foundations of Instrumental Methods in Biology** |
| **Code** | BBO103 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | I semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Vera Cesar<br>Prof. Dr. Branimir Hackenberger Kutuzović |
| **Associate teachers** | Assist. Prof. Dr. Jasenka Antunović Dunić<br>Assist. Prof. Dr. Lidija Begović<br>Assist. Prof. Dr. Selma Mlinarić<br>Assist. Prof. Dr. Željka Lončarić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about basic principles of the most commonly used instrumental methods in biology, and to enable them for independent laboratory work, for application of specific methods and for analysing and referring to scientific literature, as well as for communication with expert multidisciplinary teams. |
| **Learning outcomes** | 1. Appropriate application of basic knowledge in physics for working with instruments.<br>2. Ability to assess independently the suitability of individual instrumental methods for the analysis of various samples.<br>3. Ability to critically analyse basic principles of the most commonly used instrumental methods.<br>4. Ability to analyse and evaluate the measurement results.<br>5. Ability to connect theory and practice while working in the laboratory. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1 | Lectures | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-5 | 0.5 | Practices | Independent work by applying specific instrumental methods | Monitoring of student performance at solving of tasks | 15 | 20 |
| 1-5 | 1.5 | Written exam | Preparation for written exam | Written exam | 20 | 40 |
| 1-5 | 1 | Oral exam | Preparation for oral exam | Oral exam | 20 | 30 |
| **Total** | **4** | | | | **60** | **100** |

<table>
<tr><td></td><td colspan="3">Final grade:<br>60-70 points: grade 2 (sufficient)<br>71-80 points: grade 3 (good)<br>81-90 points: grade 4 (very good)<br>91-100 points: grade 5 (excellent)</td></tr>
<tr><td>Consultation hours</td><td colspan="3">By appointment.</td></tr>
<tr><td>Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>Hours - total</td><td>30</td><td>0</td><td>15</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">Lectures:<ul><li>Principles of the light microscope, fluorescent microscope and electron microscope</li><li>Microscopy</li><li>Principles of working with scales; weighing</li><li>Principles of pH-meter; pH-metering</li><li>Principles of thermometer; temperature measuring</li><li>Principles of oxygen electrode</li><li>Principles of spectrometer</li><li>Spectrometry</li><li>UV spectrophotometry</li><li>IR and nearIR spectrophotometry</li><li>Principles of fluorometer</li><li>Fluorometry and spectrofluorometry</li><li>Principle of electrophoresis</li><li>Principle of centrifuge, centrifugation</li><li>Main principles of chromatographic techniques</li><li>Thin-layer chromatography</li><li>Gas chromatography</li><li>Liquid chromatography</li><li>Principles of atomic absorber</li><li>Principle of mass spectrometer</li><li>Combinations of instrumental methods</li></ul>Practices:<ul><li>Microscopy</li><li>Spectrometry</li><li>UV spectrometry</li><li>NearIR spectrometry</li><li>Fluorometry</li><li>Centrifugation</li><li>pH measurement</li><li>Oxygen concentration measurement</li><li>Weighing</li><li>Electrophoresis</li><li>Isoelectric focusing</li><li>Thin-layer chromatography on paper and gel</li><li>Column chromatography</li></ul></td></tr>
<tr><td>Recommended reading</td><td colspan="3">Ambriović Ristov A. (2007) Metode u molekularnoj biologiji. Institut Ruđer Bošković, Zagreb.<br>Hilyard N.C., Biggin H.C. (1989) Fizika za biologe. Školska knjiga, Zagreb.<br>Ruzin S.E. (1999) Plant Microtechnique and Microscopy. Oxford University Press, New York, Oxford.<br>Skoog A.D., Hollert F.J., Nieman A.T. (1998) Principles of Instrumental Analysis, Saunders Golden Sunburst Series.</td></tr>
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|---|---|
| **Optional reading** | Burns D.M., Macdonald S.G.G. (1975) Fizika za biologe i medicinare. Školska knjiga, Zagreb.<br>Rickwood D., Ford T. C., Steensgaard J. (1994) Centrifugation: esential data. John Wiley & Sons, Chicester - New York.<br>Rubbi C.P. (1994) Light microscopy: essential data. John Wiley & Sons, Chicester - New York.<br>Štraus B., Stavljenić-Rukavina A., Plavšić F. (1997) Analitičke tehnike u kliničkom laboratoriju. Medicinska naklada, Zagreb. |
| **Conditions for obtaining teacher's signature** | Attending lectures and gaining minimum 5 points, attending practices and gaining minimum 15 points |
| **Exam passing procedure** | Written exam and oral exam. During lectures, the teacher monitors and evaluates performance of each student, which refers to 30% of the final grade. Passing of written exam refers to 40% of the final grade, and passing of oral exam refers to the remaining 30% of the final grade. |
| **Main language of instruction; other languages** | Croatian language, English language |
| **Method of monitoring the quality and efficiency of teaching** | Carrying out a uniform University Student Survey. Carrying out a survey among students and giving them a possibility to give a written review after a lecture or exam. Monitoring of students' success at exams. |

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|---|---|
| **Course title** | **Plant Physiology 1** |
| **Code** | BBO421 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 7 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Janja Horvatić |
| **Associate teachers** | Assist. Prof. Dr. Vesna Peršić<br>Martina Varga, Ph.D.<br>Aleksandra Kočić, Ph.D. |
| **Course entry requirements (Preceding courses)** | Cell Biology |
| **Course objective** | To learn about physiological and biochemical processes in plants and to facilitate students to develop scientific literacy by connecting theoretical knowledge with experimental research results. |
| **Learning outcomes** | 1. Definition of links between the structure of plant cells, tissues and organs and their function.<br>2. Ability to predict the connection between water potential and the transfer of water and assimilates in the plant.<br>3. Ability to analyse physiological and biochemical processes in the plant.<br>4. Ability to analyse physiological processes of autotrophic and heterotrophic plant nutrition.<br>5. Ability to determine the connection between biosynthesis and the role of secondary metabolites.<br>6. Developed skills required for application of laboratory techniques and instrumental methods in research and in explanation of physiological processes in plants. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1.5 | Lecture | Critical conversation and discussion | Records related to attendance and student activity with provision of feedback | 5 | 10 |
| 1-4, 6 | 1.5 | Practices | Performance at experimental task, writing of final reports, 2 preliminary exams | Records related to independent engagement at practices with provision of feedback | 10 | 20 |
| 1-6 | 3 | Written exam | Preparation for written exam, 2 preliminary | Written exam | 20 | 40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | exams or final written exam | | | |
| | 1-6 | 1 | Oral exam | Preparation for oral exam | Oral exam | 15 | 30 |
| | **Total** | **7** | | | | **50** | **100** |

**Final grade:**
**50-69,9 points: grade 2 (sufficient)**
**70-79,9 points: grade 3 (good)**
**80-89,9 points: grade 4 (very good)**
**90-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 45 | 0 | 45 |

**Course content / teaching units**

Lectures:

- The role of membranes, plastids, microbodies, vacuoles and cytoskeleton in the plant cell
- Biosynthesis and the role of the primary and secondary cell wall
- Water and plant cells: water potential, water status of the plant
- Uptake, transport and elimination of water in the plant
- Uptake and transport of nutrients
- Introduction to metabolism: energy and enzymes
- Photosynthesis: photochemical reactions, Calvin cycle, starch and sucrose biosynthesis
- Influence of environmental factors on photosynthesis
- Photorespiration
- Transport of assimilates in the plant
- Heterotrophic nutrition
- Cellular respiration and fat metabolism
- Phytochromes and photomorphogenesis
- Control of flowering
- Biosynthesis, structure and role of secondary metabolites in plants
- Introduction to the physiology of stress

Practices:

- Observation of plant cells and organelles
- Vital staining of plant cells
- Effect of physical and chemical factors on membrane permeability
- Plasmolysis and deplasmolysis
- Determination of the approximate protoplasm temperature maximum
- Determination of osmotic potential of cell juice by a method of borderline plasmolysis
- Determination of water potential
- Determination of water content in plant tissue
- Transpiration
- Root pressure
- Intensity of photosynthesis
- Intensity of respiration
- Respiratory chain model
- Determination of carbohydrates, proteins and lipids in plants
- Determination of phosphate, ammonium and nitrate ions in plants

| | |
|---|---|
| **Recommended reading** | Pevalek-Kozlina B. (2003) Fiziologija bilja. Profil International, Zagreb.<br>Regula I., Pevalek-Kozlina B., Vidaković-Cifrek Ž., Jelenčić B. (1997) Praktikum iz fiziologije bilja. Skripta za internu upotrebu. Prirodoslovno-matematički fakultet, Zagreb. |
| **Optional reading** | Berg J.M., Tymoczko J.L., Stryer L. (2013) Biokemija. Školska knjiga, Zagreb.<br>Taiz L., Zeiger E., Møller I M., Murphy A. (2015) Plant Physiology and Development. 6th ed. Sinauer Associates, Inc.<br>Taiz L., Zeiger E. (2010) Plant Physiology. 5th Edition. Sinauer Associates, Inc. |
| **Conditions for obtaining teacher's signature** | Regular attendance and active participation in lectures. |
| **Exam passing procedure** | Before taking oral exam, students have to pass written exam, which can be taken as a whole or split into two preliminary exams. The final grade is determined according to the number of points for student's performance and the points achieved in written and oral exams. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Monitoring of students' success at exams, making reviews during lectures, conducting survey after the course. |

| | |
|---|---|
| **Course title** | **Geobotany** |
| **Code** | BBO632 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 5 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Oleg Antonić |
| **Associate teachers** | Assist. Prof. Dr. Vesna Peršić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | Acquisition of basic knowledge about plant distribution, and about the laws of spatial and temporal distribution of plants on Earth and in Croatia. |
| **Learning outcomes** | 1. Ability to compare different strategies of plant species with regard to their distribution in an area.<br>2. Ability to identify the life forms of plants and to classify them according to their appearance in characteristic types of vegetation.<br>3. Ability to determine spatial variability of vegetation on Earth in the evolutionary (floral kingdoms) and ecological context (biomes).<br>4. Division of the area of Croatia according to vegetation types, by taking into account the basic ecological gradients.<br>5. Ability to analyse the human influence on the areals of plant species. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1 - 5 | 1 | Lecture | Participation in discussions during lectures | Records related to attendance and participation in discussions | 15 | 25 |
| 1 - 5 | 1.5 | Seminars | Preparation and presentation of seminar paper | Assessment of contents and presentation of seminar paper | 15 | 25 |
| 1-5 | 1.5 | Written exam | Preparation for written exam | Written exam | 15 | 25 |
| 1-5 | 1 | Oral exam | Preparation for oral exam | Oral exam | 15 | 25 |
| **Total** | **5** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 15 | 0 |
| **Course content / teaching units** | • Distribution of plants: autochoria, allochoria, cosmopolitans, neophytes<br>• Endemics: endemic origin, paleoendemics, relics, neoendemics, endemicity of flora<br>• Areals, disjunctions<br>• Life forms of plants<br>• Floral elements and floral kingdoms<br>• The main stages of plant development as influenced by changes in the geological past<br>• Ecological gradients in spatial distribution of plant species<br>• Overview of the vegetation of Earth and Europe<br>• Biomes and phytogeographical regions<br>• Primary and secondary vegetation succession<br>• Geobotanical position and classification of the vegetation in Croatia<br>• Human influence on the areals of plant species<br>• Plant conservation at the global, European and national level: red lists, action plans for conservation of species and habitats | | |
| **Recommended reading** | Finnie et al. (2007) Floristic elements in European vascular plants: An analysis based on Atlas Florae Europaeae. J. Biogeogr. 34, 1848-1872.<br>Mägdefrau K., Ehrendorfer F. (1997) Udžbenik botanike za visoke škole. Sistematika, evolucija i geobotanika. 4. izd. Školska knjiga, Zagreb.<br>Nikolić T., Topić J. (ed.) (2005) Crvena knjiga vaskularne flore Hrvatske: kategorije EX, RE, CR, EN i VU. Ministarstvo kulture Republike Hrvatske, Državni zavod za zaštitu prirode, Zagreb.<br>Šegulja N., Topić J. (1994) Vodič za terensku nastavu iz geobotanike i ekologije bilja. PMF, Zagreb. | | |
| **Optional reading** | Barbour M.G., Billings W.D. (2000) North American terrestrial vegetation. Cambridge University Press.<br>Forenbacher S. (2001) Velebit i njegov biljni svijet (2 iz.). Školska knjiga, Zagreb.<br>Frey W., Losch R. (1998) Lehrbuch der Geobotanik. Pflanze und Vegetation in Raum und Zeit. Gustav Fischer Verlag.<br>Tivy J. (1993) Biogeography: A Study of Plants in the Ecosphere 3rd ed. Longman Scientific & Technical. | | |
| **Conditions for obtaining teacher's signature** | Attendance at lectures and seminars and aquisition of minimum 30 points. | | |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of each student. After the course, students pass the written exam with a minimum of 15 points. After having passed the written exam, students take the oral exam and pass it with a minimum of 15 points. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form | | |

| | |
|---|---|
| **Course title** | **Genetics** |
| **Code** | BBO210 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | II semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Vera Cesar<br>Assist. Prof. Dr. Olga Jovanović Glavaš |
| **Associate teachers** | Assist. Prof. Dr. Jasenka Antunović<br>Assist. Prof. Dr. Lidija Begović<br>Assist. Prof. Dr. Selma Mlinarić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To link knowledge about inheritance with knowledge about the structure of genes and DNA, and about their functioning. To use theoretical knowledge in dealing with issues related to genetics. |
| **Learning outcomes** | 1. Ability to apply knowledge about the phenomena and laws of inheritance, i.e. about the transfer of hereditary traits from generation to generation.<br>2. Appropriate use of basic genetic terminology.<br>3. Critical analysis of basic scientific findings about the distinction between genetic and environmental influences.<br>4. Ability to integrate theoretical knowledge into practice while solving genetic problems.<br>5. Ability to analyse the relationship between the genome and the expression of individual genes.<br>6. Making correlations between an individual gene and a group of genes.<br>7. Making conclusions about complex mechanisms that influence the genome structure.<br>8. Making conclusions about the need to connect theoretical knowledge and practical skills. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-8 | 1 | Lecture | Lecture attendance and active participation | Records, evaluation | 5 | 10 |
| 2-8 | 1 | Practices | Practical classes attendance and active participation | Records, evaluation | 15 | 20 |
| 1-8 | 1 | Knowledge assessment (written exam) | Preparation for written exam | Written exam | 20 | 40 |
| 1-8 | 1 | Final exam | Exam preparation | Oral exam | 20 | 30 |
| **Total** | **4** | | | | **60** | **100** |

<table>
<tr><td></td><td colspan="3">Final grade:<br>60-70 points: grade 2 (sufficient)<br>71-80 points: grade 3 (good)<br>81-90 points: grade 4 (very good)<br>91-100 points: grade 5 (excellent)<br>Final exam: minimum number of points refers to the lowest grade (sufficient), and maximum number of points refers to the highest grade (excellent).</td></tr>
<tr><td>Consultation hours</td><td colspan="3">By appointment.</td></tr>
<tr><td>Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>Hours - total</td><td>30</td><td>0</td><td>30</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">Lectures:<ul><li>Genes and chromosomes: structure and function</li><li>Transfer of genetic material</li><li>Gametogenesis</li><li>Inheritance of one gene: Mendel's first law, monohybrid cross, codominant genes, cross test</li><li>Law of independent segregation: Mendel's second law, dihybrid cross</li><li>Bound genes and crossing-over</li><li>Gene recombination</li><li>Mechanisms of gene recombination in microorganisms: conjugation, transformation, transduction</li><li>Mechanisms of gene regulation</li><li>Nuclear and extranuclear DNA</li><li>Mutagens and mutations</li><li>Sensus stricto mutations: addition, deletion, frame-shift</li><li>Quantitative and qualitative changes in chromosome structure: duplication, deletion, translocation, inversion</li><li>Changes in the number of chromosomes: euploidy, aneuploidy</li><li>Human genetics: blood groups, HLA - system, syndromes - consequence of genetic abnormalities</li><li>Genetic engineering, cloning</li><li>Population genetics: qualitative and quantitative genes, balance and frequency of genes</li></ul>Practices:<ul><li>Cytological basis of inheritance</li><li>Gametogenesis</li><li>Monohybrid crossing</li><li>Dihybrid crossing</li><li>X2 - test</li><li>Related genes</li><li>Recombinant frequency</li><li>Vine fly</li><li>Systems of sex determination</li><li>Barr's body</li><li>Gene recombination in bacteria</li><li>Bacterial chromosome mapping</li><li>Growing bacteria for genetic research</li><li>Replica plating</li><li>Quantitative and qualitative changes in chromosome structure</li><li>Production of cytological preparations</li><li>Changes in the number of chromosomes</li></ul></td></tr>
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|---|---|
| | • Human karyotype<br>• Determination of blood groups<br>• Plant tissue culture *in vitro*<br>• Analysis of frequency of qualitative genes (Hardy-Weinberg formula) and of quantitative genes (variation polygon) in a population |
| **Recommended reading** | Lewin B. (2012) Genes XI. Oxford University Press Inc., New York.<br>Pavlica M. (2012) Genetika. Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu, web udžbenik.<br>Murray R. K., Bender D. A., Botham K. M., Kennelly P. J., Rodwell V. W., Weil P. A. (2011) Harperova ilustrirana biokemija. 28. izdanje. (Editors of Croatian edition: Lovrić, J., Sertić, J.). Medicinska naklada, Zagreb.<br>Tamarin R.H. (2004) Principles of genetics. 7th ed. McGraw – Hill Companies, New York.<br>Turnpenny P., Ellard S. (2011) Emeryjeve osnove medicinske genetike. 14. izdanje. (Editors of Croatian edition: Bulić-jakuš, F., Barišić, I.). Medicinska naklada Zagreb. |
| **Optional reading** | Ambriović Ristov A. (2007) Metode u molekularnoj biologiji. Institut Ruđer Bošković, Zagreb.<br>Alberts A., Johnson A., Lewis J., Raff M., Roberts K., Walter P. (2007) Molecular biology of the cell. 5th ed. Garland Science, New York - Abingdon.<br>Berg J. M., Tymoczko J. L., Stryer L. (2012) Biochemistry. 7th ed. W.H. Freeman & Co., New York.<br>Griffiths A.J. F., Miller J.H., Suzuki D.T., Levontin R.C., Gelbart W.M. (2000) An introduction to genetic analysis. 7th ed. W.H. Freeman & Co., New York.<br>Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. (2013) Campbell biology. 10th ed. Pearson - Benjamin Cummings, San Francisco.<br>Voet D., Voet J.G. (2010) Biochemistry. 4th ed. John Wiley & Sons, Inc. New York.<br>Lewis R. (2011) Human genetics. 10th ed. McGraw-Hill Companies, Inc., New York.<br>Zergollern LJ. et al. (1994) Humana genetika. Medicinska naklada, Zagreb. |
| **Conditions for obtaining teacher's signature** | Attendance at lectures and achievement of minimum 5 points, attendance of practices and achievement of minimum 15 points. |
| **Exam passing procedure** | Attendance at lectures and achievement of minimum 5 points, attendance of practices and achievement of minimum 15 points. |
| **Main language of instruction; other languages** | Croatian language, English language |
| **Method of monitoring the quality and efficiency of teaching** | Carrying out a uniform University Student Survey.<br>Carrying out a survey among students and giving them a possibility to give a written review after a lecture or exam.<br>Monitoring of students' success at exams. |

| | |
|---|---|
| **Course title** | **Vertebrates** |
| **Code** | BBO319 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **ECTS** | 5 |
| **Course status** | Obligatory |
| **Course teacher** | Assist. Prof. Dr. Alma Mikuška<br>Assist. Prof. Dr. Mirta Sudarić Bogojević |
| **Associate teachers** | |
| **Course entry requirements** | General Zoology |
| **Course objective** | To provide students with basic knowledge about evolution, morphology, anatomy, systematics and diversity of chordata, by putting emphasis on vertebrates, and to enable students to develop their literacy in natural science. |
| **Learning outcomes** | 1. Defined connection between different anatomical, morphological and physiological characteristics of chordata and of vertebrates and their way of life and habitats.<br>2. Make arguments about structure and function of chordata and of vertebrates during evolution.<br>3. Make review on the methods for appropriate handling of vertebrates in order to collect necessary information about their structure.<br>4. Ability to independently use manuals for vertebrate determination, and skills to distinguish between representatives of different vertebrates.<br>5. Skills to critically evaluate relevant scientific and professional literature.<br>6. Contribution to development of natural science literacy through the conceptual connection of findings, by putting emphasis on the evolution, morphology, anatomy and systematics of chordata and vertebrates. |

| **Learning outcome** | **Share of ECTS** | **Form of teaching** | **Activities of learning and teaching** | **Assessment** | | |
|---|---|---|---|---|---|---|
| | | | | **Methods of monitoring and evaluation** | **Grading Points** | |
| | | | | | **min** | **max** |
| 1, 2, 5, 6 | 1 | Lecture | Critical conversation and discussion | Records related to active participation in lectures | 5 | 10 |
| 1,3,4,5 | 2 | Practices | Anatomical section and determination of representatives from chordata and vertebrates groups | Analysis of practical work with provision of feedback | 20 | 30 |
| 1-6 | 1 | Written exam | Preparation for written exam | Written exam | 15 | 30 |
| 1-6 | 1 | Oral exam | Preparation for oral exam | Oral exam | 20 | 30 |
| **Total** | **5** | | | | **60** | **100** |

<table>
<tr><td></td><td colspan="3">Final grade:<br>60-70 points: grade 2 (sufficient)<br>71-80 points: grade 3 (good)<br>81-90 points: grade 4 (very good)<br>91-100 points: grade 5 (excellent)<br>Final exam: minimum number of points refers to the lowest grade (sufficient), and maximum number of points refers to the highest grade (excellent).</td></tr>
<tr><td>Consultation hours</td><td colspan="3">As agreed with students.</td></tr>
<tr><td>Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>Hours - total</td><td>30</td><td>0</td><td>45</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">• Introduction<br>• Systematics and evolution of Chordata<br>• Taxonomy of fossil and recent Vertebrates<br>• Characteristics of Hemichordata<br>• Biology and basic features of Tunicates and Cephalochordates<br>• Comparison of Cephalochordates and Vertebrates<br>• Systematic review of Vertebrates<br>• Evolution and characteristics of Agnatha and Placodermi<br>• Development of the skull and jaw in Vertebrates<br>• Chondrichthyes - systematics, taxonomy and anatomy<br>• Taxonomic position of Osteichthyes<br>• Actinopterygii - systematics, anatomy and diversity<br>• Morphology and anatomy of Teleostei<br>• Diversity of Teleostei<br>• Characteristics of Sarcopterygii<br>• Evolution and recent Dipnoi<br>• Evolution of the first terrestrial vertebrates<br>• Systematics, taxonomy and biology of Amphibians<br>• Adaptations of the Amphibians to extreme conditions<br>• Characteristics and diversity of Amphibians<br>• Differences between Amphibians and Reptiles<br>• Evolution of Reptiles<br>• Systematics, taxonomy and basic characteristics of the anatomy of Reptiles<br>• Varieties of Reptiles<br>• Evolution, systematics, taxonomy and biology of Birds<br>• Adjustments to flight, navigation and orientation<br>• Bird migrations<br>• Diversity of Mammals, evolution, characteristics of Mammals<br>• Systematics and characteristics of different groups of Mammals<br>• Comparative anatomy and morphology of selected representatives of Chordata and Vertebrates (Agnatha, fish, amphibians, reptiles, birds and mammals)<br>• Dissection and determination of Chondrichthyes, Osteichthyes, Amphibians, Reptiles, Birds and Mammals</td></tr>
<tr><td>Recommended reading</td><td colspan="3">Kardong V.K. (2014) Vertebrates: Comparative Anatomy, Function, Evolution. Wm.C. Brown Publishers, Duduque, Melbourne, Oxford.<br>Kardong V.K., Zalisko E. (2015) Comparative Vertebrate Anatomy: A Laboratory Dissection Guide. McGraw-Hill Education, New York.<br>King G.M., Custance D.R.N. (1982) Colour atlas of Vertebrate anatomy, an integrated text and dissection quide. Bolsover Press, London, England.<br>Pough F.H., Janis C.M., Heiser J.B. (2014) Vertebrate Life, 9th ed. Macmillan Coll Div, Prentice Hall.</td></tr>
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|---|---|
| **Optional reading** | Linzey D.W. (2012) Vertebrate Biology. Second Edition. The Johns Hopkins Univeristy Press. Baltimore.<br>Liem K.F., Bemis W.E., Walker jr. W.F., Grande L. (2001) Functional Anatomy of the Vertebrates. An Evolutionary Perspective. 3rd ed. Brooks/Cole Cengage Learning.<br>Ognev S.I., Fink N. (1956) Zoologija kralježnjaka. Školska knjiga, Zagreb. |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. |
| **Exam passing procedure** | During the exercises, the teacher reviews students' performance and corrects them, by providing information about their progress with the course content. Students are offered an option to take the written exam in form of three preliminary exams, after having completed lectures on specific groups of Chordata and Vertebrates. The first preliminary exam refers to units on Hemichordata, Tunicates, Cephalochordates, Cyclostomata, Chondrichtyes. The second preliminary exam refers to units on Teleostei, Amphibians and Reptiles. The third preliminary exam refers to units on Birds and Mammals. The points achieved at three preliminary exams are summarised and their mean value equals the points as if achieved at final written exam. The final grade refers to the points achieved on written and oral exam. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher continuously monitors the learning process and students' achievement, thus directing and adapting teaching. After the course, the teacher conducts an anonymous survey among students about their subjective experience of teaching quality. |

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|---|---|
| **Course title** | **Quantitative Biology 1** |
| **Code** | BBO208 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | II semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Branimir Kutuzović Hackenberger |
| **Associate teachers** | Assist. Prof. Dr. Željka Lončarić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | Acquisition of theoretical and practical knowledge in data processing, interpretation and selection of appropriate mathematical and/or statistical methods. |
| **Learning outcomes** | 1. Application of basic mathematical methods in solving of biology-related problems.<br>2. Setting of experiment design, from stating a hypothesis to drawing conclusions based on the collected and analysed results.<br>3. Independent application of basic statistical methods and interpretation of results.<br>4. Ability to critically review the literature related to environmental and statistical issues. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 1 | Lectures | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-4 | 1 | Practices | Solving of biology-related tasks, analysing the experiment data | Monitoring of student performance at solving of tasks | 10 | 15 |
| 1-4 | 1 | Written exam | Preparation for written exam | Written exam | 20 | 35 |
| 1-4 | 1 | Oral exam | Preparation for oral exam | Oral exam | 25 | 40 |
| **Total** | **4** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 15 |
| **Course content / teaching units** | Lectures:<br>• Review of the mathematical analyses<br>• Functions<br>• Changes in the rates of biological processes<br>• Application of linear differential equations<br>• Multivariable functions<br>• Laplace transformation<br>• Euler's method<br>• The least square method<br>• Combinatorics<br>• Probability theory<br>• Data. Sampling. Basic data properties<br>• Experiment<br>• Statistical and practical significance<br>• The t-test<br>• Analysis of variance<br>• The Wilcoxon tests<br>• Spearman's correlation<br>• The Kruskal-Wallis test<br>• The Friedman test<br>• Poisson's ratio test<br>• Binomial test<br>• hi2-test<br>• The Cochran test<br>• Time series analysis<br>• Cluster analysis<br>Practices:<br>• Application of mathematical analysis in solving biology- and ecology-related problems (functions, limits, derivatives, integrals, differential equations)<br>• Basic statistical tests (parametric and non-parametric tests)<br>• Computer-aided statistical data analysis | | |
| **Recommended reading** | Brittom F.N. (2003) Essential Mathematical Biology. Springer Verlag, London.<br>Petz B. (2004) Osnove statističke metode za nematematičare. Naklada Slap, Jastrebarsko.<br>Simon W. (1986) Mathematical Techniques for Biology and Medicine. General Publishing Company, Toronto. | | |
| **Optional reading** | Bohl E. (2001) Mathematik in der Biologie. Springer Verlag, Berlin.<br>Quinn P.G. (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press, Cambridge. | | |
| **Conditions for obtaining teacher's signature** | Regular attendance at lectures, successfully completed practices. | | |
| **Exam passing procedure** | During lectures, the teacher monitors and evaluates performance of each student, which refers to 30% of the final grade. Passing of written exam refers to 30% of the final grade, and passing of oral exam refers to the remaining 40% of the final grade. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |

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| **Method of monitoring the quality and efficiency of teaching** | Student survey to evaluate the overall quality of the course.<br>Analysis of student success at the exams. |

| | |
|---|---|
| **Course title** | **Microbiology** |
| **Code** | BBO105 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | I semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Ljiljana Krstin<br>Assist. Prof. Dr. Goran Palijan |
| **Associate teachers** | Assist. Prof. Dr. Zorana Katanić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about specifics and significance of viruses, subviral pathogens and prokaryotic and eukaryotic microorganisms, and to develop their skills required for working in a microbiological laboratory. |
| **Learning outcomes** | 1. Ability to compare morphology and structure of viruses, subviral pathogens, prokaryotic and eukaryotic microorganisms.<br>2. Skills to define the basic ecological characteristics of microorganisms.<br>3. Ability to compare metabolic characteristics of prokaryotic and eukaryotic microorganisms.<br>4. Ability to determine the most significant diseases caused by microorganisms.<br>5. Skills to select and carry out microbiological analyses in a laboratory. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 1 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 10 | 20 |
| 5 | 1.5 | Practices | Performance at experimental task | Monitoring of student performance | 20 | 30 |
| 1-5 | 1 | Written exam | Preparation for written exam | Written exam | 20 | 30 |
| 1-5 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 10 | 20 |
| **Total** | **4** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

<table>
<tr><td>Consultation hours</td><td colspan="3">By appointment.</td></tr>
<tr><td>Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>Hours - total</td><td>30</td><td>0</td><td>30</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">Lectures:<br>• Introductory lecture – presenting the course content, reading list and obligations of students<br>• Prokaryotes - cell structure<br>• Growth of microorganism and microbial ecology<br>• Biogeochemical cycles<br>• Cellular metabolism (autotrophs and heterotrophs)<br>• Biofilms - mechanisms of formation and structure<br>• Physical and chemical control of bacteria<br>• Antibiotics<br>• Relationship between humans and microorganisms<br>• The most important discoveries and historical development of virology<br>• Basic characteristics and division of viruses<br>• Diversity of viruses, shape and size of virus particles<br>• Structure and chemical composition of viral particles<br>• Types of viral genomes<br>• Bacterial viruses<br>• Mycoviruses<br>• Subviral pathogens<br>• Animal viruses and their diagnostics<br>Practices:<br>• Bacteriological substrates<br>• Microscopic bacterial preparations<br>• Isolation of pure culture<br>• Metabolic traits of bacteria<br>• Sanitary bacteriology<br>• Swab and antibiogram<br>• Processing of results<br>• Mechanical inoculation of plant viruses<br>• External and internal symptoms of viral infections<br>• Virus detection and diagnosis<br>• Transmission of viruses by vegetative propagation<br>• Conservation of viruses</td></tr>
<tr><td>Recommended reading</td><td colspan="3">Duraković S. (1999) Opća mikrobiologija. Durieux, Zagreb.<br>Juretić N. (2002) Osnove biljne virologije. Školska knjiga, Zagreb.<br>Kalenić S. i suradnici (2019) Medicinska mikrobiologija. Medicinska naklada, Zagreb.<br>Madigan, M. T., Bender K. S., Buckley D. H., Sattley W. M., Stahl D. A. (2019) Brock Biology of Microorganisms. Pearson, New York.<br>Presečki V. (2003) Virologija. Medicinska naklada, Zagreb.<br>Wiley J., Sherwood L., Woolverton C. (2017) Prescott's Microbiology, 10th ed. McGraw Hill, New York.</td></tr>
<tr><td>Optional reading</td><td colspan="3">Anderson D., Salm S., Allen D., Nester E.W. (2015) Nester’s Microbiology: A Human Perspective. 8th ed. McGraw-Hill, New York.<br>Antolović R., Frece J., Gobin I., Hrenović J., Kos B., Markov K., Mlinarić-Missoni E., Novak J., Ožanič M., Pinter Lj., Plečko V., Pleško S., Šantić M., Šegvić Klarić M., Šeruga Musić M., Škorić D., Šušković J. (2016) Priručnik za vježbe iz opće mikrobiologije. Hrvatsko mikrobiološko društvo, Zagreb.<br>Scientific papers referring to the subject area.</td></tr>
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| **Conditions for obtaining teacher's signature** | |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students take a written exam and then an oral exam. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Students have the opportunity to express their opinion about the organisation and quality of delivered lectures within an anonymous survey, and to make oral or written comments after lectures or exams; Monitoring of students' success at exams. |

| | |
|---|---|
| **Course title** | **Molecular Biology** |
| **Code** | BBO526 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Ivna Štolfa Čamagajevac |
| **Associate teachers** | Ana Vuković, assistant<br>Ksenija Doboš, laboratory technician |
| **Course entry requirements (Preceding courses)** | Cell Biology (passed exam) |
| **Course objective** | To teach students about the molecular structure of the cell by connecting the organisation of cellular structures and biomolecules with their functions. |
| **Learning outcomes** | 1. Ability to explain principles of connection between the organisation of cell structures and their function in the cell.<br>2. Ability to compare synthesis and processing of DNA, RNA and proteins between prokaryotic and eukaryotic cells.<br>3. Skills required for reviewing of mechanisms of genetic activity regulation.<br>4. Ability to explain different ways of cell signalling regulation.<br>5. Ability to compare the phases of cell cycle.<br>6. Ability to critically evaluate scientific contribution and suitability of molecular methods presented in scientific papers related to the subject area of the course.<br>7. Contribution to the development of expertise in biology by applying molecular and biological methods (isolation and characterization of DNA and RNA, PCR, RT-PCR). |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1 | Lecture | Critical conversation and discussion; collaborative learning and reciprocal teaching; knowledge-based tasks | Records related to active and independent participation in lecture activities | 5 | 10 |
| 6 | 1.5 | Seminar | Independent preparation of seminar paper and its presentation | Analysis of seminar paper with provision of feedback | 20 | 30 |
| 7 | 1 | Practices | Independent performance of laboratory exercises | Records related to active and independent participation in | 10 | 20 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | practical activities | | |
| | 1-7 | 1.5 | Written exam | Exam preparation | Exam | 20 | 30 |
| | 1-7 | 1 | Oral exam | Preparation for oral exam | Oral exam | 5 | 10 |
| | **Total** | **6** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 15 | 30 |

**Course content / teaching units**

Lecture:
- Diversity and organisation of prokaryotic and eukaryotic genomes
- DNA replication in prokaryotes and eukaryotes
- Repair and maintenance of genomic DNA
- RNA synthesis and processing
- Regulation of gene expression in prokaryotes and eukaryotes
- Synthesis, processing and regulation of proteins
- Intracellular protein transport
- Cellular signalling
- Cell cycle
- Basic methods in molecular biology

Seminars:
- Presentation of various topics referring to available scientific literature of molecular biology

Practices:
- Isolation and characterisation of DNA and RNA. PCR, agarose electrophoresis and purification of PCR products
- RT-PCR

**Recommended reading**

Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P. (2015) Molecular biology of the cell. 6th ed. Garland Science, Taylor & Francis Group. New York.
Cooper G.M., Hausman R.E. (2010) Stanica - molekularni pristup. 5 izd. Medicinska naklada, Zagreb.

**Optional reading**

Ambriović-Ristov A., Brozović A., Mađarić Bruvo B., Ćetković H., Hranilović D., Bosnar Herak M., Hećimović Katušić S., Radan Meštrović N., Mihaljević S., Slade N., Vujaklija D. (2007) Metode u molekularnoj biologiji. Institut Ruđer Bošković, Zagreb.
Voet D., Voet J.G., Pratt C.W. (2016) Fundamentals of Biochemistry: Life at the Molecular Level 5th Edition. John Wiley & Sons, Inc. New York.
Znanstveni radovi

**Conditions for obtaining teacher's signature**

Students are obliged to participate in lectures actively and to fulfil all assignments within the course.

**Exam passing procedure**

During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. The teacher thus provides continuous feedback, which students use to assess their learning progress and to create a portfolio to improve the learning process and their own professional development. At the end of the course, students shall pass the written exam, after which they take oral exam. During the

| | |
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| | oral exam, the teacher asks questions that are related to learning outcomes. The final grade is determined according to the number of points achieved at written and oral exam and the number of points gained during lectures. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher performs evaluation for learning by continuous monitoring of the learning process and student achievement, thus determining and adapting his/her teaching. After the course, the teacher conducts a survey among students to evaluate their subjective impression about the teaching quality, all with the aim to improve future teaching. |

| | |
|---|---|
| **Course title** | **Plant Morphology with Field Work 1** |
| **Code** | BBO213 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | II semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Assist. Prof. Dr. Dubravka Špoljarić Maronić |
| **Associate teachers** | Assoc. Prof. Dr. Tanja Žuna Pfeiffer<br>Assoc. Prof. Dr. Melita Mihaljević<br>Assist. Prof. Dr. Filip Stević<br>Nikolina Bek, assistant |
| **Course entry requirements (Preceding courses)** | Plant Anatomy (attended) |
| **Course objective** | To acquire knowledge about basic concepts of morphological structure and the role of plant organs and organ systems. |
| **Learning outcomes** | 1. Ability to determine relationships between morphological structure and function of plant organs.<br>2. Ability to use professional literature and basic botanical databases, as well as keys for determination of plants.<br>3. Ability to distinguish, name and systematise plant species by applying theoretical knowledge and skills acquired through field research and collection of herbaria.<br>4. Knowledge about differences in plant communities and plant adaptations to different habitats. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1, 3-4 | 0.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-4 | 1.5 | Practices | Analysis of morphological structure of plant organs, field research, determination of plants and making a herbarium | Records related to student performance at practices, field work report, control of herbarium | 25 | 40 |
| 1-4 | 1 | Written exam | Preparation for written exam | Written exam | 15 | 25 |
| 1-4 | 1 | Oral exam | Preparation for oral exam | Oral exam | 15 | 25 |
| **Total** | **4** | | | | **60** | **100** |

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|---|---|---|---|
| | **Final grade:**<br>**60-70 points: grade 2 (sufficient)**<br>**71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 30 |
| **Course content / teaching units** | Lectures:<br>• Systematics and nomenclature of land plants<br>• Life forms of plants and division according to ecological requirements/habitats<br>• Morphology of plant organs<br>• Plant propagation, change of generations, pollination and fertilization<br>• Structure and distribution of seeds and fruits<br>• Germination and sprouts<br>Practices:<br>• Analysis of morphological structure of plant organs<br>• Field-based learning: collecting information about park, meadow and ruderal communities in the area of Osijek and the vegetation of the Kopački Rit Nature Park, collecting plant material<br>• Determination of the plant taxa by using standard identification keys and botanical databases<br>• Making a herbarium | | |
| **Recommended reading** | Nikolić T. (2017) Morfologija biljaka. Razvoj, građa i uloga biljnih tkiva, organa i organskih sustava. Alfa d.d., Zagreb.<br>Nikolić T. (2013) Sistematska botanika. Raznolikost i evolucija biljnog svijeta. Alfa d.d., Zagreb<br>Nikolić T. (1996) Herbarijski priručnik. Školska knjiga, Zagreb. | | |
| **Optional reading** | Denfer D., Ziegler H. (1988) Botanika: morfologija i fiziologija. Školska knjiga, Zagreb.<br>Domac R. (1994) Flora Hrvatske Priručnik za određivanje bilja, Školska knjiga, Zagreb.<br>Idžojtić M. (2009) Dendrologija: list. Sveučilište u Zagrebu, Šumarski fakultet.<br>Idžojtić M. (2013) Dendrologija: cvijet, češer, plod, sjeme. Sveučilište u Zagrebu, Šumarski fakultet, Hrvatske šume.<br>Nikolić T. (2013) Praktikum sistematske botanike. Raznolikost i evolucija biljnog svijeta. Alfa d.d., Zagreb.<br>Nikolić T., Mitić B., Boršić I. (2014) Flora hrvatske: invazivne biljke. Alfa d.d., Zagreb.<br>Nikolić T. ed.: Flora Croatica Database (URL http://hirc.botanic.hr/fcd). Prirodoslovno-matematički fakultet, Sveučilište u Zagrebu. | | |
| **Conditions for obtaining teacher's signature** | Active participation in lectures and fulfilment of all assignments within the course. | | |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students shall pass the written exam, as well as oral exam. The final grade is determined according to the number of points gained during lectures and practices and the number of points achieved at written and oral exam. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |

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| **Method of monitoring the quality and efficiency of teaching** | Making reviews during lectures; Carrying out of a student survey to obtain remarks and comments referring to organisation and realisation of teaching after the course; Monitoring of students' success at exams. |

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|---|---|
| **Course title** | **General (1) and Inorganic (1) Chemistry** |
| **Code** | |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | I semester |
| **Workload/ECTS credits** | 7 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Valentina Pavić |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about basic concepts of general chemistry, chemical calculus and to enable them to develop basic skills in laboratory work. To introduce students to chemical theories of atomic structure, wave mechanics, quantum chemistry and thermodynamics. |
| **Learning outcomes** | 1. Ability to predict the properties of chemical elements and their compounds based on the periodicity of properties.<br>2. Ability to determine the shape, structure and properties of molecules by using the theory of chemical bonds.<br>3. Knowledge about integration of basic chemical concepts and solving of problems related to general and inorganic chemistry by applying skills in data processing, interpretation and selection of appropriate mathematical procedures.<br>4. Ability to confirm the relationships between stoichiometric coefficients, reactants and products in the chemical equation.<br>5. Skills to establish safety measures when working in the chemical laboratory, to provide first aid, to organise work in the chemical laboratory.<br>6. Skills to use acquired theoretical knowledge in experimental work by applying basic laboratory procedures. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-2 | 1 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 6 | 10 |
| 3-4 | 1.5 | Seminar | Interpretation of chemical concepts and tasks related to application of interpretation results and concepts | Monitoring of student's interpretations and performance at tasks | 15 | 25 |
| 5-6 | 1.5 | Practices | Independent work within specific experiments | Records related to students' activities within practices with provision of feedback | 12 | 20 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5-6 | 1 | Exam (preliminary) | Interpretation of experimental data and tasks related to application of interpretation results and concepts | Monitoring of student's interpretations and performance at tasks | 9 | 15 |
| | 1-6 | 1 | Written exam | Preparation for written exam | Written exam | 9 | 15 |
| | 1-6 | 1 | Oral exam | Preparation for oral exam | Oral exam | 9 | 15 |
| | **Total** | **7** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

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|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 30 | 45 |

**Course content / teaching units**

Lectures**:**

- Matter and energy
- Structure of atoms
- Basic chemical laws
- Chemical bonds
- Solids, gases and liquids
- Solutions: the concept of concentration, hydration and solvation
- Acids and bases
- Chemical reactions
- The concept of chemical equilibrium
- Periodic Table of Elements
- Chemistry of elements within main groups
- Transition metals and complex compounds
- Methods of chemical analysis

Seminar:

- Units of measurement
- Relative atomic and molecular mass
- Chemical equivalents
- Solution concentration
- Redox reactions
- Gas laws
- Electrolytes
- pH and buffers
- Neutralisation of acids and bases
- Salt hydrolysis
- Solubility product
- Electrochemistry

Practices:

- Introduction to laboratory work and laboratory equipment
- Safety measures and rules of conduct and work in the practice hall. Working with hazardous chemicals. Laboratory equipment and utensils

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| | • Gas burner flame properties<br>• Mass measurement. Chemical laws<br>• Molar mass and molar volume of gases<br>• Preparation of solutions of given composition and pH, volumetry<br>• Mechanical separation of mixtures<br>• Separation of mixtures based on vapour pressure difference<br>• Kinetics of chemical reactions<br>• Chemical equilibrium and energy of chemical reactions<br>• Properties of metal hydroxide and hydrogen peroxide<br>• Colligative properties of solutions<br>• Oxidation and reduction reactions<br>• Hydrolysis and ionic components of water<br>• Methods of instrumental analysis (thin-layer chromatography) |
| **Recommended reading** | Filipović I., Lipanović S. (1995) Opća i anorganska kemija, I i II. dio. Školska knjiga, Zagreb.<br>Pavić V. (2015) Osnovni praktikum opće kemije. Odjel za biologiju, Osijek.<br>Sikirica M. (2008) Stehiometrija. Školska knjiga, Zagreb.<br>Sikirica M., Korpar-Čolig B. (2001) Praktikum iz opće kemije. Školska knjiga, Zagreb. |
| **Optional reading** | Silberberg M. (2003) Chemistry, 3. izd. McGraw-Hill, Inc., New York.<br>Greenwood N.N., Earnshaw A. (2002) Chemistry of the Elements. Pergamon Press, Oxford. |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. |
| **Exam passing procedure** | During the course, students will take written preliminary exams, which can be considered as a substitute for the final written exam. Before taking oral exam, students are required to fulfil all practical assignments and a seminar task. During practices, students will be taking initial preliminary exam either orally or in writing. It is mandatory for students to write a laboratory diary and reports. The final grade is calculated by summarizing the points that students achieve at preliminary exams, at seminar, at written and oral exam and the points obtained during lectures. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. |

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|---|---|
| **Course title** | **General Ecology** |
| **Code** | BBO318 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Stjepan Krčmar |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To enable students to develop opinions based on arguments about concepts of ecology, and to train them to understand and assess the influence that humans have on the ecosphere. Furthermore, students will develop ability to compare and classify certain categories of nature protection and protected areas in the Republic of Croatia. |
| **Learning outcomes** | 1. Ability to define the relations between ecology and other scientific fields and to support the basic assumptions of ecology.<br>2. Ability to classify biotic systems, and to connect biogeochemical cycles of elements that are the most commonly present in living organisms.<br>3. Skills to compare abiotic and biotic factors.<br>4. Developed opinion about the influence that humans have on the atmosphere and global climate, and acquired knowledge about the importance of the ozone layer.<br>5. Ability to make revision on the impact of humans on the hydrosphere, cryosphere, pedosphere, lithosphere and biosphere, and awareness about importance of nature protection and the role of protected areas. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1 | Lecture | Lecture attendance and active participation | Records and evaluation | 30 | 50 |
| 1-5 | 0.5 | Exam (written) | Preparation for written exam | Written exam | 15 | 25 |
| 1-5 | 0.5 | Final exam | Preparation for oral exam | Oral exam | 15 | 25 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

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|---|---|---|---|
| **Consultation hours** | Regular consultation hours will be scheduled after being agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 0 |
| **Course content / teaching units** | • Historical overview of the development of ecology and the relations between ecology and other scientific fields<br>• Foundations of ecology<br>• Biotic systems, biogeochemical cycles of the elements that are the most present in living organisms<br>• Abiotic and biotic factors, and comparison of abiotic and biotic factors<br>• Human influence on the atmosphere and global climate<br>• Ozone layer<br>• Human influence on the hydrosphere and cryosphere<br>• Human influence on the pedosphere and lithosphere<br>• Human impact on the biosphere<br>• Sustainable development<br>• The main causes of global changes<br>• Nature protection and protected areas | | |
| **Recommended reading** | Glavač V. (1999) Uvod u globalnu ekologiju. DUZPO, Zagreb.<br>Krčmar S. (2012) Nastavni tekst predavanja iz Opće ekologije.<br>Krohne D.T. (2000) General ecology. Brooks/Cole Pub. Co..<br>Springer P., Springer D. (2008) Otrovani modrozeleni planet. Meridijani, Zagreb. | | |
| **Optional reading** | Carter N. (2004) Strategije zaštite okoliša. Barbat, Zagreb.<br>Delort R., Walter F. (2002) Povijest europskog okoliša. Barbat, Zagreb.<br>Townsend C.R., Begon M., Harper J.L. (2003) Essentials of ecology. Blackwell Pub. | | |
| **Conditions for obtaining teacher's signature** | Regular attendance at lectures. | | |
| **Exam passing procedure** | During lectures, the teacher monitors and evaluates performance of each student, which refers to 50% of the final grade. Passing of written exam refers to 25% of the final grade, and passing of oral exam refers to the remaining 25% of the final grade. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form | | |

| | |
|---|---|
| **Course title** | **General Zoology** |
| **Code** | BB0106 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | I semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teachers** | Prof. Dr. Enrih Merdić<br>Assist. Prof. Dr. Nataša Turić |
| **Associate teachers** | Assist. Prof. Dr. Goran Vignjević |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To introduce students to the basic concepts of zoological science, which they shall use in learning and understanding of all disciplines of zoology. |
| **Learning outcomes** | 1. Ability to interpret properly the basic principles of zoology and related areas.<br>2. Acquired knowledge about basic characteristics of tissues and about their connections within systems of organs.<br>3. Ability to determine the distribution of the living world according to the principles of systematics.<br>4. Ability to compare the structure and life actions of animal organisms.<br>5. Ability to make conclusions about relations of evolutionary mechanisms and the origin and development of species. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-5 | 2 | Practices | Performance at experimental task | Records related to achievements at preliminary exams and performance at practical assignments | 20 | 30 |
| 1-5 | 1.5 | Written exam | Preparation for written exam | Written exam | 25 | 40 |
| 1-5 | 1 | Oral exam | Preparation for oral exam | Oral exam | 10 | 20 |
| **Total** | **6** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 45 | 0 | 45 |
| **Course content / teaching units** | Lectures:<br>• Introduction to zoology<br>• What is life, diversity of animal forms, basics of systematics, systematic categories, nomenclature, and terms: species, subspecies, population, speciation and isolation mechanisms<br>• Division of the animal world<br>• The origin and development of the human race<br>• Histology - basic determinants of the structure and functioning of the four basic tissues<br>• Structure and functioning of organisms through systems of organs: the cover or integumentary system, support or skeletal system, muscular system, nervous or neural system, sensory or receptor system, respiratory system, circulatory system, digestive system, urinary or excretory system, hormonal or endocrine system and reproductive system<br>• Animal behaviour<br>Practices:<br>• Practices will be organised according to the contents and schedules of lectures | | |
| **Recommended reading** | Junqueira L.C., Carneiro J. (2005) Osnove histologije. Školska knjiga, Zagreb.<br>Matoničkin I., Erben R. (2002) Opća zoologija. Školska knjiga, Zagreb.<br>Matoničkin I., Klobučar G., Kučinić M. (2010) Opća zoologija. Školska knjiga, Zagreb.<br>Lectures within the course General Zoology:<br>http://biologija.unios.hr/webbio/nastava/nastavni-materijali | | |
| **Optional reading** | Enger E.D., Ross F.C., Bailey D.B. (2005) Concepts in Biology. WCB Mc. Graw - Hill Companiec Inc., New York.<br>Habdija I., Primc-Habdija B., Radanović I., Vidaković J., Kučinić M., Špoljar M., Matoničkin R., Miliša M. (2004) Protista – Protozoa i Metazoa – Invertebrata. Funkcionalna građa i praktikum. Meridijani, Samobor.<br>Hunter M.L. JR., Gibbs J. (2007) Fundamentals of Conservation Biology. 3rd ed. Blackwell Publishing, UK.<br>Mader S. (2004) Biology. WCB Mc. Graw - Hill Companiec Inc., New York. | | |
| **Conditions for obtaining teacher's signature** | Fulfilment of all practical assignments, passed initial preliminary exam and attendance of at least 70% of lectures. | | |
| **Exam passing procedure** | During lectures, the teacher monitors and evaluates performance of each student (Attendance at lectures and performance of practical tasks), which refers to 25% of the final grade. During the course, students can take 3 preliminary exams, which can be considered as a substitute for the final written exam that corresponds to 25-40 % of the final grade.<br>Final exam contributes with 20% to the final grade. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. | | |

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|---|---|
| **Course title** | **Organic Chemistry 1** |
| **Code** | BBO207 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | II semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Mirna Velki |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General (1) and Inorganic Chemistry (1) (attended) |
| **Course objective** | To understand basic concepts of the structure and properties of organic matter. To enable students to independently implement practical laboratory techniques for synthesis, isolation and purification of organic compounds. |
| **Learning outcomes** | 1. Ability to describe and explain the types of organic compounds (saturated, unsaturated and aromatic hydrocarbons, alcohols, ethers, amines, aldehydes and ketones, carboxylic acids and their derivatives).<br>2. Ability to compare the physical and chemical properties of organic compounds (melting point, boiling point, solubility).<br>3. Ability to analyse the reactivity of organic compounds with respect to their structure and stereochemistry.<br>4. Ability to propose appropriate mechanisms of addition, substitution and elimination reactions to which organic molecules are subjected.<br>5. Ability to interpret the division, structure and properties of natural organic compounds.<br>6. Skills to apply methods for synthesis, isolation and purification of organic compounds. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 0.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-5 | 2 | Seminars | Solving of calculus tasks | Monitoring of student performance | 10 | 20 |
| 1-6 | 2 | Practices | Performance at experimental task | Monitoring of student performance | 10 | 20 |
| 1-6 | 1 | Written exam | Preparation for written exam | Written exam | 10 | 20 |

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<tr><td></td><td>
<table>
<tr><td>1-6</td><td>0.5</td><td>Oral exam</td><td>Preparation for oral exam</td><td>Oral exam</td><td>15</td><td>30</td></tr>
<tr><td>Total</td><td>6</td><td></td><td></td><td></td><td>50</td><td>100</td></tr>
</table>
Final grade:<br>
50-63 points: grade 2 (sufficient)<br>
64-76 points: grade 3 (good)<br>
77-89 points: grade 4 (very good)<br>
90-100 points: grade 5 (excellent)
</td></tr>
<tr><td>Consultation hours</td><td>Mondays, 10.00 – 11.00 a.m.</td></tr>
<tr><td>Teaching</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Practices</th></tr>
<tr><td>30</td><td>15</td><td>30</td></tr>
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</td></tr>
<tr><td>Hours - total</td><td></td></tr>
<tr><td>Course content / teaching units</td><td>
Lectures:<br>
• Characteristics of organic compounds (electronic structure, structural formulas)<br>
• Bonds in organic molecules, hybridisation, resonance of conjugate systems<br>
• Division and properties of organic compounds<br>
• Reactivity and nomenclature of organic compounds, basics of reaction mechanisms<br>
• Stereochemistry, optical activity and chirality of compounds<br>
• Alkanes, alkenes, alkynes<br>
• Aldehydes, ketones and carboxylic acids<br>
• Aromatic hydrocarbons<br>
• Alcohols, ethers, phenols and halogenoalkanes<br>
• Carbohydrates and heterocyclic compounds<br>
Seminars:<br>
• Solving of tasks related to the following units: nomenclature of carbon compounds; stereochemistry; mechanisms of addition, substitution and elimination reactions<br>
Practices:<br>
• Determination of compound composition<br>
• Classification and identification of hydrocarbon<br>
• Classification and identification of alcohols and phenols<br>
• Classification and identification of aldehydes and ketones<br>
• Carboxylic acids and derivatives<br>
• Identification of carbohydrates from natural sources<br>
• Isolation of natural compounds<br>
• Reactions of electrophilic aromatic substitution<br>
• Reactions of nucleophilic substitution<br>
• Identification of organic compounds
</td></tr>
<tr><td>Recommended reading</td><td>Pine S.H. (1994) Organska kemija. Školska knjiga, Zagreb.<br>Rapić V. (1994) Postupci priprave i izolacije prirodnih spojeva. Školska knjiga, Zagreb.<br>Rapić V. (2004) Nomenklatura organskih spojeva. Školska knjiga, Zagreb.Vodič kroz IUPAC-ovu nomenklaturu organskih spojeva (2002); translated by: Bregovec, Horvat, Majerski, Rapić. Školska knjiga, Zagreb.</td></tr>
<tr><td>Optional reading</td><td>Clayden J., Greeves N., Warren S. (2012) Organic Chemistry, 2nd ed. Oxford University Press.<br>Crowe J., Bradshaw T. (2014) Chemistry for the Biosciences - The Essential Concepts 3rd ed. Oxford University Press.</td></tr>
<tr><td>Conditions for obtaining teacher's signature</td><td>Students are obliged to participate in lectures actively and to fulfil all assignments within the course.</td></tr>
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| **Exam passing procedure** | Before taking oral exam, students are obliged to pass final written exam (which can be passed within preliminary exams held during the course). The final grade refers to the points achieved on written and oral exam and the points obtained during lectures. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Student survey, possibility to make oral or written remarks after lectures. Monitoring of student success at preliminary and final exams. |

| | |
|---|---|
| **Course title** | **Basic Practice in General Chemistry** |
| **Code** | BBO102 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | I semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Valentina Pavić |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students how to predict possible hazards when performing practical tasks, to explain the rules of conduct and the basics of safe work in a chemical laboratory. To develop students' creative and critical thinking skills when drawing conclusions based on data obtained by using laboratory techniques and instrumental methods. To raise students' awareness of ethics and responsibility at interpreting the obtained experimental results. |
| **Learning outcomes** | 1. Knowledge about the safety measures and first aid measures applied in a chemical laboratory, and developed skills related to organisation of work in a chemical laboratory.<br>2. Ability to analyse basic chemical concepts.<br>3. Ability to determine the molar mass of metal and molar volume of gas by using laboratory methods.<br>4. Ability to neutralise the self-created solution of the given composition and pH value.<br>5. Ability to separate mixtures into individual ingredients by using laboratory separation techniques.<br>6. Ability to determine the links between hydrolysis, the influence of soluble substances and ionic components on the colligative properties and levels of chloride in water, and to design procedures for gaining of drinking water.<br>7. Ability to determine the dependence of chemical reaction rate on concentration, temperature and other factors.<br>8. Ability to solve problems in the field of general and inorganic chemistry by applying knowledge and skills in data processing, data interpretation and selection of appropriate mathematical procedures. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-8 | 1.5 | Practices | Independent preparation of specific experiments | Records related to students' activities within practices with provision of feedback | 15 | 30 |
| 1-8 | 1.5 | Knowledge assessment (preliminary exam) | Interpretation of experimental data and tasks related to application of interpretation results to the concepts learned within the course | Monitoring of student's interpretations and performance at tasks | 25 | 40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1-8 | 1 | Final exam | | Written exam | 20 | 30 |
| | **Total** | **4** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 0 | 0 | 45 |

**Course content / teaching units**

- Introduction to laboratory work and laboratory equipment
- Safety measures and rules of conduct and work in the practice hall. Working with hazardous chemicals. Laboratory equipment and utensils
- Gas burner flame properties
- Mass measurement. Chemical laws
- Molar mass and molar volume of gases
- Preparation of solutions of given composition and pH. Volumetry
- Mechanical separation of mixtures
- Separation of mixtures based on vapour pressure difference
- Kinetics of chemical reactions
- Chemical equilibrium and energy of chemical reactions
- Properties of metal hydroxide and hydrogen peroxide
- Colligative properties of solutions
- Oxidation and reduction reactions
- Hydrolysis and ionic components of water
- Methods of instrumental analysis (thin-layer chromatography)

**Recommended reading**

Pavić V. (2015) Osnovni praktikum opće kemije. Odjel za biologiju, Osijek.
Sikirica M., Korpar-Čolig B. (2001) Praktikum iz opće kemije. Školska knjiga, Zagreb.

**Optional reading**

Filipović I., Lipanović S. (1995) Opća i anorganska kemija, 1st and 2nd part. Školska knjiga, Zagreb.
Sikirica M. (2008) Stehiometrija. Školska knjiga, Zagreb.
Silberberg M. (2003) Chemistry, 3rd edition. McGraw-Hill, Inc., New York.

**Conditions for obtaining teacher's signature**

Students are obliged to attend practices, and to fulfil all assignments within the course.

**Exam passing procedure**

During the course, students will take oral and/ or written preliminary exams. They are obliged to write laboratory diary and reports. The final grade is calculated by summarizing the points that students achieve at the written exam and the points that students obtain during the course.

**Main language of instruction; other languages**

Croatian language

**Method of monitoring the quality and efficiency of teaching**

Survey on the subjective impression about the organisation of the course will be carried out after the course, during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.

| | |
|---|---|
| **Course title** | **Cormophyte** |
| **Code** | BBO422 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Ljiljana Krstin |
| **Associate teachers** | Assist. Prof. Dr. Zorana Katanić<br>Assoc. Prof. Dr. Tanja Žuna Pfeiffer<br>Nikolina Bek, assistant |
| **Course entry requirements (Preceding courses)** | Plant Anatomy, Plant Morphology with Field Work (attended) |
| **Course objective** | To learn about hierarchical structure and phylogenetic classification of Cormophyte. |
| **Learning outcomes** | 1. Ability to compare the morphological and anatomical characteristics of Cormophyte and to evaluate ways of adapting to different ecological conditions.<br>2. Ability to determine and classify plant taxa by using professional literature.<br>3. Ability to determine economically significant and cultivated plants.<br>4. Knowledge about the importance of conserving endemic, rare and protected plant species.<br>5. Obtained insights into the great diversity of plants and developing awareness about the importance of preserving plant taxa by making of herbarium. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 1 | Lecture | Critical conversation and discussion | Records related to active and independent participation in conversations and discussions | 5 | 10 |
| 1-5 | 1.5 | Practices | Independent analysis and comparison of anatomical and morphological characteristics of plant taxa from different systematic categories, determination of plants and making of herbarium | Records related to active and independent practical work with provision of feedback | 25 | 40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1-5 | 1 | Written exam | Preparation for written exam | Written exam | 15 | 25 |
| | 1-5 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 15 | 25 |
| | **Total** | **4** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 45 |

**Course content / teaching units**

Lectures:

- Introductory lecture - introduction to the course content, reading list, and student obligations
- Systematic botany - basic definitions, systematic categories
- Research methods, history of systematics and nomenclature
- Overview of modern phylogenetic system of Cormophyte
- Morphological and anatomical structure as a basis for distinguishing between plant groups
- Origin and developmental directions of plants, change of generations
- Bryophytes, Polypodiophyta, Acrogymnospermae and Angiospermae (monocotyledons and dicotyledons) - main characteristics, evolution, classification, reproduction, diversity, ecology, phytochemistry and overview of significant groups
- Economically significant and cultivated plants
- Endemic, rare and protected plant species in the world, in Europe and in Croatia
- Determination of plant taxa by using professional literature in Botany, and making of herbarium

Practices:

- Learning about morphological and anatomical characteristics and generation changes on typical representatives of some groups of Cormophyte: Bryophytes, Polypodiophyta, Acrogymnospermae and Angiospermae
- Learning how to determine taxa by using determination keys

**Recommended reading**

Mägdefrau K., Ehrendorfer F. (1997) Udžbenik botanike za visoke škole. Sistematika, evolucija i geobotanika. 4. izd. Školska knjiga, Zagreb.
Nikolić T. (2013) Sistematska botanika - Raznolikost i evolucija biljnog svijeta. Alfa d.d., Zagreb.
Nikolić T. (2013) Praktikum sistematske botanike - Raznolikost i evolucija biljnog svijeta. Alfa d.d., Zagreb.

**Optional reading**

Aichele D. (1999) Was blüht denn da? Wildwachsende Blütenpflanzen Mitteleuropas. Kosmos, Stuttgart.
Domac R. (2002) Flora Hrvatske. Priručnik za određivanje bilja. 2. izd. Školska knjiga, Zagreb.
Idžojtić M. (2013) Dendrologija-cvijet, češer, plod, sjeme. Udžbenici Sveučilišta u Zagrebu, Šumarski fakultet, Zagreb.
Idžojtić M. (2009) Dendrologija-list. Udžbenici Sveučilišta u Zagrebu, Šumarski fakultet, Zagreb.
Javorka S., Csapody V. (1991) Iconographia florae partis Austro-orientalis Europae centralis. Akademiai Kiado, Budapest http://www.botanic.hr/praktikum/home.htm.

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| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the performance of each student, which makes up to 30% of the final grade. During the course, students will be taking written preliminary exams, which can be considered as a substitute for the final written exam, if they achieve at least 75% of total points. Preliminary exam or final written exam make up to 30% of the final grade, while oral exam makes up to 40% of the final grade. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Student survey, possibility to make oral or written remarks after lectures or exam. Monitoring of student success at preliminary and final exams. |

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|---|---|
| **Course title** | **Field Work 1 – Zoology** |
| **Code** | BBO212 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | I semester |
| **Workload/ECTS credits** | 1 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Enrih Merdić |
| **Associate teachers** | Ivana Vrućina, M.Sc., expert advisor<br>Željko Zahirović, M.Sc., expert advisor |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To get acquainted with different groups of animals and their habitats and to explore on site each group of animals by using research equipment and determination keys (fish, amphibians, reptiles, birds, mammals and insects). |
| **Learning outcomes** | 1. Awareness about importance of making a field work diary.<br>2. Ability to identify different groups of animals *in situ* and to determine them by using determination keys.<br>3. Skills to use different devices and equipment on field.<br>4. Skills to evaluate critically the application of different sampling methods. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 0.5 | Field work | Critically-guided demonstration classes | Records related to student performance | 30 | 50 |
| 1-4 | 0.5 | Field work | Independent work on the research assignment | Records and control of field work diary | 30 | 50 |
| **Total** | **1** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 0 | 0 | 15 |
| **Course content / teaching units** | • Introductory presentation about the concept and organisation of field work, rules for work and behaviour in the field, and rules for writing of a field work diary.<br>• Students will be divided in groups, within which they will perform zoological research into one group of animals. While being supervised by the teacher, students will plan, prepare and independently perform the research work. | | |

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| **Recommended reading** | Biološka raznolikost Hrvatske, Priručnici za inventarizaciju i praćenje stanja, 2008. Ministarstvo kulture, DZZP, RH.<br>Antolović J., Frković A., Grubešić M. (2006) Crvena knjiga sisavaca Hrvatske, Ministarstvo kulture, DZZP, RH.<br>Belančić A., Bogdanović T., Franković M. (2008) Crvena knjiga vretenaca Hrvatske, Ministarstvo kulture, DZZP, RH.<br>Bogut I., Novoselić D., Pavličević J. (2006) Biologija riba. Poljoprivredni fakultet u Osijeku, Osijek.<br>Mikuska J., Mikuska T., Romulić M. (2002) Ptice. Matica Hrvatska Osijek, Kopački rit.<br>Mikuska J., Mikuska T., Mikuska A. (2006) Gmazovi. Vlastita naklada, Kopački rit.<br>Mikuska J., Mikuska T., Mikuska A. (2004) Vodozemci. Filozofski fakultet, Osijek.<br>Heinzel H. (1999) Colnsov džepni vodič Ptice Hrvatske i Europe. HarperCollins publishers, London.<br>Šafarek G. (2014) Životinje Hrvatske. Mozaik knjiga, Zagreb.<br>Tutiš V., Kralj J., Radović D. (2013) Crvena knjiga ptica Hrvatske, Ministarstvo kulture, DZZP, RH. |
| **Optional reading** | http://www.vusz.hr/Cms_Data/Contents/VSZ/Folders/dokumenti/javanustanovazaupravlj anjezasticenimprirodnimvrijednostima/arhiva/~contents/E7X2RXYGCTUYPPPN/2011-3-21-58011335-biodiversityofcroatia.pdf<br>http://iucn.org/about/union/secretariat/offices/europe/resources/country_focus/croatia /<br>http://biodiversity.europa.eu/<br>http://www.bbc.co.uk/nature/places/Europe |
| **Conditions for obtaining teacher's signature** | Students are obliged to write field work diary. |
| **Exam passing procedure** | Oral exam and field work diary |
| **Main language of instruction; other languages** | Croatian language, English language |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. |

| | |
|---|---|
| **Course title** | **Field Work 2 - Botany** |
| **Code** | BBO424 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Ljiljana Krstin<br>Assist. Prof. Dr. Filip Stević |
| **Associate teachers** | Assist. Prof. Dr. Dubravka Špoljarić Maronić<br>Assoc. Prof. Dr. Tanja Žuna Pfeiffer<br>Nikolina Bek, assistant |
| **Course entry requirements (Preceding courses)** | Plant Anatomy (attended), Plant Morphology with Field Work (attended), Algae, Fungi and Lichens (attended), Cormophyte (attended) |
| **Course objective** | To develop practical skills of sampling and determination of plant taxa and algae of different biotopes and to learn how to make a herbarium. |
| **Learning outcomes** | 1. Ability to distinguish plant families, plant species and algal communities.<br>2. Skills to apply modern strategies and methods of studying, sampling, determination and collection of plants and algae from different biotopes.<br>3. Ability to understand the horizontal and vertical distribution of algae in ecological systems.<br>4. Developed skills for performing microscopic analysis of cell structures of plants and algae.<br>5. Ability to identify protected and endangered species of plants and algae.<br>6. Ability to use professional and scientific literature and standard keys for determination of algae and plants. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-6 | 2 | Practices performed on field | Practical classes attendance on field and active participation, making of herbarium of marine algae, making of herbarium of vascular plants | Records, evaluation, control of herbariums and field work report | 60 | 100 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | |
|---|---|
| **Consultation hours** | As agreed with students. |

| Teaching | Lectures | Seminars | Practices |
|---|---|---|---|
| **Hours - total** | 0 | 0 | 30 |
| **Course content / teaching units** | Practices:<br>• The freshwater and marine algal communities<br>• Determination of basic abiotic factors that influence algal development<br>• Sampling of algae from different habitats (lakes, rivers, wetlands, sea).<br>• Conservation, collection and taxonomic determination of algae. Vertical and horizontal distribution of algae in ecological systems<br>• Algae as indicators of water quality<br>• Observation, photographing and sampling of plants in the field<br>• Analysis and determination of plants (moss, ferns, gymnosperms and angiosperms) by using keys for determination and making of herbarium of collected plants<br>• Introduction to relict, endemic, rare and protected plant species of Croatian flora | | |
| **Recommended reading** | Aichele D., Golte-Bechtle M. (1997) Das neue Was blüht denn da? Wildwachsende Blütenpflanzen Mitteleuropas. Kosmos, Stuttgart.<br>Domac R. (1994) Flora Hrvatske. Priručnik za određivanje bilja. 2. izd. Školska knjiga, Zagreb.<br>Javorka S., Csapody V. (1991) Iconographia florae partis Austro-orientalis Europae centralis. Akademiai Kiado, Budapest.<br>Riedl R. (ed) (1981) Fauna und Flora der Adria. Verlag Paul Parey, Hamburg, Berlin. | | |
| **Optional reading** | Braune W. (2008) Meeresalgen. A.R.G. Gantner Verlag K.G., Ruggell.<br>Idžojtić M. (2009) Dendrologija: list. Sveučilište u Zagrebu, Šumarski fakultet.<br>Idžojtić M. (2013) Dendrologija: cvijet, češer, plod, sjeme. Sveučilište u Zagrebu, Šumarski fakultet, Hrvatske šume.<br>Nikolić T. (1996) Herbarijski priručnik. Školska knjiga, Zagreb.<br>Takhtajan A. (1997) Diversity and classification of flowering plants. Columbia University Press, New York.<br>Nikolić T., Mitić B., Boršić I. (2014) Flora Hrvatske. Invazivne biljke. Alfa d.d., Zagreb.<br>Nikolić T. (2019) Flora Croatica. Vaskularna flora Republike Hrvatske. Alfa d.d., Zagreb.<br>Nikolić T. ed.: Flora Croatica Database (URL http://hirc.botanic.hr/fcd). Prirodoslovno-matematički fakultet, Sveučilište u Zagrebu.<br>Streble, H., Krauter, D., 2002: Das Leben im Wassertropfen. Kosmos, Stuttgart.<br>Freshwater Flora of Central Europe – series of keys for determination of algae | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form | | |

| | |
|---|---|
| **Course title** | **Field Work 2 - Zoology** |
| **Code** | BBO423 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Obligatory |
| **Course teacher** | Assoc. Prof. Dr. Dubravka Čerba |
| **Associate teachers** | Assist. Prof. Dr. Olga Jovanović Glavaš<br>Barbara Vlaičević, Ph.D. |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To familiarise students with field work and to enable them to develop skills required for sampling and processing of samples of marine invertebrates in order to learn about their functional anatomy and physiology and their distribution in the sea. Students will be taught about the vertebrate fauna of continental Croatia and about different types of animal habitats. |
| **Learning outcomes** | 1. Ability to explain anatomical and morphological adaptations of invertebrates, their horizontal and vertical distribution in the littoral zones of marine ecosystems and to identify characteristic representatives of marine benthos and pelagic zone.<br>2. Ability to identify various marine invertebrate communities living in the coastal area and to practically apply knowledge about sampling, processing of samples and determination of species.<br>3. Developed skills to independently use keys for determination.<br>4. Knowledge about fauna of vertebrates living in the area of the Kopački Rit Nature Park.<br>5. Ability to evaluate the importance of carp ponds as habitats for many vertebrate species.<br>6. Ability to distinguish the most important representatives of the ornithofauna of lowland wetland.<br>7. Ability to distinguish the most important representatives of the herpetofauna of lowland wetland. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 1.5 | Field work / practices | Involvement in activities on field and in laboratory | Records related to attendance. Control of field work diaries | | |
| 4-7 | 0.5 | Field work | Active participation in field work | Records related to attendance. Evaluation of performed activities. | | |

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|---|---|---|---|---|---|---|---|
| | **Total** | **2** | | | | **60** | **100** |

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 0 | 0 | 30 |
| **Course content / teaching units** | • Benthos and pelagic zones in the Adriatic Sea. The Rovinj aquatorium<br>• Physical and chemical conditions in the Adriatic Sea<br>• Sampling of marine invertebrate organisms in the coastal area (supra- and mediolittoral zones)<br>• Sampling of marine invertebrates in the infralittoral zone<br>• Determination of marine invertebrates<br>• Anatomical, morphological and physiological characteristics of marine invertebrates (Bryozoa, Echinodermata, Crustacea, Annelida)<br>• Vertebrate fauna of the Kopački Rit Nature Park<br>• Carp ponds as a habitat for various vertebrates<br>• Ichthyofauna, herpetofauna and ornithofauna of wetlands<br>• Vertebrate fauna of the Papuk Nature Park | | |
| **Recommended reading** | Campbell A. (2005) Guide to seashores and shallow seas of Britain and northern Europe. Philip's, London.<br>Fish J.D., Fish S. (2011) A student's guide to the seashore. University Press, Cambridge.<br>Grubišić F. (1990) Ribe, rakovi i školjke Jadrana. Naprijed, Zagreb.<br>Heinzel H. (1999) Ptice Hrvatske i Europe: sa Sjevernom Afrikom i Srednjim Istokom. Hrvatsko ornitološko društvo, Zagreb.<br>Mikuska J., Romulić M., Mikuska T. (2002) Ptice - vodič kroz biološku raznolikost Kopačkog rita. Matica hrvatska Osijek, Osijek.<br>Mikuska J., Mikuska T., Mikuska A., Romulić M. (2004) Vodozemci - vodič kroz biološku raznolikost Kopačkog rita. Filozofski fakultet Osijek, Osijek.<br>Mikuska J., Mikuska T., Mikuska A., Bogdanović T., Romulić, M. (2006) Gmazovi - vodič kroz biološku raznolikost Kopačkog rita. Odjel za biologiju, Sveučilište J.J. Strossmayera, Osijek.<br>Milišić N. (2008) Enciklopedija jadranskih koralja. Marjan tisak, Split.<br>Milišić N. (2008) Jadranski rakovi deseteronošci. Marjan tisak, Split.<br>Riedl R. (ed.) (1981) Fauna und Flora der Adria. Verlag Paul Parey, Hamburg, Berlin.<br>Turk T. (2011) Pod površinom Mediterana. Školska knjiga, Zagreb.<br>Vidaković J., Bogut I., Čerba D., Galir A. (2007) Priručnik za terensku nastavu 2. - zoologija: Invertebrates mora. | | |
| **Optional reading** | Antolović J., Flajšman E., Frković A., Grgurev M., Grubešić M., Hamidović D., Holcer D., Pavlinić I., Vuković M., Tvrtković N. (2006) Crvena knjiga sisavaca Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Republika Hrvatska.<br>Arnold N., Burton J. A., Ovenden D. (1978) Field Guide to the Reptiles and Amphibians of Britain and Europe (Collins Field Guide). HarperCollins Publishers, London.<br>Janev Hutinec B., Jovanović O., Šafarek G., Janković S. (2013) Žaba, kača, kuščar-vodozemci i gmazovi u Međimurju. Međimurska priroda - Javna ustanova za zaštitu prirode, Međimurje.<br>Radanović I., Miliša M. (ed.) (2004) Protista-Protozoa i Metazoa-Invertebrata: funkcionalna građa i praktikum. Meridijani, Samobor.<br>Ruppert E.E., Fox R.S., Barnes R.D. (2004) Invertebrate Zoology. A functional evolutionary approach. 7th ed. Thomson Brooks/Cole. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course.<br>Properly completed field work diary. | | |

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| **Exam passing procedure** | |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | The teacher continuously monitors students' performance, according to which he/she modifies field-based teaching and work. |

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|---|---|
| **Course title** | **Field work 3 - Botany** |
| **Code** | BBO634 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Janja Horvatić |
| **Associate teachers** | Aleksandra Kočić, Ph.D. |
| **Course entry requirements (Preceding courses)** | Cormophyte, Plant Ecology (attended), Geobotany (attended) |
| **Course objective** | To develop students' knowledge about representatives of plant taxa, and of various plant communities within different types of vegetation in their natural habitats, and to develop students' skills in sampling through independent research. |
| **Learning outcomes** | 1. Ability to determine correlation between ecological factors and the origin and development of forests and to determine the characteristic types of the tree, shrub and herbaceous layers.<br>2. Ability to explain the ecological conditions of floodplain habitats and the principles of formation of grasslands and other anthropogenic habitats by human activity.<br>3. Ability to analyse types of vegetation by methods of assessment and sampling of vegetation along the basic ecological gradients.<br>4. Ability to make connection between the structure, life forms and biological diversity of plant communities within the concept of their adaptation to ecological conditions of habitat. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 1 | Practices | Practical classes attendance and fulfilment of tasks, determination of collected material | Assessment of practical skills by reviewing collected and determined material | 20 | 40 |
| 1-4 | 1 | Written exam | Preparation for written exam – research project | Written exam – research project | 30 | 60 |
| **Total** | **2** | | | | **50** | **100** |

**Final grade:**
**50-69.9 points: grade 2 (sufficient)**
**70-79.9 points: grade 3 (good)**
**80-89.9 points: grade 4 (very good)**
**90-100 points: grade 5 (excellent)**

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| **Consultation hours** | By appointment. |

| Teaching | Lectures | Seminars | Practices |
|---|---|---|---|
| **Hours - total** | 0 | 0 | 30 |
| **Course content / teaching units** | • Forests - climazonal communities, ecological factors of their origin and development<br>• Characteristic types of the tree, shrub and herbaceous layers<br>• General zoning of Croatian forest cover<br>• Grasslands-semi-natural habitats: meadows, pastures<br>• Composition of flora, determination of plants on the field by using keys, making the floral lists<br>• The frequency of the certain plants, the rare grasslands plants of Croatian flora<br>• Macrophytes: characteristic plants of the aquatic, wetland and humid habitats<br>• Zoning of the macrophytes<br>• The anthropogenic shaping of flora: weeds of cereals and row crops, ruderal flora<br>• Identification and determination of the plants, ecological conditions of the certain habitats | | |
| **Recommended reading** | Nikolić T. (1996) Herbarijski priručnik. Školska knjiga, Zagreb.<br>Topić J., Vukelić J. (2009) Priručnik za određivanje kopnenih staništa u Hrvatskoj prema Direktivi o staništima EU. Državni zavod za zaštitu prirode, Zagreb.<br>Topić J., Ilijanić LJ., Tvrtković N., Nikolić T. (2006) Staništa. Priručnik za inventarizaciju, kartiranje i praćenje stanja, Državni zavod za zaštitu prirode, Zagreb. | | |
| **Optional reading** | Domac R. (2002) Flora Hrvatske. Priručnik za određivanje bilja. 2. izd. Školska knjiga, Zagreb.<br>Javorka S., Csapody V. (1991) Iconographia florae partis Austro-orientalis Europae centralis. Akademiai Kiado, Budapest.<br>Nikolić T., Topić J. (2005) Crvena knjiga vaskularne flore Hrvatske. Minstarstvo kulture, Državni zavod za zaštitu prirode, Zagreb.<br>Vukelić J., Mikac S., Baričević D., Bakšić D., Rosavec R. (2008) Šumska staništa i šumske zajednice u Hrvatskoj. Nacionalna ekološka mreža. Državni zavod za zaštitu prirode, Zagreb. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to attend and actively participate in lectures and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Assessment of student performance at assignments, at sampling and determination of plant material. Completion of a research project determines the final grade. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. | | |

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|---|---|
| **Course title** | **Field Work 3 - Zoology** |
| **Code** | BBO633 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Stjepan Krčmar |
| **Associate teachers** | Assist. Prof. Dr. Olga Jovanović<br>Željko Zahirović, M.Sc., expert advisor |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To enable students to independently select methods for sampling of invertebrate and vertebrate fauna, and to enable them to evaluate the effectiveness of individual methods for fauna sampling. To teach students how to independently prepare the collected material, to create a collection, to select appropriate keys for determination of species, and to evaluate and critically assess the role of national parks, nature parks and natural monuments in protection of nature through functional connection of organisms and environment. |
| **Learning outcomes** | 1. Ability to determine the zoogeographical characteristics of continental Croatia, and to analyse the diversity of vertebrate fauna and of some groups of invertebrates living in some floodplain and aquatic habitats of continental Croatia.<br>2. Ability to compare the fauna of vertebrates and some groups of invertebrates in three climatic areas of Croatia (continental, mountainous, Mediterranean).<br>3. Ability to explain and review the influence of altitude on the distribution of individual species, and to assess the influence of abiotic factors on biology of species (daily and seasonal dynamics).<br>4. Knowledge about protected animal species in the climatic areas of Croatia (continental, mountainous, Mediterranean - northern Croatian coast) and ability to classify them according to categories of endangered species.<br>5. Skills to select appropriate methods for fauna sampling, as well as suitable keys for determination of fauna selected for research.<br>6. Ability to evaluate and critically assess the role and importance of national parks, nature parks and natural monuments in overall protection of nature (habitats, rare and endangered species). |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-6 | 2 | Practices | Attendance of practices, active participation and completion of all tasks | Records on and evaluation of completed tasks | 60 | 100 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

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|---|---|---|---|
| **Consultation hours** | Regular consultation hours will be scheduled after being agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 0 | 0 | 30 |
| **Course content / teaching units** | • Zoogeographical features of continental Croatia<br>• Analysis of diversity of vertebrate fauna and some groups of invertebrates of the Lonjsko Polje Nature Park<br>• Comparison of freshwater ichthyofauna, herpetofauna, ornithofauna, theriofauna and some groups of invertebrates living in three climatic areas of Croatia (continental, mountainous, Mediterranean) based on field work in the Lonjsko Polje Nature Park, the Risnjak National Park, at Snježnik, Bjelolasica, Matić Poljana, Vrajži Prolaz, on the Kupa River, on the islands of Krk and Košljun<br>• Analysis and review of the influence of altitude and other abiotic factors, primarily climatic ones, on the distribution of some species, and on daily and seasonal dynamics<br>• Determination of protected animal species in the climatic areas of Croatia (continental, mountainous, Mediterranean - northern Croatian coast), and analysis and classification according to categories of endangered species<br>• Installation of various traps for sampling of vertebrates (live animal trapping) and insects in the vicinity of Sunger and on the island of Krk<br>• Analysis of some types of traps, analysis of keys for determination of sampled species<br>• Making a collection of insects<br>• Evaluation and critical assessment of the importance of national parks (Risnjak), nature parks (Lonjsko Polje) and geomorphological natural monuments (The Lokvarka Cave) in the overall protection of nature, habitats, and of rare and endangered species | | |
| **Recommended reading** | Antolović J., Frković A., Grubešić M., Holcer D., Vuković M., Flajšman E., Grgurev M., Hamidović D., Pavlinić I., Tvrtković N. (2006) Crvena knjiga sisavaca Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode RH.<br>Belančić A., Bogdanović T., Franković M., Ljuština M., Mihoković N., Vitas B. (2008) Crvena knjiga vretenaca Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode RH.<br>Biološka raznolikost Hrvatske. Fauna. Priručnici za inventarizaciju i praćenje stanja. 2008. DZZP, Zagreb.<br>Garms H., Borm L. (1981) Fauna Evrope. Mladinska knjiga, Ljubljana.<br>Janev Hutinec B., Kletečki E., Lazar B., Podnar Lešić M., Skejić J., Tadić Z., Tvrtković N. (2006) Crvena knjiga vodozemaca i gmazova Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode RH.<br>Jardas I., Pallaoro A., Vrgoč N., Jukić-Peladić S., Dadić V. (2008) Crvena knjiga morskih riba Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode RH.<br>Mrakovčić M., Brigić A., Buj I., Ćaleta M., Mustafić P., Zanella D. (2006) Crvena knjiga slatkovodnih riba Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode RH.<br>Ozimec R., Bedek J., Gottstein S., Jalžić B., Slapnik R., Štamol V., Bilandžija H., Dražina T., Kletečki E. Komerički A., Lukić M., Pavlek M. (2009) Crvena knjiga špiljske faune Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode RH.<br>Schneider – Jacoby M., Ern H. (1993) Park prirode Lonjsko polje. Hrvatsko ekološko društvo Zagreb.<br>Zahradnik J. (1990) Insects. Aventinum Nakladitelstvi, Prague. | | |
| **Optional reading** | Haupt J., Haupt H. (1998) Fliegen und Mücken. Natur Buch Verlag, Augsburg.<br>Krčmar S., Hackenberger K. D., Hackenberger K. B. (2011) Key to the horse flies fauna of Croatia (Diptera, Tabanidae). Periodicum biologorum 113, Suppl. 2, 1-61.<br>Zahradnik J. (1991) Bees and Wasps. Aventinum Nakladitelstvi, Prague. | | |

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| | Wachman E., Saure C. (1997) Netzflügler, Schlamm und Kamelhalsfliegen. Natur Buch Verlag, Augsburg. |
| **Conditions for obtaining teacher's signature** | Attendance of practices and fulfilment of assignments. |
| **Exam passing procedure** | |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form |

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|---|---|
| **Course title** | **Physical Education** |
| **Code** | BBT111 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | I, II, III and IV semester |
| **Workload/ECTS credits** | 1 |
| **Course status** | Obligatory |
| **Course teacher** | Željko Beissmann, M.A., senior lecturer |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To engage students in physical education within the activities of gymnastics, sports, sports games, aesthetic gymnastics and dance, hiking and excursions that will be organised within available resources. |
| **Learning outcomes** | 1. Knowledge about specific kinesiological theories and skills referring to various sports and recreational sports<br>2. Ability to independently review the exercises that are needed for better physical functioning<br>3. Ability to assess the acquired knowledge about the level of responsibility for personal health condition and for the health of others<br>4. Ability to critically judge fundamental motor skills<br>5. Ability to recommend exercises for development and strengthening of all muscle groups<br>6. Awareness about benefits of physical education and ability to choose an appropriate way of personal health care. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-6 | 1 | Practices | Independent work on tasks and advancement at tasks. | Monitoring of students' performance | | |
| **Total** | **1** | | | | | |

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 0 | 0 | 30 |
| **Course content / teaching units** | • General physical preparation: developing knowledge, skills and habits of movement, learning about the laws and interdependence of movement within various sports activities; developing a notion of space, time and energy of movement, developing a sense of hearing, sight and balance. The course content will be adjusted to students' skills in the selected sports and recreational activities.<br>• Sports. Theoretical part: sport and its position in physical education; historical development in the world and in our country, biomechanical basis, | | |

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| | methodology, rules and organisation of competitions. Practical part: movement techniques, movement improvement: error detection. Improvement of motor skills, integration of movement elements. Usage of equipment, devices, aids.<br>• Sports games: handball, football, volleyball, basketball. Development of sports games in the world and in our country, the importance of the game, rules and judging, playground, devices and equipment, methodology and testing of motor-technical achievements. Practice: movement technique, elements of testing at a spot and in movement, game tactics in attack and defence, counterattack, individual and collective tactics and game.<br>• Aesthetic gymnastics and dances. Realisation of note values and texts, metric and rhythmic exercises. Elements of classical and modern dances. Folk dances (selection).<br>• Gymnastics. Reels, swirls, resistors and pushers, oscillations and swinging, turns, swings, jumps, flips, connecting these elements on ground and on devices. Assistance and protection during exercises.<br>• Excursion and hiking, preparation for hiking, orientation skills, signalisation, ways of movement, selection and usage of equipment, nature conservation. Building of shelters, types of fireplaces and fires. Field games.<br>• Corrective gymnastics and rehabilitation. Students with reduced physical abilities are offered appropriate activities that are adapted to their personal rehabilitation needs.<br>• Competitions. Participation in universities' and faculties' sports competitions and other appropriate competitions. |
| **Recommended reading** | |
| **Optional reading** | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in PE classes actively and to fulfil all assignments within the course. Out of the planned 15 classes, they have to attend 11 classes to obtain a teacher's signature. |
| **Exam passing procedure** | No exam |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | After the course, students will be given a survey to evaluate their subjective impression about the organisation of the course. |

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|---|---|
| **Course title** | **Zoogeography** |
| **Code** | BBO631 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Obligatory |
| **Course teacher** | Prof. Dr. Enrih Merdić |
| **Associate teachers** | Assist. Prof. Dr. Mirta Sudarić Bogojević<br>Assist. Prof. Dr. Goran Vignjević<br>Nataša Bušić, assistant |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To enable students to acquire comprehensive knowledge about animal distribution and to valorise it through learning about areal, fauna, regionality and geological past. |
| **Learning outcomes** | 1. Ability to analyse the areal with respect to various factors that determine it.<br>2. Ability to connect historical geological occurrences and current animal distribution.<br>3. Ability to explain the reasons for the existence of various animal areas.<br>4. Ability to present the island, relict and closed-region fauna.<br>5. Skills to integrate knowledge of individual areas of zoology and comprehensive knowledge of animal distribution. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1 | Lecture | Critical conversation and discussion | Records related to student performance, preliminary exam | 25 | 40 |
| 1-5 | 1 | Seminars | Independent work on the research assignment | Independent work on the research project and its presentation | 10 | 20 |
| 1-5 | 0.5 | Practices | Practical work on the distribution mapping | Records, monitoring of student performance, preliminary exams | 5 | 10 |
| 1-5 | 1.5 | Final exam | Written exam | Written exam | 10 | 15 |
| 1-5 | 2 | Final exam | Oral exam | Oral exam | 10 | 15 |
| **Total** | **6** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

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|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 15 | 15 |
| **Course content / teaching units** | Lectures:<br>• Fundamentals of zoogeography<br>• Ecological, historical and regional zoogeography<br>• History of zoogeography<br>• Areal, active and passive distribution of animals and barriers in animal distribution<br>• Fauna, endemic species, relicts, rare and allochthone species.<br>• The centres of distribution<br>• Continental fauna<br>• Closed-region fauna<br>• The island and relict fauna<br>• Historical zoogeography: geological division of the earth's history, Wegener's theory, Pleistocene and Holocene fauna in Croatia<br>• Regional zoogeography<br>• Antarctogaea<br>• Notogaea: the fauna of New Zealand, Australia and the Pacific Islands<br>• Neogaea: the fauna of the Amazon rainforest, the Andes, Central America and the Galapagos Islands<br>• Arctogaea: the fauna of Madagascar, Africa, India and Indochina, the Arctic, North America, Asia and Europe<br>• Zoogeography in Croatia<br>Seminars and practices:<br>• Mapping of distribution of individual animal species<br>• Usage of the UTM map in scientific research<br>• Application of GIS (Geographic Information System) in zoogeography<br>• Analysis and interpretation of the fauna of Antarctogaea, Notogaea, Neogaea and Arctogaea based on videos, Internet resources and scientific literature, preparation of seminar papers related to these subject areas | | |
| **Recommended reading** | Cox C.B., Moore P.D. (2005) Biogeography. An Ecological and Evolutionary Approach. 7th ed. Blackwell Publishing Ltd.<br>Lomolino M.V, Ridle B.R., Whittaker R.J., Brown J.H. (2010) Biogeography. Elswere London-Paris-New York. | | |
| **Optional reading** | Maxley S. (1989) Veliki atlas životinja. Mladinska knjiga, Ljubljana-Zagreb.<br>Peres J.M., Gamulin-Brida H. (1973) Biološka oceanografija. Školska knjiga, Zagreb. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | During the course, students take three preliminary exams. If achieving min. 70% success at each preliminary exam, they are exempted from taking the final written exam, so they proceed to the oral exam. Students who do not achieve the defined passing rate at preliminary exams need to take the final written exam, upon passing of which they take the oral exam, as well. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |

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| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. |

## Elective Courses

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| **Course title** | **Insect Anatomy and Morphology** |
| **Code** | BBZ40 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Prof. Dr. Stjepan Krčmar |
| **Associate teachers** | Barbara Vlaičević, Ph.D. |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students how to describe and compare the anatomical and morphological characteristics of the main insect orders, and to enable them to independently use the keys for determination of different orders, families, genera and species of insects. |
| **Learning outcomes** | 1. Ability to compare the morphological characteristics of the main insect orders.<br>2. Ability to distinguish, draw and describe different shapes of insects' mouthparts.<br>3. Ability to compare the different shapes of joints in insects' legs according to functional adaptations, to compare insects' wings, the structure of insect thorax and abdomen.<br>4. Skills in selection of appropriate keys for determination of different insect species.<br>5. Skills to present a seminar paper referring to the topics of organ systems of different groups of insects. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 0.5 | Lecture | Lecture attendance and active participation | Records and evaluation | 15 | 25 |
| 5 | 1 | Independent study (seminar) | Independent study, critical reviewing of scientific literature used in preparation of seminar paper and presentation of seminar paper | Records and assessment of the presented seminar paper | 30 | 50 |
| 1-4 | 0.5 | Exam | Preparation for final exam | Written exam | 15 | 25 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

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|---|---|---|---|
| **Consultation hours** | Regular consultation hours will be scheduled after being agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 30 | 0 |
| **Course content / teaching units** | Lectures:<br>• Morphological and anatomical characteristics of the main orders of insects, morphological and anatomical characteristics of insect's head, mouthparts, and tentacles, morphological and anatomical characteristics of the insect's thorax, abdomen, legs and wings<br>• Selection and application of the keys for determination of insect groups<br>Seminars:<br>• Organ systems of various insect groups | | |
| **Recommended reading** | Habdija I., Primc-Habdija B., Radanović I., Vidaković J., Kučinić M., Špoljar M., Matoničkin R., Miliša M. (2004) Protista-Protozoa i Metazoa-Invertebrata: funkcionalna građa i praktikum. Meridijani, Samobor.<br>Romoser W.S., Stoffolano J.G. (1998) The science of entomology. WCB McGraw-Hill.<br>Steinmann H., Zombori L. (1985) An atlas of insect morphology. Akademiai kiado, Budapest. | | |
| **Optional reading** | Habdija I., Primc-Habdija B., Radanović I., Špoljar M., Matoničkin-Kepčija R., Vujčić-Karlo S., Miliša M., Ostojić A., Sertić-Perić M. (2011) Protista-Protozoa, Metazoa-Invertebrata. Alfa d.d., Zagreb.<br>Taylor M. (2020) The pocket book of Insect anatomy. Bloomsbury publishing, UK. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | During lectures, the teacher monitors and evaluates performance of each student, which refers to 25% of the final grade. Presentation of the seminar paper refers to 50% of the final grade, and passing of the final written exam refers to the remaining 25% of the final grade. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form | | |

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|---|---|
| **Course title** | **Plant Microtechnique and Microscopy** |
| **Code** | BMZ82 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Prof. Dr. Vera Cesar |
| **Associate teachers** | Assist. Prof. Dr. Jasenka Antunović Dunić<br>Assist. Prof. Dr. Lidija Begović<br>Assist. Prof. Dr. Selma Mlinarić |
| **Course entry requirements (Preceding courses)** | Physical Foundations of Instrumental Methods in Biology, Cell Biology, Plant Anatomy |
| **Course objective** | To develop students' knowledge and skills required for the preparation of cytological and histological specimens and for usage of light and fluorescence microscope. |
| **Learning outcomes** | 1. Skills required for application of methods of fixation and tissue preparation as appropriate to the plant material structure.<br>2. Skills to prepare materials that are suitable for planned experiment and to make photographic documentation.<br>3. Ability to evaluate the quality of prepared material.<br>4. Ability to interpret tissues structure of available preparations by applying previously acquired knowledge about the structure of cells and tissues.<br>5. Contribution to the development of professional knowledge by making critical interpretation of scientific research results. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1, 3, 4, 5 | 1 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 12 | 20 |
| 2, 3 | 0.5 | Practices | Independent preparation and microscopic examination of material | Records related to students' performance at preparing and examining of materials | 21 | 35 |
| 1 - 5 | 0.25 | Written exam | Preparation for written exam | Assessment of practical work, written exam and/or delivered presentation | 18 | 30 |
| 1 - 5 | 0.25 | Oral exam | Preparation for oral exam | Oral exam | 9 | 15 |
| **Total** | **2** | | | | **60** | **100** |

<table>
<tr><td></td><td colspan="3">Final grade:<br>60-70 points: grade 2 (sufficient)<br>71-80 points: grade 3 (good)<br>81-90 points: grade 4 (very good)<br>91-100 points: grade 5 (excellent)</td></tr>
<tr><td>Consultation hours</td><td colspan="3">By appointment.</td></tr>
<tr><td rowspan="2">Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>30</td><td>0</td><td>15</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">Lectures:<br>• Introduction to plant microtechniques<br>• Sampling of plant material<br>• Fixation<br>• Dehydration<br>• Infiltration and fitting<br>• Histochemical and cytochemical reactions: fresh sections, sections in embedding medium, such as paraffin, methacrylate and epoxy resins<br>• Usage of rotating microtome and cryostat<br>• Immunolocalisation<br>• In situ hybridisation of nucleic acids<br>• Light microscopy: microscope with phase and differential-interference contrast, fluorescence microscope, confocal microscope<br>• Electron microscopy: TEM and SEM (ESEM)<br>Practices:<br>• Preparation of cytological and histological material, staining and microscopy<br>• Application of some microscopy methods to analyse permanent preparations</td></tr>
<tr><td>Recommended reading</td><td colspan="3">Ambriović Ristov A. (2007) Metode u molekularnoj biologiji. Institut Ruđer Bošković, Zagreb.<br>Ruzin S.E. (1999) Plant Microtechnique and Microscopy. Oxford University Press, NewYork,<br>Oxford.</td></tr>
<tr><td>Optional reading</td><td colspan="3">Bowes B.G. (1996) A Colour Atlas of Plant Structure. Manson Publishing Ltd, London.<br>Maliga P., Klessig D. F., Cashmore A. R., Gruissem W., Varner J. E. (1995) Methods in Plant Molecular Biology. A Laboratory Course Manual. Cold Spring Harbor Laboratory Press, New<br>York.<br>O'Brien T. P., McCully M.E. (1981) The Study of Plant Structure. Princples and Selected Methods. Termercarphi Pty. Ltd., Melbourne, Australia.<br>Van De Graaf K.M., Rushforth S.R., Crawely J.L. (1998) A Photographic Atlas for the Botany Laboratory. 3rd edition. Morton Publishing Company, Colorado.<br>Relevant scientific papers referring to the subject area.</td></tr>
<tr><td>Conditions for obtaining teacher's signature</td><td colspan="3">Students are obliged to attend lectures and practices, to participate in lectures actively and to fulfil assignments.</td></tr>
<tr><td>Exam passing procedure</td><td colspan="3">During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. The final grade is determined according to the number of points collected during the lectures and the points achieved in written and oral exams.</td></tr>
<tr><td>Main language of instruction; other languages</td><td colspan="3">Croatian language, English language</td></tr>
</table>

| | |
|---|---|
| **Method of monitoring the quality and efficiency of teaching** | Survey carried out during the course, opportunity given to students to make written remarks and/or suggestions after the lectures.<br>Monitoring of students' success at exams.<br>Carrying out a uniform University Student Survey. |

| | |
|---|---|
| **Course title** | **Phytogeographical Characteristics of Eastern Croatia** |
| **Code** | BBZ47 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Prof. Dr. Oleg Antonić |
| **Associate teachers** | Dragan Prlić, assistant |
| **Course entry requirements (Preceding courses)** | Geobotany (attended) |
| **Course objective** | Acquisition of basic knowledge about ecological (geological, hydrological, climatic) conditions that determine the spatial distribution of flora and vegetation in Eastern Croatia, with a review of phytogeographical and vegetation characteristics of that area. |
| **Learning outcomes** | 1. Ability to analyse geological history of Eastern Croatia and its consequences on the biogeographical characteristics of today's flora and vegetation<br>2. Ability to analyse the impact of hydrological dynamics on vegetation succession in Eastern Croatia.<br>3. Ability to determine the human impact on the spatial distribution of vegetation in Eastern Croatia.<br>4. Knowledge about division of vegetation of Eastern Croatia into basic types, by referring to the prevailing ecological gradients.<br>5. Ability to describe the areals of plant species and communities in Eastern Croatia, by putting emphasis on rare and endangered plant species and habitats. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1 - 5 | 0.5 | Lecture | Participation in discussions during lectures | Records related to attendance and participation in discussions | 15 | 25 |
| 4 - 5 | 0.5 | Practices | Preparation and presentation of seminar paper | Assessment of contents and presentation of seminar paper | 15 | 25 |
| 1-5 | 0.5 | Written exam | Preparation for written exam | Written exam | 15 | 25 |
| 1-5 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 15 | 25 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | • Paleoecology and paleophytogeography of Eastern Croatia<br>• Eastern Croatia in the Pannonian region: hydrological, climatological and relief characteristics<br>• Geomorphological regionalisation of the area: Western Slavonia, Slavonian massive mountains, the Požega Bay, Slavonian Podravina, Baranja, the Đakovo-Vinkovci and Vukovar plateau, the Bosut lowland, Slavonian Posavina<br>• Climate, water, geological base and soil<br>• Phytogeographical position<br>• Climazonal vegetation<br>• Anthropogenic impact on the vegetation of Eastern Croatia throughout past<br>• Overview of the vegetation of Eastern Croatia by types: forest, grassland, water and swamp, weed and ruderal<br>• Areals of plant species and communities in Eastern Croatia, with reference to rare and endangered species and their habitats | | |
| **Recommended reading** | Rauš Đ., Šegulja N. (1983) Flora Slavonije i Baranje. Glasnik za šumske pokuse 21, 179-211.<br>Rauš Đ., Šegulja N., Topić J. (1985) Vegetacija sjeveroistočne Hrvatske. Glasnik za šumarske pokuse 23, 223-355.<br>Nikolić T., Topić J. (ed.) (2004) Crvena knjiga vaskularne flore Hrvatske: kategorije EX, RE, CR, EN and VU. Ministarstvo kulture Republike Hrvatske, Državni zavod za zaštitu prirode, Zagreb. | | |
| **Optional reading** | Kovar-Eder J. (1987) Pannonian (UpperMiocene) Vegetational Character and Climatic Inferences in the Central Parathethys Area. Ann.Naturhist.Mus.Wien 88A, 117-129<br>Prpić B. (1974) Ekološko-biološke značajke šuma jugoistočne Slavonije. JAZU, Centar za znastveni rad u Vinkovcima, Vinkovci-Slavonski Brod, 65-77.<br>Rauš Đ. (1976) Vegetacija ritskih šuma dijela Podunavlja od Aljmaša do Iloka. Glasnik za šumarske pokuse 19, 5-75.<br>Vukelić J. Rauš Đ. (1998) Šumska fitocenologija i šumske zajednice u Hrvatskoj. Sveučilište u Zagrebu, Šumarski fakultet, 310. | | |
| **Conditions for obtaining teacher's signature** | Attendance at lectures and practices and gaining of minimum 30 points. | | |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of each student. After the course, students pass the written exam with a minimum of 15 points. After having passed the written exam, students take the oral exam and pass it with a minimum of 15 points. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form | | |

| | |
|---|---|
| **Course title** | **Biology of Rodents and Insects and its Significance for Human Health** |
| **Code** | BBZ59 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Mirta Sudarić Bogojević |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about the public health significance of some species of insects and rodents, to explain basic principles of disinsection and deratisation measures, to raise students' science literacy and awareness of responsible behaviour of individuals and of whole community in prevention of occurrence and spread of infectious diseases transmitted by rodents and insects. |
| **Learning outcomes** | 1. Ability to determine significance of rodents and insects in the public health, and to compare their basic biological characteristics.<br>2. Knowledge about rodents and insects that are harmful to human health, and about diseases that they transmit.<br>3. Ability to assess methods for prevention of harmful rodent and insect reproduction.<br>4. Ability to critically assess prevention methods, rodent and insect control, time and manner of application of chemical agents and particularities of their field implementation.<br>5. Ability to compare methods for treating of diseases caused by rodents and insects.<br>6. Suggestion of methods for control and treatment of harmful rodents and insects on a concrete example. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 0.5 | Lecture | Lecture attendance and active participation | Records related to active and independent participation in conversations and discussions | 10 | 15 |
| 1-6 | 0.5 | Practices | Practical classes attendance and active participation | Records related to students' activities within practices with provision of feedback | 25 | 35 |
| 1-6 | 0.5 | Written exam | Preparation for written exam | Written exam | 10 | 20 |
| 1-6 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 15 | 30 |
| **Total** | **2** | | | | **60** | **100** |
| | | | | | | |

| | | | |
|---|---|---|---|
| | **Final grade:**<br>**60-70 points: grade 2 (sufficient)**<br>**71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | • Fundamentals of biology, etiology and rodent control (mouse and rat)<br>• Significance of rodents in the public health and economic damages they cause<br>• Biology, etiology and public health significance of hematophagous arthropods with emphasis on insects (ants, bedbugs, cockroaches, mosquitoes, Phlebotominae, flies, wasps, bees, horse-flies)<br>• Insect molesters, vectors of infectious diseases and economic pests<br>• Insects that cause allergic reactions in humans<br>• Repellents and attractants<br>• Biological control<br>• Disinsection and deratisation<br>• Methods of insecticide and rodenticide application within DDD measures (disinfection, disinsection and deratisation) for pathogen prevention<br>• Implementation of disinsection and deratisation in facilities with a sensitive population of people (kindergartens, schools, hospitals)<br>• Infectious diseases and symptoms of infectious diseases transmitted by rodents and insects<br>• Procedures for disease treatment<br>• Adverse effects of disinsection and deratisation on the environment and human health<br>• Current national and European regulations for the implementation of measures related to preventive and mandatory disinfection, disinsection and deratisation<br>• Basic biological characteristics of some species of rodents and insects<br>• Pesticides. Insecticides and rodenticides: types and basic division; mode of action; method of application and first aid in cases of poisoning<br>• Site visit to an authorised company involved in implementation of DDD measures is planned, so that students become acquainted with disinsection and deratisation in practice | | |
| **Recommended reading** | Asaj A.(1999) Deratizacija u praksi. Medicinska naklada, Zagreb.<br>Asaj A. (2000) Zdravstvena dezinsekcija u nastambama i okolišu. Medicinska naklada, Zagreb. Atkinson P. W. (2010) Vector Biology, Ecology and Control. Springer.<br>Goddard J. (2007) Physician's guide to Arthropods of Medical Importance. Fifth edition. CRC Press, Taylor and Francis Group. | | |
| **Optional reading** | Marquardt W.H. (2004) Biology of Disease Vectors. 2nd ed. Academic Press.<br>Mallis A. (2011) Handbook of Pest Control - the Behavior, Life History and Control of Household Pests. 10th ed. Franzak and Foster Co., Cleveland, Ohio.<br>Service M. (2012) Medical Entomology for Students. 5th ed. Cambridge University Press.<br>Takken W., Knols B.G.J. (2007) Emerging pests and vector-borne diseases in Europe. Wageningen Academic Publishers. | | |
| **Conditions for obtaining teacher's signature** | Regular attendance and active participation in all forms of teaching. | | |

| | |
|---|---|
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students take a written exam and then oral exam. The final grade is determined according to the number of points collected during the lectures and practices and the points achieved in written and oral exams. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher continuously monitors the learning process and student achievements, thus determining and adapting his/her teaching. After the course, the teacher conducts an anonymous survey among students to evaluate their subjective impression about the teaching quality. |

| | |
|---|---|
| **Course title** | **Marine Biology** |
| **Code** | BBZ43 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Goran Palijan |
| **Associate teachers** | Assist. Prof. Dr. Anita Galir Balkić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about the basics of sea and ocean functioning so that they will be able to predict the adaptations of marine organisms with respect to the marine habitat from which they originate. |
| **Learning outcomes** | 1. Ability to examine the basic physical and chemical properties of seawater.<br>2. Ability to compare the structure and function of marine ecosystems.<br>3. Ability to critically assess the relations between different adaptations of marine organisms and their habitat.<br>4. Ability to critically review relevant scientific literature. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 0.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-4 | 0.5 | Seminar | Interpretation of scientific papers and application of obtained results at concepts learned within lectures | Monitoring of student's interpretations and performance at tasks | 10 | 15 |
| 1-4 | 0.5 | Written exam | Preparation for written exam | Written exam | 20 | 32,5 |
| 1-4 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 25 | 42,5 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 15 | 0 |
| **Course content / teaching units** | Lectures:<br>• Introductory lecture – course content, reading list and obligations of students<br>• Geology and origin of oceans<br>• Sea currents and tides<br>• Physical and chemical properties of seawater<br>• Plankton and nekton<br>• Tide zone<br>• Estuaries<br>• Deep-sea organisms<br>Seminars:<br>• Location, climate, geological past, physical and chemical properties of the Adriatic Sea (chemical composition of water, types of sediments, stationary and mobile seabed)<br>• Endangered and protected species in the Adriatic Sea | | |
| **Recommended reading** | Nybakken J.W., Bertness M.D. (2005) Marine Biology. Pearson-Benjamin Cummings, San Francisco. | | |
| **Optional reading** | Castro P., Huber M.E. (2005) Marine Biology. McGraw-Hill, New York. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass written exam. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

| | |
|---|---|
| **Course title** | **Protozoa Biology** |
| **Code** | BBZ35 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Goran Palijan |
| **Associate teachers** | Assist. Prof. Dr. Anita Galir Balkić |
| **Course entry requirements (Preceding courses)** | General Zoology, Invertebrates |
| **Course objective** | To teach students about the basic structure and functioning of protozoa in the context of their habitat. |
| **Learning outcomes** | 1. Skills required for examination of the basic characteristics of protozoa.<br>2. Ability to assess the ways of protozoa nourishment.<br>3. Ability to critically assess the relations between different adaptations of protozoa and their habitat.<br>4. Ability to determine the affiliation of unknown protozoa from samples by using professional literature. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 0.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-4 | 0.5 | Practices | Work on experimental task | Monitoring of student performance | 10 | 15 |
| 1-4 | 0.5 | Written exam | Preparation for written exam | Written exam | 20 | 32.5 |
| 1-4 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 25 | 42.5 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | |
|---|---|
| **Consultation hours** | By appointment. |

| Teaching | Lectures | Seminars | Practices |
|---|---|---|---|
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | Lectures:<br>• Classification, evolution and history of the protozoa research<br>• Protozoa communities of aquatic and terrestrial ecosystems<br>• Ways of nourishment and functional groups of protozoa<br>• Polymorphic life cycles of protozoa<br>• Symbiosis – commensalism, mutualism, parasitism<br>• Protozoa as parasites in humans: taxonomy of the parasitic protozoa; transmission of parasites (oral-fecal, predator-prey, by hematophagous arthropods); ecological niches of parasitic protozoa in the human body.<br>Practices:<br>• General characteristics of protozoa: plant-like / animal-like<br>• Preparing and maintaining the protozoa cultures<br>• Sampling and analysis of protozoa from different habitats: periphyton (algae and moss); protozoa in macrophytic vegetation; protozoa of soil and various sediments | | |
| **Recommended reading** | Fenchel T.M. (1996) Ecology of Protozoa: The Biology of Free-Living Phagotrophic Protists. Springer-Verlag, Berlin.<br>Patterson D.J. (2003) Free-Living Freshwater Protozoa. Manson, Washington, D. C.<br>Wiser M.F. (2010) Protozoa and human disease. Garland Science, New York. | | |
| **Optional reading** | Lynn D. (2011) The Ciliated Protozoa. Springer, Berlin. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass written exam. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

| | |
|---|---|
| **Course title** | **Ecophysiology of Algae** |
| **Code** | BBZ37 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Prof. Dr. Janja Horvatić |
| **Associate teachers** | Assist. Prof. Dr. Vesna Peršić<br>Vera Tikas, expert advisor |
| **Course entry requirements (Preceding courses)** | Cell Biology; General Ecology; Algae, Fungi and Lichens |
| **Course objective** | To teach students the principles and applications of scientific determination of algae growth potential and to develop their practical skills for laboratory cultivation of algae. |
| **Learning outcomes** | 1. Ability to explain the function of algae in the aquatic ecosystem.<br>2. Ability to analyse adaptations of algae to environmental variability.<br>3. Skills to determine the influence of algae on the fluctuations of basic physical and chemical parameters.<br>4. Ability to critically evaluate the implementation of laboratory bioassays on algae, and to analyse and interpret the obtained data in the assessment of water quality. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 0.5 | Lecture | Critical conversation and discussion | Records related to student performance with provision of feedback | 5 | 10 |
| 4 | 0.5 | Practices | Practical classes attendance and active participation | Records related to active and independent involvement in practices with provision of feedback | 10 | 20 |
| 1-4 | 0.5 | Written exam | Preparation for written exam | Written exam | 20 | 40 |
| 1-4 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 15 | 30 |
| **Total** | **2** | | | | **50** | **100** |

**Final grade:**
**50-69.9 points: grade 2 (sufficient)**
**70-79.9 points: grade 3 (good)**

| | | | |
|---|---|---|---|
| | **80-89.9 points: grade 4 (very good)**<br>**90-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | Lectures:<br>• Photosynthetic pigments of algae<br>• Algae as ecological indicators<br>• Phosphorus and nitrogen cycle<br>• Algae need for phosphorus and nitrogen in freshwater systems<br>• Nutrients and eutrophication of inland waters<br>• Algal development and nutritive elements<br>• Preparation and composition of nutrient medium for algal cultures in the laboratory conditions<br>• Laboratory bioassays<br>• Miniaturized bioassay<br>Practices:<br>• Determination of the assimilation pigments in phytoplankton.<br>• Measurement of the algal growth potential (AGP) of algal cultures.<br>• Evaluation of bioproduction, trophic level and water toxicity by the miniaturised bioassay method | | |
| **Recommended reading** | Barsanti L., Gualtieri P. (2006) Algae, Anatomy, Biochemistry and Biotechnology. Taylor and Francis Group, USA.<br>Kersey W.T., Munger S.P. (2009) Marine Phytoplankton. Nova Science Publishers, Inc., New York. | | |
| **Optional reading** | Gopal B., Wetzel G. (2004) Limnology in Developing Countries. Volume 4. International Association of Theoretical and Applied Limnology. International Scientific Publications, New Delhi. | | |
| **Conditions for obtaining teacher's signature** | Regular attendance and active participation in lectures. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass written exam. The final grade is determined according to the number of points for student's performance and the points achieved in written and oral exams. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. | | |

| | |
|---|---|
| **Course title** | **Experimental Biochemical Techniques** |
| **Code** | BBZ39 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Rosemary Vuković |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To develop students' skills required for research work in the field of biochemistry and molecular biology. Such skills refer to literature review, experiment design, selection and implementation of methods and techniques for testing of hypotheses, collection, analysis and interpretation of data by using relevant scientific literature. |
| **Learning outcomes** | 1. Ability to select and evaluate an appropriate model organism, as well as optimal biochemical and molecular methods and techniques that are required for research and for proving of scientific hypothesis.<br>2. Development of knowledge and skills by using bioinformatics tools and databases.<br>3. Ability to critically analyse and comment on primary publications, research hypotheses, applied experimental techniques and research results.<br>4. Ability to assess the results of performed research and of scientific findings by comparing them with results published in other relevant scientific papers. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 1 | Lecture | Critical conversation and discussion; case-study analysis; independent analysis of scientific articles, and presentation of student's own experimental design | Records related to student performance during lectures; assessment of a scientific article analysis; evaluation of experimental design and provision of feedback | 5 | 10 |
| 1-4 | 0.5 | Practices | Independent performance of experimental tasks, data collection and analysis; presentation and interpretation of obtained results | Monitoring of experimental work progress; work diary; assessment of presentation and interpretation of obtained results | 20 | 40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | with provision of feedback | | |
| | 1-4 | 0.25 | Written exam | Writing of an academic essay | Essay | 15 | 30 |
| | 1-4 | 0.25 | Oral exam | Preparation of presentation | Presentation delivery | 10 | 20 |
| | **Total** | **2** | | | | **50** | **100** |

**Final grade:**
**50.1-62.5 points: grade 2 (sufficient)**
**62.6-75 points: grade 3 (good)**
**75.1-87.5 points: grade 4 (very good)**
**87.6-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | Two hours a week according to schedule defined at the beginning of the academic year and additional consultation hours as agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 15 |

**Course content / teaching units**

Lectures:

- Introduction to the experimental biochemical techniques
- Laboratory safety procedures
- Experimental systems and models
- Biological material: preservation and preparation
- Spectrophotometry in the protein analysis
- Sedimentation techniques
- Chromatographic techniques
- Electrophoretic techniques
- Immunochemical techniques
- Radioactivity
- Bioinformatics
- Gene expression analysis

Practices:

- Protein expression in Escherichia coli
- Protein extraction and purification by using affinity chromatography
- SDS-PAGE protein identification
- Protein-protein interaction analysis
- Western blot analysis
- Gene expression analysis

**Recommended reading**

Ambriović-Ristov A. et al. (2007) Metode u molekularnoj biologiji. Institut Ruđer Bošković, Zagreb.
Balen B. et al. (2011) Elektroforetske tehnike istraživanja proteina. Hrvatska sveučilišna naklada.
Reed R.H. (2014) Practical skills in biomolecular sciences. Pearson education.

**Optional reading**

Holme D.J., Peck H. (1998) Analytical Biochemistry. 3rd. Addison Wesley Longman Ltd., New York.
Wilson K., Walker J. (1997) Principles and Techniques of Practical Biochemistry. 4th. Cambridge University Press, Cambridge.
Original scientific papers and review papers.

**Conditions for obtaining teacher's signature**

Students are obliged to participate in lectures actively and to fulfil all assignments within the course.

| | |
|---|---|
| **Exam passing procedure** | During the lectures and practices, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, each student writes and presents an academic essay in which they need to include a critical analysis of selected scientific article or several articles. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher continuously evaluates student achievement, and gives students the opportunity to make oral or written comments. After the course, students are given a survey in which they give their subjective opinion about quality and organisation of teaching, all with the aim to improve future teaching. |

| | |
|---|---|
| **Course title** | **Phytobiology** |
| **Code** | BBZ60 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Elective |
| **Course teacher** | Assoc. Prof. Dr. Ivna Štolfa Čamagajevac<br>Assoc. Prof. Dr. Ljiljana Krstin |
| **Associate teachers** | Assist. Prof. Dr. Rosemary Vuković<br>Assist. Prof. Dr. Zorana Katanić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To familiarise students with the importance of plants and biologically active plant substances, their action and application with the aim to preserve human health and to reduce the environment burden. |
| **Learning outcomes** | 1. Ability to predict the application, significance and effect of biologically active plant substances on human health.<br>2. Ability to assess the importance of functional plant foods in the nutrition.<br>3. Ability to evaluate ecological principles of plant cultivation and plant protection with the aim to preserve human health and to reduce the environment burden.<br>4. Ability to assess the importance of antimicrobial activity of plant extracts on human/plant pathogens.<br>5. Ability to select and use appropriate laboratory methods for analysis of biologically important substances in plant extracts. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1.5 | Lecture | Critical conversation and discussion; collaborative learning and reciprocal teaching; knowledge-based tasks | Records related to active and independent participation in lecture activities | 5 | 10 |
| 1-5 | 1.5 | Seminar | Independent preparation of seminar paper and its presentation | Analysis of seminar paper with provision of feedback | 20 | 30 |
| 5,6 | 1 | Practices | Independent performance of laboratory exercises | Records related to active and independent participation in practical activities | 10 | 20 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1-6 | 1 | Written exam | Exam preparation | Exam | 20 | 30 |
| | 1-6 | 1 | Oral exam | Preparation for oral exam | Oral exam | 5 | 10 |
| | **Total** | **6** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 45 | 15 | 20 |

**Course content / teaching units**

Lectures:

- Plants as functional food and their importance for human health
- Antioxidants in food and biotechnological methods for achieving better food quality
- The influence of processing and storage on the quality of plant foods
- Traditional and modern use of medicinal plants and spices
- Biologically active substances in plants: isolation, classification of properties and the mechanism of action
- The study of the biological effects of the herbal products and their individual active components
- The use of herbs in alternative and complementary medicine
- Plant tissue culture in the production of biologically active substances
- Legislation in the field of herbal medicine, food supplements and cosmetics with special emphasis on the regulations in the EU and Croatia
- The organic principles and standards in the cultivation of plant food
- Extensive use of the fertilisers and chemical preparations for plant protection as a potential environmental problem
- Nitrates in the environment and the Nitrates Directive
- Environmentally friendly methods of plant protection
- Plants as a source of energy
- Energy crops in the production of biofuels, bioethanol, biomass and natural textiles
- Ecological potential of biofuels
- Other important plant products

Seminars:

- Elaboration of course-related topics based on recent scientific literature

Practices:

- Determination of antioxidants in plant foods by assessing the influence that environmental factors of cultivation, processing and storage have on plant foods
- Determination of nitrate in plants
- Preparation of the plant extracts and separation of the active components
- Determination of phenols, flavonoids and anthocyanins in the plant extracts
- Antioxidant activity of plant extracts (DPPH, FRAP, ABTS)
- Antimicrobial activity of plant extracts on human/plant pathogens
- Essential oils and their antimicrobial activity
- Plant tissue culture in production of biologically active substances

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|---|---|
| **Recommended reading** | Kuštrak D. (2005) Farmakognozija-fitofarmacija. Golden Marketing-Tehnička knjiga d.d., Zagreb.<br>Handa S.S., Singh S.P., Longo K.G., Rakesh D.D. (2008) Extraction Technologies for Medicinal<br>and Aromatic Plants. International centre for science and high technology, Trst. |
| **Optional reading** | Šubarić D., Babić J. (2019) Neke mogućnosti iskorištenja nusproizvoda prehrambene industrije. Knjiga 2. Sveučilište J.J. Strossmayera, Prehrambeno-tehnološki fakultet, Osijek.<br>Mateljan G. (2019) Najzdravije namirnice svijeta. Zdravi grad i Mozaik knjiga.<br>Joy P.P., Thomas J., Mathew S., Skaria B.P. (1998) Medicinal plants. Kerala Agricultural University.<br>Relevant scientific papers referring to the subject area. |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. The teacher thus provides continuous feedback, which students use to assess their learning progress and to create a portfolio to improve the learning process and their own professional development. At the end of the course, students shall pass the written exam, after which they take oral exam. During the oral exam, the teacher asks questions that are related to learning outcomes. The final grade is determined according to the number of points achieved at written and oral exam and the number of points gained during lectures. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher performs evaluation for learning by continuous monitoring of the learning process and student achievement, thus determining and adapting his/her teaching. After the course, the teacher conducts a survey among students to evaluate their subjective impression about the teaching quality, all with the aim to improve future teaching. |

| | |
|---|---|
| **Course title** | **Phytoplankton** |
| **Code** | BBZ36 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Filip Stević |
| **Associate teachers** | Assist. Prof. Dr. Dubravka Špoljarić Maronić |
| **Course entry requirements (Preceding courses)** | Algae, Fungi and Lichens (attended) |
| **Course objective** | To enable students to use the knowledge about phytoplankton ecology and to develop skills required for analysis of qualitative and quantitative composition of phytoplankton for the purpose of assessing the trophy and water quality. |
| **Learning outcomes** | 1. Practical application of acquired basic knowledge in ecology of phytoplankton.<br>2. Skills to analyse the qualitative and quantitative composition of phytoplankton and the horizontal and vertical distribution of phytoplankton.<br>3. Ability to valorise the structure and seasonal dynamics of phytoplankton communities based on the most important abiotic and biotic factors.<br>4. Ability to assess the degree of trophy and water quality.<br>5. Ability to critically evaluate the relevant scientific literature. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 0.5 | Lecture | Critical conversation and discussion | Records related to active and independent participation in conversations and discussions | 10 | 15 |
| 2, 4, 5 | 0.5 | Practices | Written report containing results and conclusions of performed analyses | Records related to students' activities within practices, evaluation of the report | 10 | 15 |
| 1-5 | 0.5 | Written exam | Preparation for written exam | Written exam | 15 | 25 |
| 1-5 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 25 | 45 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | As agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | Lectures:<br>• Phytoplankton – definition, classification, basic energy features in aquatic ecosystems<br>• Adjustments to the phytoplankton life conditions<br>• Phytoplankton communities – structure and seasonal dynamics in different ecosystems<br>• Horizontal and vertical distribution of phytoplankton<br>• Photosynthetic activity of phytoplankton<br>• Influence of nutrients on phytoplankton development<br>• Trophic interactions: phytoplankton – zooplankton – ichtyofauna<br>• Phytoplankton as an indicator of the trophic condition in aquatic ecosystems<br>Practices:<br>• Qualitative and quantitative analysis of phytoplankton<br>• Determination of phytoplankton fresh-weight biomass<br>• Analysis of chlorophyll -a, -b, -c in phytoplankton samples<br>• Saprobiological analysis of phytoplankton<br>• Usage of analyses results in the assessment of trophic condition of aquatic ecosystems | | |
| **Recommended reading** | Reynolds C.S. (2006) The Ecology of Phytoplankton. Cambridge University Press, Cambridge.<br>Sommer U. (eds) (1989) Plankton Ecology: Succession in Plankton Communities. Springer Verlag, Berlin. | | |
| **Optional reading** | Sommer U. (1984) Planktologie. Springer Verlag, Berlin.<br>Reynolds C. S. (1984) The Ecology of Freshwater Phytoplankton. Cambridge University Press, Cambridge.<br>Hindak F. (eds) (1978) Slatkovodne riasy. Slovenske pedagogicke nakladatelstvo, Bratislava.<br>Viličić D. (2003) Fitoplankton u ekološkom sustavu mora. Sveučilište u Zagrebu, PMF, Zagreb.<br>Viličić D. (2002) Fitoplankton Jadranskog mora. Biologija i taksonomija. Sveučilište u Zagrebu, PMF, Zagreb. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course in order to achieve a minimum of 30 points. | | |
| **Exam passing procedure** | Students' performance is assessed during lectures and practices, and within written and oral exam. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

| | |
|---|---|
| **Course title** | **Photosynthesis** |
| **Code** | BBZ45 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Selma Mlinarić |
| **Associate teachers** | Assist. Prof. Dr. Zorana Katanić |
| **Course entry requirements (Preceding courses)** | Cell Biology (passed exam), Biochemistry 2 (attended), Plant Physiology 1 (attended). |
| **Course objective** | To develop students' ability to understand the organisation and function of photosynthetic apparatus and the regulation mechanisms of photosynthetic processes, and to enable students to carry out experiments by selecting appropriate analytical methods. |
| **Learning outcomes** | 1. Ability to critically evaluate the relations between molecular organisation and function of the photosynthetic apparatus.<br>2. Ability to review the process of photosynthesis of C3, C4, CAM and aquatic plants.<br>3. Knowledge about mechanisms of photosynthesis regulation in stress conditions.<br>4. Ability to select and apply appropriate experimental methods for analysis of photosynthesis processes in different physiological conditions. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 0.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 10 | 20 |
| 4 | 0.5 | Practices | Design and completion of an experimental task | Monitoring of student performance | 20 | 30 |
| 1-4 | 0.5 | Written exam | Preparation for written exam | Written exam | 20 | 30 |
| 1-4 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 10 | 20 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | Lectures:<br>• Photosynthesis and evolution<br>• Molecular organisation of the thylakoid membranes: photosynthetic pigments, photosystems, electron-transport chain<br>• Light-dependent and light-independent reactions<br>• Characteristics of photosynthesis in C4, CAM and aquatic plants<br>• Photosynthesis in abiotic stress conditions<br>• Methods for determination of the photosynthetic efficiency<br>Practices:<br>• Experimental techniques in the study of photosynthesis: chromatographic and spectrometric analysis of photosynthetic pigments, immunodetection of photosynthetic proteins; monitoring of primary reactions of photosynthesis | | |
| **Recommended reading** | Kalaji M.H., Goltsev V. N., Żuk-Gołaszewska K., Zivcak M., Brestic M. (2017) Chlorophyll fluorescence: understanding crop performance - basics and applications. CRC Press.<br>Pevalek-Kozlina B. (2003) Fiziologija bilja. 1. izdanje. Profil, Zagreb. | | |
| **Optional reading** | Hopkins W.G. (2009) Plant Physiology 4th Edition. John Wiley & Sons, Inc. Hoboken, SAD. Raghavendra A.S. (2000) Photosynthesis: a comprehensive treatise. Cambridge University Press, Cambridge.<br>Relevant scientific papers referring to the subject area. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students take a written exam and then an oral exam. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | After the course, an anonymous survey will be carried out among students to evaluate their subjective impression about the organisation and quality of teaching; during the lectures, students will have opportunity to make written or oral remarks; monitoring of students' success at exams. | | |

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|---|---|
| **Course title** | **Genetic Engineering** |
| **Code** | BBO630 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Rosemary Vuković |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To enable students to understand basic concepts and principles of recombinant DNA technology, as well as to get an insight into wide application of this technology. |
| **Learning outcomes** | 1. Knowledge about basic concepts and principles of recombinant DNA technology.<br>2. Ability to compare the principles, procedures and application of basic techniques and methods for gene cloning, transformation of microorganisms for production of recombinant proteins, production of transgenic plants and animals.<br>3. Ability to assess the importance of genetic engineering in biotechnology, medicine and forensics.<br>4. Development of knowledge and skills by using bioinformatics tools and databases relevant to genetic engineering.<br>5. Formed opinion on ethical issues related to the application of genetic engineering. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1 | Lecture | Critical conversation and discussion; debate | Records related to student performance during lectures; Records related to engagement in debate | 20 | 40 |
| 1-5 | 0.75 | Written exam | Preparation for written exam | Written exam | 20 | 40 |
| 1-5 | 0.25 | Oral exam | Preparation for oral exam | Oral exam | 10 | 20 |
| **Total** | **2** | | | | **50** | **100** |

**Final grade:**
**50.1-62.5 points: grade 2 (sufficient)**
**62.6-75 points: grade 3 (good)**
**75.1-87.5 points: grade 4 (very good)**
**87.6-100 points: grade 5 (excellent)**

| | |
|---|---|
| **Consultation hours** | Two hours a week according to schedule defined at the beginning of the academic year and additional consultation hours as agreed with students. |

| Teaching | Lectures | Seminars | Practices |
|---|---|---|---|
| **Hours - total** | 30 | 0 | 0 |
| **Course content / teaching units** | • Introduction to genetic engineering<br>• Basic concepts of genetic engineering and concepts of molecular biology<br>• Working with nucleic acids - isolation, quality determination and quantification, PCR, RT-PCR<br>• Enzymes in genetic engineering<br>• Nucleic acid labelling<br>• Hybridization techniques (probe preparation, Southern and Northern blotting)<br>• DNA sequencing<br>• New generation sequencing technologies<br>• Bioinformatics<br>• Hosts and vectors<br>• Molecular cloning strategies<br>• Selection, verification and analysis of recombinants<br>• Genetic engineering in biotechnology<br>• Use of gene manipulation in medicine and forensics<br>• Transgenic plants and animals<br>• Debate | | |
| **Recommended reading** | Ambriović-Ristov A. et al. (2007) Metode u molekularnoj biologiji. Institut Ruđer Bošković, Zagreb.<br>Delić V. (1997) Genetičko inženjerstvo u biotehnologiji. PMF, Zagreb.<br>Nicholl D.S.T. (2008) Introduction to Genetic Engineering. Cambridge University Press, New York.<br>Primrose S.B., Twyman R.M. (2008) Principles of gene manipulation and genomics. 7th ed. Blackwell Publishing, Oxford. | | |
| **Optional reading** | Brown T.A. (2006) Gene cloning and DNA analysis, 5th edition, Blackwell Publishing, Oxford.<br>Lewis B. (2008) Genes IX . Oxford University & Cell Press.<br>Sambrook J., Fritsch E. F., Maniatis T. (2001) Molecular cloning: A laboratory manual, 3rd ed. Vols 1, 2 and 3. Cold Spring Harbor Laboratory, Cold Spring Harbor, New York.<br>Izvorni znanstveni i znanstveno-popularni članci | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | During the lectures, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After the course, students take written and oral exam. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher continuously evaluates student achievement, and gives students the opportunity to make oral or written comments. After the course, students are given a survey in which they give their subjective opinion about quality and organisation of teaching, all with the aim to improve future teaching. | | |

| | |
|---|---|
| **Course title** | **Hematophagous arthropods (Arthropoda)** |
| **Code** | BBZ41 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Prof. Dr. Stjepan Krčmar |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To enable students to understand and compare the developmental cycles and vector roles of hematophagous arthropods. To teach students how to classify certain groups of hematophagous arthropods into appropriate systematic categories. To develop students' skills in selection of appropriate sampling methods and procedures for analysing individual groups of hematophagous arthropods. |
| **Learning outcomes** | 1. Ability to identify groups of hematophagous arthropods.<br>2. Ability to compare the morphological and anatomical characteristics of hematophagous arthropods and to determine them accordingly. Based on those skills, students shall classify individual groups of hematophagous arthropods into appropriate systematic categories.<br>3. Knowledge about biological characteristics of hematophagous arthropods, and ability to compare the developmental cycles of hematophagous arthropods.<br>4. Ability to evaluate the vector role of hematophagous arthropods in the spread of infectious diseases.<br>5. Ability to select appropriate methods and procedures for sampling of individual groups of hematophagous arthropods. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 0.5 | Lecture | Lecture attendance and active participation | Records on and evaluation of active participation | 15 | 25 |
| 2,5 | 0.5 | Practices | Practical classes attendance and active participation | Records on and evaluation of active participation | 15 | 25 |
| 1-5 | 0.5 | Exam | Preparation for written exam | Written exam | 15 | 25 |
| 1-5 | 0.5 | Final exam | Preparation for final exam | Oral exam | 15 | 25 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | Regular consultation hours will be scheduled after being agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | Lectures:<br>• Identification of systematic groups of hematophagous arthropods belonging to: Cheliceriformes (claw horns), Crustacea (crabs) and Hexapoda (six-legged insect)<br>• Comparison of morphological and anatomical features of hematophagous arthropods and their developmental cycles<br>• Parasitism as an ecological concept<br>• Review and analysis of the vector role of individual groups of hematophagous arthropods in the spread of infectious diseases<br>Practices:<br>• Comparison of morphological and anatomical characteristics of individual groups of hematophagous arthropods belonging to: Cheliceriformes (claw horns), Crustacea (crabs) and Hexapoda (six-legged insect)<br>• Classification of individual groups of hematophagous arthropods into appropriate systematic categories<br>• Selection of methods and procedures for sampling of hematophagous arthropods<br>• Determination of hematophagous arthropods. | | |
| **Recommended reading** | Crosskey R.W. (1993) Medical Insects and Arachnids. Chapman & Hall, London.<br>Gratz N.G. (2006) The vector and rodent-borne diseases of Europe and North America: their distribution and public health burden. Cambridge University Press, Cambridge, UK.Lane R. P.,<br>Lehane M. (2000) Biology of blood sucking insects. Chapman & Hall, London. | | |
| **Optional reading** | Habdija I., Primc-Habdija B., Radanović I., Špoljar M., Matoničkin-Kepčija R., Vujčić-Karlo S., Miliša M., Ostojić A., Sertić-Perić M. (2011) Protista-Protozoa, Metazoa-Invertebrata. Alfa d.d., Zagreb. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all practical assignments. | | |
| **Exam passing procedure** | During lectures, the teacher monitors and evaluates performance of each student, which refers to 50% of the final grade. Passing of written exam refers to 25% of the final grade, and passing of oral exam refers to the remaining 25% of the final grade. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form | | |

| | |
|---|---|
| **Course title** | **Land Vertebrates in Croatia** |
| **Code** | BBZ44 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Alma Mikuška |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | Attended obligatory courses: General Zoology and Vertebrates, completed courses Field Work 1 – Zoology and Field Work 2 - Zoology. |
| **Course objective** | To develop students' knowledge and skills in science literacy by elaborating topics referring to biological value of Croatian fauna of land vertebrates at the national and international level. To raise students' awareness of the importance of responsible behaviour in biodiversity protection. |
| **Learning outcomes** | 1. Ability to examine the reasons for the endangerment of land vertebrate taxa in Croatia.<br>2. Ability to use relevant scientific research methods in studying of biology and ecology of land vertebrates living in Croatia.<br>3. Ability to propose measures and activities for protection of land vertebrates living in Croatia.<br>4. Awareness about responsible social behaviour in terms of preserving the biological diversity of land vertebrates in Croatia<br>5. Ability to classify the species of land vertebrates of Croatia according to the endangerment status at national and global level. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 0.5 | Lecture | Critical conversation and discussion, flipped classroom | Monitoring of students' activity during lectures (participation in discussions, asking of questions, involvement in analyses, etc.) | 15 | 25 |
| 2,3,4 | 0.5 | Seminar | Preparation and presentation of a seminar paper | Analysis of seminar paper content by giving a feedback on student's progress in the learning process | 15 | 25 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1-5 | 0.5 | Written exam | Preparation for written exam | Analysis of written exam | 15 | 25 |
| | 1-5 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 15 | 25 |
| | **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 15 | 0 |

**Course content / teaching units**

Lectures:

- Introductory lecture – course content, reading list and obligations of students
- Systematic position and taxonomy of amphibians, reptiles, birds and mammals living in Croatia
- Diversity of Croatian land vertebrate fauna in relation to the diversity of land vertebrate fauna in Europe and in the world
- Croatian herpetofauna: history and research methods, general characteristics of amphibians and reptiles, their diversity in the world and in Croatia, zoogeographic analysis of Croatian herpetofauna, analysis of endangerment status and of protection of amphibians and reptiles in Croatia, areas of importance for protection of Croatian herpetofauna
- Description of Croatian herpetofauna species
- Croatian ornithofauna: history and methods of bird research in Croatia, analysis of endangerment status and of protection measures of Croatian birds, areas of importance for the protection of Croatian ornithofauna
- Bird statuses in Croatian ornithofauna (nesting birds, non-nesting birds, wintering birds, migratory birds, resident birds)
- Theriofauna of Croatia: history and methods of mammal research in Croatia, analysis of endangerment status and of protection measures of Croatian mammals, areas of importance for the protection of Croatian theriofauna
- Endemic and allochthon species of land vertebrates in Croatia

Seminars:

- Student tasks: choosing of one group of the Croatian vertebrates, writing a seminar paper and presenting it in the class
- In the seminar paper, students describe the biological, ecological and zoogeographical characteristics of one group of land vertebrates, status in the world compared with the status in Croatia, if the species is endangered, define the reasons of endangerment and overview the protection measures

**Recommended reading**

Antolović J., Flajšman E., Frković A., Grgurev M., Grubešić M., Hamidović D., Holcer D., Pavlinić I., Tvrtković N., Vuković M. (2006) Crvena sisavaca Hrvatska. Ministarstvo zaštite prirode i okoliša i Državni zavod za zaštitu prirode, Zagreb

Jelić D., Kuljerić M., T Koren T., Treer D., Šalamon D., Lončar M., Podnar-Lešić M., Janev-Hutinec Lj., Bogdanović T., Mekinić S., Jelić K. (2013) Crvena knjiga vodozemaca i gmazova Hrvatska. Ministarstvo zaštite prirode i okoliša i Državni zavod za zaštitu prirode, Zagreb.

Tutiš V., Kralj J., Čiković D., Barišić S. (2013) Crvena knjiga ptica Hrvatske. Ministarstvo zaštite prirode i okoliša i Državni zavod za zaštitu prirode, Zagreb.

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|---|---|
| **Optional reading** | Clarke K.R., Gorely R.N. (2020) Primer 7. User Manual/ Tutoral. Primer-E Ltd.Plymouth.<br>Holcer D., Pavlinić I. (2008) Fauna, Priručnik za inventarizaciju i praćenje stanja. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb.<br>Purger J. (2007) Priručnik za istraživanje biološke raznolikosti duž rijeke Drave. Sveučilište u Pečuhu. Pečuh<br>Izvješće o stanju okoliša u RH za razdoblje 2013 -2016:<br>http://www.haop.hr/sites/default/files/uploads/dokumenti/06_integrirane/dokumenti/niso/IZVJOKOLIS_2013-2016.pdf |
| **Conditions for obtaining teacher's signature** | Regular attendance and activity at lectures, presented seminar paper. |
| **Exam passing procedure** | During the presentation of the seminar paper, the teacher evaluates the activities of students by awarding points according to the determined criteria. The teacher provides feedback on students' progress, so that students have an insight into their advancement within the learning process for the purpose of improvement and professional development Within written and oral exam, the teacher defines tasks that are related to learning outcomes. The final grade refers to the sum of points that students achieve at the seminar paper presentation and at written and oral exam. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | The teacher continuously monitors the learning process and students' achievement, thus directing and adapting the teaching. After the course, the teacher and students analyse the success of the teaching process and carry out a survey to evaluate students' subjective impression about the teaching quality. The results are used for improvement of teaching. |

| | |
|---|---|
| **Course title** | **Neurobiology** |
| **Code** | BBZ61 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 6 |
| **Course status** | Elective |
| **Course teacher** | Prof. Dr. Marija Heffer |
| **Associate teachers** | Assist. Prof. Dr. Irena Labak<br>Assist. Prof. Dr. Senka Blažetić |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To enable students to understand the basic concepts of neurobiology and to develop their skills required for experimental work, such as application of methods used in cell and molecular biology, overview of scientific literature and communication with experts and multidisciplinary teams. |
| **Learning outcomes** | 1. Ability to examine the molecular basis of processes that are characteristic for functioning of neurons and glial cells.<br>2. Ability to make connection between the structure and function of sensory organs and the processing of stimuli.<br>3. Ability to analyse the systems of motor neurons and their modulation levels.<br>4. Ability to explain speech, emotions and memory as complex brain functions.<br>5. Ability to critically evaluate the relevant scientific literature.<br>6. Ability to review the suitability of methods for solving of some experimental issues. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 1.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-5 | 1.5 | Seminar | Interpretation of scientific papers and application of obtained results in concepts learned within lectures | Monitoring of student's interpretations and performance at tasks | 10 | 20 |
| 1-6 | 1.5 | Practices | Work on experimental task | Monitoring of student performance | 10 | 20 |
| 1-6 | 1 | Written exam | Preparation for written exam | Written exam | 10 | 20 |
| 1-6 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 15 | 30 |
| **Total** | **6** | | | | **50** | **100** |

<table>
<tr><td></td><td colspan="3">Final grade:<br>50.1-62.5 points: grade 2 (sufficient)<br>62.6-75 points: grade 3 (good)<br>75.1-87.5 points: grade 4 (very good)<br>87.6-100 points: grade 5 (excellent)</td></tr>
<tr><td>Consultation hours</td><td colspan="3">By appointment.</td></tr>
<tr><td>Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>Hours - total</td><td>40</td><td>20</td><td>30</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">Lecture topics include the basics of anatomy, physiology, molecular biology and genetics, maturation, regeneration and aging of the brain.<br>Lectures:<br>• Neuronal signalisation<br>• Processing of stimuli<br>• System of motoric control<br>• Development, regeneration and plasticity<br>• Complex brain functions<br>Seminars:<br>• Each lecture unit is accompanied by mandatory scientific papers that present turning points in thinking or in laboratory methods<br>Practices:<br>• Conventional histology<br>• Immunochemistry<br>• Cell culture<br>• Techniques of stereotaxic lesion and microdissection<br>• Techniques of labelling the molecules and cells (tracing)<br>• Behavioural tests<br>• Gene manipulation and neurobiology databases</td></tr>
<tr><td>Recommended reading</td><td colspan="3">Purves D., Augustine G.J., Fitzpatrick D., Hall W.C., LaMantia A.S., White L.E. (2012) Neuroscience, 5th ed. Sinauer Associates, INC, Sunderland, Massachusetts, U.S.A.</td></tr>
<tr><td>Optional reading</td><td colspan="3">Judaš M., Kostović I. Temelji neuroznanosti. Udžbenik na Internetu (http://www.him.unizg.hr/dokumenti/<Judas&Kostovic-Temelji_Neuroznanosti.pdf)<br>Kandel E.R., Schwartz J.H., Jesell T.M. (2000) Principes of Neural Science, 4th ed. McGraw-Hill, Healt Professions Division, New York, London, Tokyo.</td></tr>
<tr><td>Conditions for obtaining teacher's signature</td><td colspan="3">Students are obliged to participate in lectures actively and to fulfil all assignments within the course.</td></tr>
<tr><td>Exam passing procedure</td><td colspan="3">Before taking oral exam, students are obliged to pass final written exam, which can be divided into two preliminary written exams. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade.</td></tr>
<tr><td>Main language of instruction; other languages</td><td colspan="3">Croatian language, English language</td></tr>
<tr><td>Method of monitoring the quality and efficiency of teaching</td><td colspan="3">Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.</td></tr>
</table>

| | |
|---|---|
| **Course title** | **Poisonous Animals and Plants** |
| **Code** | BBZ51 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Goran Palijan |
| **Associate teachers** | Assist. Prof. Dr. Olga Jovanović Glavaš |
| **Course entry requirements (Preceding courses)** | General Zoology, Invertebrates, General Botany, Microbiology |
| **Course objective** | To teach students how to assess the toxicity of various organisms. |
| **Learning outcomes** | 1. Ability to examine the basic properties of toxic organisms.<br>2. Ability to compare various poisonous organisms.<br>3. Ability to assess the toxicity of various organisms.<br>4. Ability to critically evaluate the professional literature. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 0.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-4 | 0.5 | Seminar | Interpretation of scientific papers and application of obtained results in concepts learned within lectures | Monitoring of student's interpretations and performance at tasks | 10 | 15 |
| 1-4 | 0.5 | Written exam | Preparation for written exam | Written exam | 20 | 32.5 |
| 1-4 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 25 | 42.5 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |

| | | | |
|---|---|---|---|
| **Hours/week total** | 15 | 15 | 0 |
| **Course content / teaching units** | Lecture:<br>• Poisonous animals (fanerotoxic animals)<br>• Poisonous animals in the narrow sense (cryptotoxic animals)<br>• Poisonous plants<br>• Poisonous mushrooms<br>• Mycotoxicosis<br>• Bacterial toxins<br>Seminars:<br>• Within the seminars, students shall independently prepare and present seminar papers referring to lecture topics, and participate in discussions | | |
| **Recommended reading** | Mallis A. (2011) Handbook of pest control. GIE Pub.<br>Maretić Z. (1985) Naše otrovne životinje i bilje. Stvarnost, Zagreb. | | |
| **Optional reading** | Maretić Z, Lebez D. (1985) Otrovni pauci. Pula.<br>Maretić Z. (1988) Crna udovica ipak nije bauk. Stvarnost, Zagreb. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass written exam. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

| | |
|---|---|
| **Course title** | **Experimental Animals** |
| **Code** | BBZ62 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Senka Blažetić |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General Zoology (attended), Vertebrates (attended) |
| **Course objective** | To introduce students to the principles of high-quality scientific research and ethically correct approach to handling of animals for experimental purposes. |
| **Learning outcomes** | 1. Ability to determine the biology of experimental animals (especially of mice and rats).<br>2. Knowledge about provisions of global, European and national Animal Protection Acts.<br>3. Ability to define basic concepts related to research on animals (experimental animals, laboratory animals, laboratory animal breeder, users, procedures).<br>4. Awareness on the importance of applying the 3R principle in handling of experimental animals.<br>5. Ability to assess published studies and students' scientific researches on experimental animals. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 0.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 10 | 15 |
| 1-5 | 0.5 | Practices | Independent preparation of a scientific research on animals, data collection and analysis | Records related to activities during project preparation | 20 | 45 |
| 1-5 | 0.5 | Written exam | Preparation for written exam | Written exam | 10 | 20 |
| 1-5 | 0.5 | Oral exam | Preparation for oral exam | Oral exam<br>Project presentation | 10 | 20 |
| **Total** | **2** | | | | **50** | **100** |

**Final grade:**
**50.1-62.5 points: grade 2 (sufficient)**
**62.6-75 points: grade 3 (good)**

| | | | |
|---|---|---|---|
| | **75.1-87.5 points: grade 4 (very good)**<br>**87.6-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | Lectures:<br>• Biology of rodents (primarily of mouse and rat)<br>• National, European and global legislation on the keeping and using animals in experiments<br>• Ethical and bioethical justification of performing experiments on animals<br>• The GLP principles (Good Laboratory Practice)<br>• Housing and zoohygienic conditions before and during the experiment<br>• Health surveillance before and during the experiment<br>• Research-conditioned animal diet<br>• Animal diseases (zoonoses and allergoses) significant for humans<br>• Surgical and non-surgical techniques applied in experiments<br>• Pain caused by the experiment and its relief<br>• Experimental design and statistical evaluation of results<br>• Post-mortem techniques and procedures<br>• Use of specific animals in biological experiments (nude mice, knockout mice, SCID, germ free, flora defined), and large animals (dog, monkey, cattle)<br>Practices:<br>• Basic methods and tests applied in experiments on animals<br>• Debate on the justification of using animals in scientific research | | |
| **Recommended reading** | Hedrich J.H., Bullock G.R. (eds) (2004) The Laboratory Mouse-Handbook of Experimental Animals, Elsevier Academic Press.<br>Radačić M., Bašić I., Eljuga D. (2000) Pokusni modeli u biomedicini. Medicinska naklada, Zagreb.<br>Šuman L. (2011) Uvod u znanost o laboratorijskim životinjama. Udžbenik Sveučilišta u Rijeci.<br>Animal Protection Act. | | |
| **Optional reading** | Hedrich H. (2004) The Laboratory Mouse. Elsevier Ltd., London.<br>Pough F.H., Janis C.M., Heiser J.B. (2008) Vertebrate life. 8th edn. Pearson education Inc., San Francisco. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass final written exam, which can be divided into two preliminary written exams. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

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|---|---|
| **Course title** | **Preparation and Production of Biological Collections** |
| **Code** | BBZ42 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Goran Vignjević |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To enable students to successfully apply the methods of preparation and taxidermy of various biological material and to learn how to use such material in study. |
| **Learning outcomes** | 1. Making collection of different biological samples by using appropriate tools.<br>2. Developed skills in preparation and stuffing of biological material by using appropriate taxidermy methods.<br>3. Usage of acquired knowledge and skills in selection of the most appropriate methods for stuffing of specific groups of animals.<br>4. Independent preparation of biological collection. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 0.25 | Lecture | Critical conversation and discussion; collaborative learning while performing analysis of different procedures of stuffing biological material | Records related to active participation in discussions and analysis | 5 | 10 |
| 1-4 | 0.25 | Field-based teaching | Practical application of methods in sampling of biological material, selection of suitable biological material within field classes | Records related to active engagement in the field-based learning | 5 | 10 |

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|---|---|---|---|---|---|---|---|
| | 1-4 | 0.5 | Practices | Independent preparation of biological collection | Analysis of stuffed material with provision of feedback, preparation of a small collection | 10 | 20 |
| | 1-4 | 1 | Oral practice-based exam | Prepared student's own biological collection | Control of methods applied for taxidermy, determination and storage of collection | 40 | 60 |
| | **Total** | **2** | | | | **60** | **100** |
| | **Final grade:**<br>**60-70 points: grade 2 (sufficient)**<br>**71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | | | | | |

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | • What is a biological collection, how it looks like, an overview of taxidermy methods, procedures for creating biological collection<br>• Methods of stuffing of biological material (protozoa, plants, fungi and lichens, arthropods, vertebrates)<br>• Production of permanent and semi-permanent microscopic preparations<br>• Making aquariums, terrariums, and live corners<br>• Selection of biological material that is suitable for field-based teaching | | |
| **Recommended reading** | Chinery M. (1989) 1000 ideja za prirodoslovca. Svjetlost, Sarajevo.<br>Durrell G. (1990) Svijet prirode. GZH, Zagreb.<br>Various authors (2015) Taxidermy Vol. 9 Bones and Skeletons - The Collection, Preparation and Mounting of Bones, Sigaud Press. | | |
| **Optional reading** | | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. In this way, the teacher provides continuous feedback, which students use to assess their learning progress and to create their own biological collection. After having prepared their biological collection, students take the oral exam. During the oral exam, the teacher checks the applied methods that are related to learning outcomes. The final grade is determined according to the number of points gained during the course and at the oral exam, as well as for preparation of biological collection. | | |

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|---|---|
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | During the course, the teacher performs evaluation for learning by continuous monitoring of the learning process and student achievement, thus determining and adapting his/her teaching. After the course, the teacher conducts a survey among students to evaluate their subjective impression about the teaching quality, all with the aim to improve future teaching. |

| | |
|---|---|
| **Course title** | **Toxicology** |
| **Code** | BBZ46 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Prof. Dr. Branimir Hackenberger Kutuzović |
| **Associate teachers** | Assoc. Prof. Dr. Davorka Hackenberger Kutuzović |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To enable students to understand the basic concepts and principles of toxicological science in order to comprehend its multidisciplinarity and basic biological principles of toxicological research. |
| **Learning outcomes** | 1. Acquired knowledge about basic concepts and principles in toxicology.<br>2. Ability to explain the mechanism of toxic action on organ systems.<br>3. Ability to analyse the response of organ systems to exposure to various toxicants.<br>4. Ability to explain and analyse the mechanisms of toxicity of pesticides, metals, solvents and vapours, radiation and radioactive substances.<br>5. Ability to elaborate practical examples referring to toxicology. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 0.5 | Lecture | Lecture attendance and active participation | Records related to student attendance and activity | 5 | 10 |
| 5 | 0.5 | Practices | Practical classes attendance, active participation | Records related to student attendance and activity | 10 | 15 |
| 1-5 | 0.5 | Written exam | Preparation for written exam | Written exam | 20 | 35 |
| 1-5 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 25 | 40 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | |
|---|---|
| **Consultation hours** | By appointment. |

| Teaching | Lectures | Seminars | Practices |
|---|---|---|---|
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | Lectures:<br>• Introduction to toxicology and short historical overview of its development<br>• Principles of toxicology<br>• Mechanisms of toxicity<br>• Toxicological risk, assessment and management<br>• Absorption, distribution and excretion of toxins<br>• Xenobiotics biotransformation<br>• Toxicokinetics<br>• Acute, subacute, subchronic and chronic toxicity<br>• Chemical carcinogenesis<br>• Genetic toxicology<br>• Developmental toxicology<br>• Response of the organ systems on xenobiotics exposure<br>• Immunotoxicology<br>• Toxic effects of pesticides<br>• Toxic effects of metals<br>• Toxic effects of solvents and vapours<br>• Toxic effect of radiation and radioactive substances<br>• Animal and plant toxicology<br>• Applied toxicology<br>• Food toxicology<br>• Analytical and forensic toxicology<br>• Clinical toxicology<br>• Regulations on toxicology<br>Practices:<br>• Students will be studying, discussing and analysing practical examples referring to toxicology | | |
| **Recommended reading** | Klaassen D.C. (2013) Casarett & Doull's Toxicology: The Basic Science of Poisons. McGraw-Hill, New York. | | |
| **Optional reading** | Wallace Hayes, A. (2007) Principles and Methods of Toxicology. Taylor & Francis, Philadelphia - London. | | |
| **Conditions for obtaining teacher's signature** | Regular attendance at lectures and successful completion of practical assignments. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass final written exam, which can be divided into two preliminary written exams. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

| | |
|---|---|
| **Course title** | **Ultrastructure of Cell Organelles** |
| **Code** | BBZ38 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Selma Mlinarić |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | Cell Biology (passed exam), Physical Foundations of Instrumental Methods in Biology (passed exam) |
| **Course objective** | To enable students to understand the function of cell structures, and to train students for experimental work by elaborating appropriate methods used in preparation and observation of cell structures. |
| **Learning outcomes** | 1. Ability to examine the relations between cell structures and their functions.<br>2. Ability to critically assess the learned theoretical knowledge about cell ultrastructure.<br>3. Ability to distinguish and analyse cell structures on micrographs.<br>4. Ability to select and apply appropriate methods for tissue preparation, contrast techniques and production of ultrathin preparations. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 0.5 | Lecture | Critical conversation and discussion, flipped classroom | Records related to active participation in conversations and discussions | 10 | 20 |
| 3 | 0.5 | Practices | Interpretation of scientific papers and application of obtained results at concepts learned within lectures | Monitoring of student's interpretations and performance at tasks | 20 | 30 |
| 1-4 | 0.5 | Written exam | Preparation for written exam | Written exam | 20 | 30 |
| 1-4 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 10 | 20 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | |
|---|---|
| **Consultation hours** | By appointment. |

| Teaching | Lectures | Seminars | Practices |
|---|---|---|---|
| **Hours - total** | 15 | 0 | 15 |
| **Course content / teaching units** | Lecture:<br>• Ultrastructure of biomembranes: lipid bilayer, membrane proteins and their functions in transport through the biomembrane<br>• Structural and functional connection between the nucleus and the endoplasmic reticulum: analysis of electron microscopic images, transport of molecules from and into the nucleus<br>• Ultrastructure of the Golgi apparatus and its products<br>• Mitochondria and plastids: characteristics of ultrastructure under the influence of various factors<br>• Cytoskeleton and cell differentiation<br>Practices:<br>• Fixation of live material, preparation of blocks, cutting on ultramicrotome, site-visit to the Ruder Bošković Institute, working with an electron microscope, interpretation of microphotographs. Making of conclusions. | | |
| **Recommended reading** | Cooper G.M. (2004) Stanica – molekularni pristup, 3. izdanje. Medicinska naklada, Zagreb.<br>Taylor N., Millar A. (2017) Isolation of Plant Organelles and Structures. Methods in Molecular Biology, Humana Press, New York. | | |
| **Optional reading** | Yeung E.C.T., Stasolla C., Sumner M.J., Huang B.Q. (eds.) (2015) Plant microtechniques and protocols. Springer International Publishing, Switzerland.<br>Pifat-Mrzljak G. (ed.) (2004) Supramolecular structure and function 8. Kluwer Academic.<br>Relevant scientific papers referring to the subject area. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students take a written exam and then an oral exam. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | After the course, an anonymous survey will be carried out among students to evaluate their subjective impression about the organisation and quality of teaching; during the lectures, students will have opportunity to make written or oral remarks; monitoring of students' success at exams | | |

| | |
|---|---|
| **Course title** | **Protected Animal Species** |
| **Code** | BBZ48 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Prof. Dr. Enrih Merdić |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To develop students' ability to valorise protected and endangered animal species in Croatia. |
| **Learning outcomes** | 1. Ability to critically assess the criteria defined out by the IUCN for threatened species.<br>2. Knowledge about legal provisions for animal protection in Croatia.<br>3. Ability to justify the endangerment status of certain groups of animals.<br>4. Ability to define the most important protected animals and to explain the reasons for their protection.<br>5. Ability to review the status of protected animal species by making comparison with the endangered species on the red lists. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 0.5 | Lecture | Attendance of lectures | Records | 18 | 30 |
| 4-5 | 0.5 | Seminar | Independent research work | Assessment of seminar paper | 24 | 40 |
| 1-5 | 1 | Final exam | Preparation for final exam | Oral presentation | 18 | 30 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-65 points: grade 2 (sufficient)**
**66-75 points: grade 3 (good)**
**76-85 points: grade 4 (very good)**
**86-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | The schedule of consultation hours is announced at the teacher's office door. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 15 | 0 |
| **Course content / teaching units** | Lectures:<br>• Reasons of the animal endangerment<br>• Models of protection<br>• Determination of the endangerment criteria | | |

| | |
|---|---|
| | • Protection mechanism assured within international conventions and agreements, especially within the EU legislation (the EU Birds and Habitats Directives)<br>• Action plan for the protection of the special animals<br>• Legislative framework in the Republic of Croatia<br>• Overview of protected animals in the world and Croatia<br>Seminars:<br>• Students shall present seminar papers about topics of their interest |
| **Recommended reading** | Radović J. (ed.) (1999) Pregled stanja biološke i krajobrazne raznolikosti Hrvatske sa strategijom i akcijskim planovima zaštite. Državna uprava za zaštitu prirode i okoliša.<br>Radović D., Kralj J., Tutiš V., Čiković D. (2003) Crvena knjiga ugroženih ptica Hrvatske. MZOiPO, Zagreb. |
| **Optional reading** | www.iucn.org<br>www.redlist.org<br>www.dzzp.hr |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively. |
| **Exam passing procedure** | Students shall deliver an oral presentation about the topic of their choice. Presentations are evaluated according to criteria valid for the assessment of seminar papers. Monitoring of students' performance during the course refers to 40% of the final grade, and the remaining 60% refers to success at the final exam. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Evaluation form |

## Facultative Module Chemistry

| | |
|---|---|
| **Course title** | **Analytical Chemistry 1** |
| **Code** | K031 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assoc. Prof. Dr. Maja Molnar |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General (1) and Inorganic Chemistry (1) (attended) |
| **Course objective** | To acquire basic knowledge necessary for understanding and performing regular methods of chemical analysis, and to enable students to think critically about conducting sample analysis in the laboratory. |
| **Learning outcomes** | 1. Ability to recommend an analytical method or several ones for processing of various types of samples.<br>2. Ability to evaluate and determine the type of analytical method based on types of chemical reactions and chemical equilibrium.<br>3. Ability to solve computational problems related to particular course unit.<br>4. Ability to compare and assess certain types of qualitative and quantitative analytical methods, and to apply them in analytical calculations.<br>5. Ability to identify errors in quantitative analysis, including the basics of statistical processing of analytical results. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 0.5 | Lecture | Lecture attendance and active participation in critical discussion, and presentation of seminar paper | Records, evaluation | 10 | 20 |
| 1-5 | 0.5 | Exam | Written exam | Written exam | 15 | 30 |
| 1-5 | 1.0 | Final exam | Oral exam | Oral exam | 25 | 50 |
| **Total** | **2** | | | | **50** | **100** |

**Final grade:**
**50-69.9 points: grade 2 (sufficient)**
**70-79.9 points: grade 3 (good)**
**80-89.9 points: grade 4 (very good)**
**90-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 0 | 0 |
| **Course content / teaching units** | • The role of analytical chemistry in science,<br>• Sampling, sample decomposition and solution<br>• Chemicals, devices, basic operations and calculations in analytical chemistry,<br>• Chemical equilibrium in solutions that are significant for chemical analysis (acid-base, redox, complex formation, solubility),<br>• Titrimetric methods of analysis - theory and practice<br>• Neutralising, redox titrations, complexometric and precipitation titrations<br>• Principles of the gravimetric analysis | | |
| **Recommended reading** | Skoog D.A., West D.M., Holler F. J. (1999) Osnove analitičke kemije. Školska knjiga, Zagreb. | | |
| **Optional reading** | Radić Nj., Kukoč Modun L. Uvod u analitičku kemiju. Školska knjiga, Zagreb.<br>Šoljić Z. (1998) Računanje u analitičkoj kemiji. FKIT, Zagreb. | | |
| **Conditions for obtaining teacher's signature** | Lecture attendance and presentation of seminar paper. | | |
| **Exam passing procedure** | Based on the attendance records and the presented seminar paper, the students proceed with the written exam. If achieving sufficient number of points (min. 60%) at the written exam, they take the oral exam, which makes the major share in the final grade. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. | | |

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|---|---|
| **Course title** | **Analytical Chemistry 2** |
| **Code** | K032 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Olivera Galović |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General Chemistry (attended), Analytical Chemistry 1 (attended) |
| **Course objective** | To enable students to understand the basic principles of instrumental methods that are applied in analytical chemistry and to teach them how to select appropriate analytical techniques for sample analysis and how to use the scientific literature. |
| **Learning outcomes** | 1. Ability to compare the principles of instrumental methods that are used for analysis of various samples.<br>2. Ability to select an instrumental method, which is the most suitable for the analysis of specific samples.<br>3. Ability to define the most common instrumental methods.<br>4. Ability to apply the learned concepts in solving of calculus tasks. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 1 | Lecture | Discussion | Records related to students' engagement in discussions | 6 | 10 |
| 1-4 | 0.5 | Seminar | Solving of calculus tasks by applying concepts learned within lectures | Records related to students' performance at solving of tasks | 6 | 10 |
| 1-4 | 0.5 | Written exam | Preparation for written exam | Written exam | 48 | 80 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70.9 points: grade 2 (sufficient)**
**71-80.9 points: grade 3 (good)**
**81-90.9 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 15 | 0 |

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|---|---|
| **Course content / teaching units** | • Separation techniques, introduction to analytical separations (precipitation, distillation, extraction, ion exchange)<br>• Spectrochemical methods, introduction to the spectrochemical methods, instrumentation for optical spectrometry, molecular absorption spectrometry (UV-VIS spectroscopy, IR spectroscopy)<br>• Electrochemical methods, introduction to electrochemistry, potentiometry, amperometry, voltammetry. |
| **Recommended reading** | Radić Nj., Kukoč Modun L. (2016) Uvod u analitičku kemiju. Školska knjiga, Zagreb.<br>Skoog D.A., West D.M., Holler F. J. (1999) Osnove analitičke kemije. Školska knjiga, Zagreb. |
| **Optional reading** | Douglas A., Skoog F., Holler J., Crouch S.R. (2017) Principles of Instrumental Analysis, 7th ed. Cengage Learning, US.<br>Harris D.C. (2010) Quantitative Chemical Analysis, 8th ed. W.H.Freeman and Company. |
| **Conditions for obtaining teacher's signature** | Active participation in classes and completion of all assignments within the course. |
| **Exam passing procedure** | Two preliminary exams passed during the course, or final written exam after lectures. The final grade comprises points that students collect during lectures and seminars (points referring to active participation in classes). |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Conversation with students during lectures, student survey after the course. |

| | |
|---|---|
| **Course title** | **Inorganic Chemistry 2** |
| **Code** | K021 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 3 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Tomislav Balić |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | Passed exams within the courses General and Inorganic Chemistry 1 and 2 |
| **Course objective** | To enable students to understand basic concepts of structure and properties of inorganic substances and elements. To enable students to independently search the scientific literature in the field of inorganic chemistry and to write and present current scientific issues within their seminar papers. |
| **Learning outcomes** | 1. Ability to explain and describe the electronic structure of atoms, ions and molecules and the structure of crystalline matter.<br>2. Skills required for reviewing the differences in atomic structure of metals, non-metals, transition metals and noble gases.<br>3. Knowledge about the structure of ionic, metallic and molecular compounds.<br>4. Ability to analyse and apply the basic coordination polyhedra.<br>5. Knowledge about the principles of the X-ray diffraction method.<br>6. Widening of the acquired knowledge within the preparation of seminar paper and at problem solving.<br>7. Ability to critically assess the relevant scientific literature. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 1 | Lecture | Lecture attendance and active participation | Records related to students' attendance and activities | 5 | 10 |
| 1-6 | 0.5 | Knowledge assessment (preliminary exams) | Preparation for knowledge assessment (preliminary exams) | Preliminary written exam | 15 | 30 |
| 6,7 | 0.5 | Writing and presenting a seminar paper | Writing of seminar paper | Oral presentation | 10 | 20 |
| 1-7 | 1 | Final exam | Preparation for written and oral exam | Written and oral exam | 20 | 40 |
| **Total** | **3** | | | | **50** | **100** |

| | | | |
|---|---|---|---|
| | **Final grade:**<br>**50-60 points: grade 2 (sufficient)**<br>**61-75 points: grade 3 (good)**<br>**76-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 15 | 0 |
| **Course content / teaching units** | • Basic concepts of the electronic structure, chemical bonding, molecular and crystal structure<br>• Bonds, structures and properties of elements and compounds<br>• Chemistry of selected anions<br>• Coordination chemistry<br>• Solutions, acids and bases<br>• Periodic Table of Chemical Elements<br>• Chemistry of the Main Group elements: Hydrogen, Group 1, Group 2, Boron and Group 13, Carbon and Group 14<br>• Within the seminars, current topics published in journals of Inorganic Chemistry will be discussed (students deliver presentations of their seminar papers). Students will be engaged in solving of tasks. | | |
| **Recommended reading** | Cotton F. A., Wilkinson G., Gaus P. L. (1995) Basic Inorganic Chemistry, 3. ed. John Wiley & Sons, New York.<br>Filipović I., Lipanović S. (1995) Opća i anorganska kemija, 9. izd. Školska knjiga, Zagreb.<br>Grdenić D. (2005) Molekule i kristali, 5. izd. Školska knjiga, Zagreb.<br>Houscroft C. E., Sharp A. G. (2005) Inorganic Chemistry. Prentice Hall.<br>West A.R. (1998) Solid State Chemistry and its Applications. Wiley, New York. | | |
| **Optional reading** | Cotton F. A., Wilkinson G. (1999) Advanced Inorganic Chemistry, 6. ed. John Wiley & Sons, New York.<br>Shriver D.F., Atkinson P.W. (2006) Inorganic Chemistry, 4. ed., Oxford University Press, Oxford. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course (seminar tasks and seminar papers). | | |
| **Exam passing procedure** | Written and oral exams are taken after the attended lectures. The final grade refers to: regular attendance and active participation in lectures – 10%, seminar paper – 20%, preliminary exams in the middle and at the end of semester - 30% and success at the final exam – 40%. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. | | |

| | |
|---|---|
| **Course title** | **Inorganic Chemistry 3** |
| **Code** | K022 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Elvira Kovač-Andrić |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | Passed exam within General and Inorganic Chemistry, and attended course Inorganic Chemistry 2 |
| **Course objective** | To enable students to understand basic concepts related to the chemistry of coordination compounds and properties of element groups. |
| **Learning outcomes** | 1. Ability to discuss coordination compounds and compare the structure of coordination compounds.<br>2. Integrated knowledge about atomic structure between elements of groups 15 and 16 and their properties.<br>3. Written and explained electronic structure of transition metals and magnetic and spectroscopic properties arising from it.<br>4. Ability to compare the crystal and ligand field and to explain the consequences of their properties on the solid state.<br>5. Ability to determine electronic states of individual coordination compounds.<br>6. Application of acquired knowledge in performing of laboratory practices. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-6 | 1.5 | Lecture | Critical conversation and discussion | Records related to student performance during discussion and analysis | 15 | 30 |
| 1-6 | 1 | Seminar | Interpretation of problem-based tasks | Monitoring of student's interpretations and performance at tasks | 20 | 40 |
| 1-6 | 1 | Written exam | Preparation for written exam | Written exam | 10 | 20 |
| 1-6 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 5 | 10 |
| **Total** | **4** | | | | **50** | **100** |

**Final grade:**
**50-60 points: grade 2 (sufficient)**
**61-75 points: grade 3 (good)**

<table>
<tr><td></td><td colspan="3">76-90 points: grade 4 (very good)<br>91-100 points: grade 5 (excellent)<br>Final exam: minimum number of points refers to the lowest grade (sufficient), and maximum number of points refers to the highest grade (excellent).</td></tr>
<tr><td>Consultation hours</td><td colspan="3">By appointment.</td></tr>
<tr><td>Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>Hours - total</td><td>45</td><td>15</td><td>0</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">• Chemistry of the main group elements: nitrogen and Group 15, oxygen and Group 16, halogens, noble gases, chemistry of the selected metals<br>• Transition metals and properties of complex compounds in relation to their structure, nature of chemical bonds, spectroscopic and magnetic-chemical behaviour<br>• Crystal and ligand field theories in the chemistry of coordination compounds<br>• Electron spectroscopy<br>• Introduction to the solid state chemistry;<br>• Introduction to the bioinorganic chemistry<br>• Within the seminars, current topics published in journals of inorganic chemistry will be discussed (students deliver presentations of their seminar papers). Students will be engaged in solving of tasks.</td></tr>
<tr><td>Recommended reading</td><td colspan="3">Cotton F.A., Wilkinson G., Gaus P.L. (1995) Basic Inorganic Chemistry, 3rd ed. John Wiley & Sons, New York.<br>Filipović I., Lipanović S. (1995) Opća i anorganska kemija, 9. izd. Školska knjiga, Zagreb.<br>Grdenić D. (2005) Molekule i kristali, 5. izd.. Školska knjiga, Zagreb.<br>Rayner-Canham G., Overton T. Descriptive Inorganic Chemistry. Freeman & Co., New York.</td></tr>
<tr><td>Optional reading</td><td colspan="3">Cotton F.A., Wilkinson G. (1999) Advanced Inorganic Chemistry, 6th ed., John Wiley & Sons, New York.<br>Rodgers E. (2002) Descriptive Inorganic, Coordination, and Solid State Chemistry, 2. izd., Brooks Cole, Belmont.<br>Shriver D.F., Atkinson P.W. (2006) Inorganic Chemistry, 4th ed. Oxford University Press, Oxford.</td></tr>
<tr><td>Conditions for obtaining teacher's signature</td><td colspan="3">Students are obliged to participate in lectures actively and to fulfil all assignments within the course (practices, seminar tasks).</td></tr>
<tr><td>Exam passing procedure</td><td colspan="3">Written and oral exams are taken after the attended lectures. The final grade refers to: regular attendance and active participation in lectures – 10 %, seminar paper – 25 %, preliminary exam in the middle of semester – 25 % and success at the final exam – 40 %.</td></tr>
<tr><td>Main language of instruction; other languages</td><td colspan="3">Croatian language</td></tr>
<tr><td>Method of monitoring the quality and efficiency of teaching</td><td colspan="3">Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams.</td></tr>
</table>

| | |
|---|---|
| **Course title** | **Chemistry in Everyday Life** |
| **Code** | K083 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Olivera Galović |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | Courses related to chemistry |
| **Course objective** | To enable students to understand basic concepts in chemistry that are applicable to everyday situations. |
| **Learning outcomes** | 1. Ability to compare the daily activities of humans and chemical processes that take place in their environment.<br>2. Ability to assess positive and negative impact of humans on nature and natural processes.<br>3. Ability to analyse the relevant scientific literature.<br>4. Ability to apply knowledge in solving of simpler problem-based tasks. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-3 | 1 | Lecture | Discussion | Records related to students' engagement in discussions | 6 | 10 |
| 1-4 | 0.5 | Practices | Working on tasks by applying knowledge acquired during lectures | Records related to performance at solving of tasks | 6 | 10 |
| 1-4 | 0.5 | Written exam | Preparation for written exam | Written exam | 48 | 80 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70.9 points: grade 2 (sufficient)**
**71-80.9 points: grade 3 (good)**
**81-90.9 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 15 | 0 | 15 |

| | |
|---|---|
| **Course content / teaching units** | • By using examples from everyday life (medications, detergents, plastics, food additives, cosmetic products, fertilisers), as well as by elaborating selected issues and solutions, students will be introduced to the role of chemistry in criminology, ecology, technology, transport, waste management, food production and other industries.<br>• Better understanding of chemistry and chemistry laws for better control of chemicals in everyday life situations and for achievement of maximum benefit and minimum risk of their usage. |
| **Recommended reading** | American Chemical Society (2018) Chemistry in context - Applying Chemistry to Society, 9th ed.<br>Hill J.W., McCreary T.W., Kolb D.K. (2016) Chemistry for Changing Time (Global Edition). Pearson Higher Ed. |
| **Optional reading** | Lee H.C., Gaensslen R.E. (2013) Advances in Fingerprint Technology, 3rd ed. CRC Press, New York.<br>Journal of Chemical Education |
| **Conditions for obtaining teacher's signature** | Active participation in classes and completion of all assignments within the course. |
| **Exam passing procedure** | Passed two preliminary exams during the course or final written exam after the attended lectures. The final grade also includes the points obtained for active participation in lectures and seminars. |
| **Main language of instruction; other languages** | Croatian language |
| **Method of monitoring the quality and efficiency of teaching** | Conversation with students during lectures, student survey after the course. |

| | |
|---|---|
| **Course title** | **General Chemistry 2** |
| **Code** | K016 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 3 |
| **Course status** | Elective |
| **Course teacher** | Assoc. Prof. Dr. Maja Molnar |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General Chemistry (1) |
| **Course objective** | Students that attended the course General Chemistry (1) will expand their basic knowledge about concepts, phenomena and laws of general chemistry. Such widened knowledge students will use in further studies. |
| **Learning outcomes** | 1. Ability to determine the substance based on the structure of pure substances, and to distinguish types of chemical bonding in characterisation of individual substances and groups.<br>2. Ability to determine properties of elements and their position in the periodic table of elements, and vice versa.<br>3. Ability to determine the type of chemical equilibrium in a system (homogeneous /heterogeneous), and to predict the behaviour of a system based on the type of equilibrium, with emphasis on the equilibrium in electrolyte solutions.<br>4. Ability to assess the influence of specific factors on the chemical reaction rate.<br>5. Ability to determine the reactivity and stability of complex compounds based on their structure.<br>6. Ability to distinguish basic concepts of nuclear and radio chemistry.<br>7. Application of acquired knowledge in solving of calculus tasks in General Chemistry 2. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-7 | 1 | Lecture | Attendance of lectures, and active participation in discussions | Records | 10 | 15 |
| 1-7 | 1.5 | Seminars | Attendance of lectures, preparation and presentation of seminar paper, and completion of tasks | Records, assessment of seminar paper presentation | 20 | 35 |
| 1-7 | 0.5 | Final exam | Exam preparation | Oral exam | 30 | 50 |
| **Total** | **3** | | | | **60** | **100** |

| | | | |
|---|---|---|---|
| | **Final grade:**<br>**60-70 points: grade 2 (sufficient)**<br>**71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)**<br>Final exam: minimum number of points refers to the lowest grade (sufficient), and maximum number of points refers to the highest grade (excellent). | | |
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 15 | 0 |
| **Course content / teaching units** | Lectures:<br>• Advanced study in general chemistry involves acquisition of knowledge referring to the structure of matter, chemical bonding, molecular orbitals and the periodic table of elements. The teaching units refer to gas laws, properties of solids and solutions, electrochemistry, chemical kinetics and equilibrium. Students shall acquire knowledge about the chemistry of complex compounds, radio and nuclear chemistry.<br>Seminars:<br>• At seminars, students will develop skills in solving stoichiometric tasks related to the above-mentioned teaching units, and they will apply the acquired knowledge in the interpretation of specific everyday phenomena. | | |
| **Recommended reading** | Filipović I., Lipanović S. (1995) Opća i anorganska kemija I. Dio. Školska knjiga, Zagreb.<br>Silberberg M. (2000) Chemistry, 2nd ed. McGraw-Hill, Inc., New York.<br>Sikirica M. (1989) Stehiometrija. Školska knjiga, Zagreb. | | |
| **Optional reading** | Eatough N. (1992) Study Guide to Accompany Russel General Chemistry, 2nd ed. McGraw-Hill, Inc., New York.<br>Mortimer C.H. (1996) Chemistry, 6th ed. Wadsworth, Inc., Belmont.<br>Rusell J.B. (1992) General Chemistry, 2nd ed. McGraw-Hill, Inc., New York.<br>Weiss R. (1992) Student Solution Manual to Accompany Russel General Chemistry, 2nd ed. McGraw-Hill, Inc., New York. | | |
| **Conditions for obtaining teacher's signature** | Attendance of lectures and presentation of a seminar paper. | | |
| **Exam passing procedure** | Based on the attendance records and the presented seminar paper, the students proceed with the written exam. If achieving sufficient number of points (min. 60%) at the written exam, they take the oral exam, which makes the major share in the final grade. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. | | |

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|---|---|
| **Course title** | **Organic Chemistry 2** |
| **Code** | K042 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | III semester |
| **Workload/ECTS credits** | 3 |
| **Course status** | Elective |
| **Course teacher** | Assoc. Prof. Dr. Dajana Gašo-Sokač |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General (1) and Inorganic Chemistry (1) (attended), Organic Chemistry 1 (attended) |
| **Course objective** | Acquisition of knowledge about the structure and reactivity of organic molecules, with special emphasis on the mechanisms of reactions. Acquisition of knowledge about natural organic compounds present in organisms and in food. |
| **Learning outcomes** | 1. Ability to define and classify individual organic compounds according to the type of bonding and functional group.<br>2. Ability to predict the reactivity of a particular group of compounds with respect to their structure.<br>3. Ability to distinguish stereoisomers and to recognise elements of symmetry; ability to determine the absolute and relative configuration of chiral compounds.<br>4. Skills required to demonstrate and interpret mechanisms of chemical reactions.<br>5. Knowledge about properties of individual compounds and their dependence on the structure.<br>6. Ability to apply the acquired knowledge in solving tasks related to reactivity of individual compounds and their stereochemical characteristics.<br>7. Skills in designing a chemical synthesis (selection of reactants and calculation of their amounts with respect to the desired amount of product and the reaction rate). |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-7 | 1 | Lectures | Critical conversation and discussion | Records related to active participation in conversations and discussions | 2,5 | 5 |
| 1-7 | 0.5 | Seminar | Solving of tasks and their interpretation | Monitoring of student's interpretations and performance at tasks | 2,5 | 5 |
| 1-7 | 0.5 | Written exam | Preparation for written exam | Written exam | 25 | 30 |
| 1-7 | 1 | Oral exam | Preparation for oral exam | Oral exam | 30 | 60 |
| **Total** | **3** | | | | **60** | **100** |

| | | | |
|---|---|---|---|
| | **Final grade:**<br>**60-70 points: grade 2 (sufficient)**<br>**71-80 points: grade 3 (good)**<br>**81-90 points: grade 4 (very good)**<br>**90-100 points: grade 5 (excellent)** | | |
| **Consultation hours** | Two hours a week (according to schedule defined at the beginning of the academic year) and additional consultation hours as agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 30 | 15 | 0 |
| **Course content / teaching units** | • Introduction to the course<br>• Carboxylic acids and functional derivatives of carboxylic acids, reactivity of carboxylic acids and derivatives, mechanisms of nucleophilic acyl substitution<br>• Amines and diazonium salts, organic dyes<br>• Phenols, phenolic acidity<br>• Carbohydrates, monosaccharides, disaccharides, polysaccharides, starch and cellulose, reducing and non-reducing sugars<br>• Heterocyclic compounds, pyrrole, pyridine, purine and pyrimidine bases, reactions of electrophilic and nucleophilic aromatic substitution<br>• Lipids, division of lipids, fats and oils, essential fatty acids<br>• Terpenes<br>• Carboxylic acids with several functional groups (dicarboxylic acids, oxy-, oxo-amino acids) | | |
| **Recommended reading** | Klein D.R. (2013) Organic chemistry. John Wiley and Sons.<br>Pine S. (1994) Organska kemija. Školska knjiga, Zagreb.<br>Smith J.G. (2010) Organic chemistry, 3rd ed. McGraw-Hill.<br>Wade L.G. ml (2017) Organska kemija. Školska knjiga, Zagreb.<br>Skupina autora (2002) Vodič kroz IUPAC-ovu nomenklaturu organskih spojeva, Školska knjiga, Zagreb. | | |
| **Optional reading** | Carey F.A. (2000) Organic Chemistry, McGraw Hill.<br>Clayden J., Greeves N., Warren S., Wothers P. (2001) Organic Chemistry. Oxford University Press.<br>Solomons T.W.G., Fryhle C.B. (2000) Organic Chemistry, 10 ed. John Wiley & Sons, New York.<br>Lewis D.E. (1996) Organic Chemistry: a modern Perspective. Brown Publishers, USA. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to attend minimum 70% of lectures and 70% of seminars. | | |
| **Exam passing procedure** | The exam is divided into the written and oral part. Within the written exam, students need to achieve minimum 60% of total points in order to proceed with the oral exam. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

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| **Course title** | **Analytical Chemistry Laboratory Practice 1** |
| **Code** | K033 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | IV semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assoc. Prof. Dr. Maja Molnar |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General (1) and Inorganic Chemistry (1), Analytical Chemistry (1), Analytical Chemistry (2) (attended) |
| **Course objective** | To enable students to develop skills referring to application of basic methods and procedures of chemical analysis, and to study qualitative methods of analysis by separation of cations and anions. |
| **Learning outcomes** | 1. Ability to apply specific method of analysis to prove cations and anions individually and in a mixture.<br>2. Skills required to carry out elementary chemical analysis of unknown salts.<br>3. Skills required to carry out organic elemental analysis.<br>4. Ability to compare different methods in qualitative analysis. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-4 | 1 | Practices | Practical classes attendance and active engagement | Records, evaluation of performed analyses | 15 | 30 |
| 1-4 | 1 | Exam | Preparation for written exam | Written exam | 45 | 70 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | By appointment. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 0 | 0 | 30 |
| **Course content / teaching units** | Qualitative chemical analysis, separation and detection of cations and anions individually by groups and in a mixture<br>Selected methods of classical chemical analysis<br>Application of chemical and physical principles of qualitative analysis | | |

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|---|---|
| **Recommended reading** | Skoog D.A., West D.M., Holler F.J. (1999) Osnove analitičke kemije. Školska knjiga, Zagreb.<br>Praktikum iz analitičke kemije, skripta za internu uporabu. |
| **Optional reading** | Šoljić Z. (2003) Kvalitativna kemijska analiza anorganskih tvari. FKIT, Zagreb. |
| **Conditions for obtaining teacher's signature** | Completion of laboratory practices. |
| **Exam passing procedure** | During the course, the teacher monitors the activities of each student and evaluates performance at experiments. Upon successfully completed experiments, students proceed with the written exam in qualitative chemical analysis. |
| **Main language of instruction; other languages** | Croatian language, English language |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. |

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|---|---|
| **Course title** | **Analytical Chemistry Laboratory Practice 2 and Seminar** |
| **Code** | K099 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 3 |
| **Course status** | Elective |
| **Course teacher** | Assoc. Prof. Dr. Maja Molnar |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General (1) and Inorganic Chemistry (1), Analytical Chemistry (1), Analytical Chemistry (2) (attended), Analytical Chemistry Laboratory Practice (1) |
| **Course objective** | To introduce students to basic analytical techniques and procedures of quantitative chemical analysis. To enable students to critically evaluate the application of individual methods, and to perform calculations within analytical tasks and problems. |
| **Learning outcomes** | 1. Ability to evaluate and apply certain type of qualitative and quantitative chemical analysis based on the composition of analysed sample.<br>2. Skills in using instruments to perform standard laboratory procedures.<br>3. Ability to monitor chemical processes or changes, and to critically analyse them in order to obtain data on the qualitative and quantitative sample composition.<br>4. Ability to interpret and analyse data obtained by laboratory observation and measurements.<br>5. Ability to calculate and evaluate the accuracy of data obtained by electroanalytical, gravimetric and titrimetric methods of analysis. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 0.5 | Seminar | Practical classes attendance and active participation | Records, evaluation | 15 | 25 |
| 1-5 | 1 | Practices | Completion of tasks and getting results with minimum deviation | Evaluation of analysis results | 15 | 25 |
| 1-5 | 1.5 | Written exam | Preparation for written exam | Written exam | 30 | 50 |
| **Total** | **3** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | |
|---|---|
| **Consultation hours** | |

| Teaching | Lectures | Seminars | Practices |
|---|---|---|---|
| **Hours - total** | 0 | 15 | 30 |
| **Course content / teaching units** | • Quantitative chemical analysis<br>• Selected methods of classical chemical analysis<br>• Procedures based on chemical and physical principles of quantitative analysis<br>• Acid-base titrations<br>• Redox titrations<br>• Complexometric titrations<br>• Precipitation titrations<br>• Solution preparation, calculation and standardisation<br>• Tasks referring to application of electroanalytical methods<br>• Tasks referring to gravimetry<br>• Tasks referring to volumetry (neutralisation titration, redox titration, complexometric titration, precipitation titration, standardisation) | | |
| **Recommended reading** | Skoog D.A., West D.M., Holler F.J. (1999) Osnove analitičke kemije. Školska knjiga, Zagreb. Praktikum iz analitičke kemije, skripta za internu uporabu | | |
| **Optional reading** | Šoljić Z. (1998) Računanje u analitičkoj kemiji. FKIT, Zagreb. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course | | |
| **Exam passing procedure** | During the course, the teacher monitors the activities of each student and evaluates performance at experiments (deviations of experiment results, solving of calculus tasks). The final grade refers to assessment of performed activities and achieved success at the written exam. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams. | | |

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|---|---|
| **Course title** | **Inorganic Chemistry Laboratory Practice** |
| **Code** | K023 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 4 |
| **Course status** | Elective |
| **Course teacher** | Assist. Prof. Dr. Anamarija Stanković |
| **Associate teachers** | Željka Maduna, laboratory technician |
| **Course entry requirements (Preceding courses)** | Passed exams within courses General and Inorganic Chemistry, and General Chemistry 2 |
| **Course objective** | To enable students to work independently in the laboratory by applying basic synthetic and analytical procedures and to predict the course of a chemical reaction by consulting scientific references. |
| **Learning outcomes** | 1. Ability to explain complex compounds coordination based on oxidation-reduction changes that occur in the chemical reactions of inorganic compounds.<br>2. Ability to compare the observed changes that occur during coordination of ligand to the metal cation.<br>3. Ability to assess suitability of methods for solving of experimental problems and apply them in other areas of chemistry<br>4. Skills required for analysis of obtained products by applying analytical methods, such as FTIR, TGA/DSC methods.<br>5. Ability to carry out experiments correctly and independently by complying with all safety measures. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 2 | Practices | Attendance, participation in classes by asking questions or giving suggestions, experimental work | Records related to attendance, evaluation of workbooks and practices, analysis of samples | 5 | 10 |
| 1-5 | 1 | Periodic exams (preliminary exam, oral exam, practical exam) | Preparation for laboratory practices, taking of preliminary written/oral/practical exams during or prior to practical classes | Written preliminary exams, records referring to perform-ance at practices | 45 | 90 |
| 1-5 | 1 | Final exam* | Repetitions; written and/or oral exams | Written and/or oral exam* | 45* | 90* |

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|---|---|---|---|---|---|---|---|
| | *This teaching activity will be carried out only if a student has not achieved minimum number of points within a certain time span of the teaching activity: Periodic exams. | | | | | | |
| | **Total** | **4** | | | | **50** | **100** |
| | **Final grade:**<br>**50-60 points: grade 2 (sufficient)**<br>**61-75 points: grade 3 (good)**<br>**76-90 points: grade 4 (very good)**<br>**91-100 points: grade 5 (excellent)** | | | | | | |
| **Consultation hours** | By appointment. | | | | | | |
| **Teaching** | **Lectures** | | **Seminars** | | **Practices** | | |
| **Hours - total** | 0 | | 0 | | 60 | | |
| **Course content / teaching units** | • Synthesis of potassium tetraperoxochromate (V), $K_3[Cr(O_2)_4]$ (+experiment)<br>• Analysis of potassium content in the complex<br>• Synthesis of oxobis(2,4-pentandionato)vanadium(IV) $[VO(C_5H_7O_2)_2]$ (+experiment)<br>• Synthesis of oxobis(2,4-pentadionato)vanadium(IV), determination of vanadium<br>• Synthesis of copper(I) chloride, CuCl<br>• Synthesis of hexaamminecobalt(III) nitrate, $[Co(NH_3)_6](NO_3)_3$<br>• Analysis of the ammonium content<br>• Analysis of the cobalt content<br>• Synthesis of potassium tris(oxalato)chromate(III) trihydrate, $K_3[Cr(C_2O_4)_3]\cdot 3H_2O$ (+experiment)<br>• Analysis of the chromium content<br>• Synthesis of potassium bis(oxalato)copper(II) dihydrate, $K_2[Cu(C_2O_4)_2]\cdot 2H_2O$<br>• Analysis of the oxalate content<br>• Complexes identification by using FTIR, DSC/TGA instruments | | | | | | |
| **Recommended reading** | Cindrić M., Popović Z., Vrdoljak V. (2007) Priprava anorganskih spojeva (Upute za internu upotrebu u praktikumu iz anorganske kemije), Zagreb.<br>Filipović I., Lipanović S. (1995) Opća i anorganska kemija, I i II. dio. Školska knjiga, Zagreb.<br>Cotton F.A., Wilkinson G., Gaus P.L. (1995) Basic Inorganic Chemistry, 3rd. ed. John Wiley & Sons., New York.<br>Housecroft C.E., Sharpe A.G. (2005) Inorganic Chemistry, Pearson Education Limited, 2nd ed. Harlow, England, str. 922-924.<br>Šter A. (2014) Interni nastavni radni materijal iz praktikuma anorganske kemije 2 za studente preddiplomskog studija kemije s Odjela za kemiju / Vicković I., Marković B. (ed.). Osijek: Sveučilište J. J. Strossmayera u Osijeku, Odjel za kemiju.<br>Šter A., Balić, T. (2015) Interni nastavni radni materijal iz praktikuma anorganske kemije 1 za studente preddiplomskog studija kemije s Odjela za kemiju / Vicković I., Marković B. (ed.). Osijek: Sveučilište J. J. Strossmayera u Osijeku, Odjel za kemiju. | | | | | | |
| **Optional reading** | Grdenić D. (2005) Molekule i kristali, 5. izd. Školska knjiga, Zagreb.<br>Rayner-Canham G., Overton T. (2006) Descriptive Inorganic Chemistry, Freeman & Co., New York.<br>Silberberg M. (2003) Chemistry, 3. rd.ed. McGraw-Hill, Inc., New York. | | | | | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course (practices, workbooks). | | | | | | |
| **Exam passing procedure** | Preliminary exams are taken prior to each practical class.<br>The final grade refers to the average grade achieved at each practice, including all preliminary exams, results and performance of exercises, and completed workbooks. | | | | | | |

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| **Main language of instruction; other languages** | Croatian language, English language |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. |

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|---|---|
| **Course title** | **Organic Chemistry Laboratory Practice 2** |
| **Code** | K043 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | V semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assoc. Prof. Dr. Dajana Gašo-Sokač |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | General (1) and Inorganic Chemistry (1) (attended), Organic Chemistry 1 (attended), Organic Chemistry 2 (attended) |
| **Course objective** | Acquisition of knowledge about the reactivity of organic molecules, types of reactions and the ways in which they are performed in the laboratory. Learning about methods applied in organic laboratory. |
| **Learning outcomes** | 1. Knowledge about methods of purification of solids and liquids.<br>2. Ability to calculate the yield of chemical reaction, the required amount of reactants and catalysts.<br>3. Knowledge about the mechanisms of organic reactions.<br>4. Ability to identify organic compounds.<br>5. Ability to connect chemical structure of compounds and the choice of method for synthesis and purification.<br>6. Ability to predict the factors that influence chemical reaction and to apply the acquired knowledge in the practical work on the synthesis of organic compounds. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-6 | 1 | Practices | Practical work | Monitoring of student performance in laboratory | 30 | 60 |
| 1-6 | 0.25 | Reports on completed practices | Solving and interpreting the tasks | Monitoring of student's interpretations and performance at tasks | 10 | 15 |
| 1-6 | 0.75 | Final exam | Preparation for written exam | Written exam | 20 | 35 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**90-100 points: grade 5 (excellent)**

| | | | |
|---|---|---|---|
| **Consultation hours** | Two hours a week (according to schedule defined at the beginning of the academic year) and additional consultation hours as agreed with students. | | |
| **Teaching** | **Lectures** | **Seminars** | **Practices** |
| **Hours - total** | 0 | 0 | 30 |
| **Course content / teaching units** | • Introductory lecture<br>• General reactions of purification of the organic compounds, distillation, simple vacuum distillation, fractional distillation<br>• Grignard reaction<br>• Cannizzaro reaction<br>• Synthesis of β-naphtholorange, diazocopulation reactions<br>• Isolation of lactose from evaporated milk, casein isolation, preparation of osazone<br>• Melting point determination | | |
| **Recommended reading** | Rapić V. (1994) Postupci priprave i izolacije prirodnih spojeva. Školska knjiga, Zagreb.<br>Smith J.G. (2010) Organic chemistry, 3rd ed. McGraw-Hill.<br>Wade L.G. ml. (2017) Organska kemija. Školska knjiga, Zagreb. | | |
| **Optional reading** | Carey F.A. (2000) Organic Chemistry. McGraw Hill.<br>Clayden J., Greeves N., Warren S., Wothers P. (2001) Organic Chemistry. Oxford University Press.<br>Lewis D.E. (1996) Organic Chemistry: a modern Perspective. Brown Publishers, USA.<br>Solomons T.W.G., Fryhle C.B. (2000) Organic Chemistry, 10 ed. John Wiley & Sons, New York. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate actively in lectures and to attend all practical classes. | | |
| **Exam passing procedure** | Student is required to perform practices independently and to submit reports on each performed practice, based on which the teacher evaluates the quality of prepared or isolated compound and of applied reaction of synthesis or isolation. Final exam is taken in the written form, and student can pass the exam with a min. 60% of points. The final grade refers to the average grade obtained for the experimental work, for the reports about performed practical tasks and for the success achieved at the final written exam. | | |
| **Main language of instruction; other languages** | Croatian language, English language | | |
| **Method of monitoring the quality and efficiency of teaching** | Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams. | | |

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|---|---|
| **Course title** | **Toxicology and Environmental Chemistry** |
| **Code** | K081 |
| **Study programme** | Undergraduate university study programme in Biology |
| **Semester** | VI semester |
| **Workload/ECTS credits** | 2 |
| **Course status** | Elective |
| **Course teacher** | Assoc. Prof. Dr. Mirna Velki |
| **Associate teachers** | |
| **Course entry requirements (Preceding courses)** | |
| **Course objective** | To teach students about poisons and their impact on living organisms and on the environment. |
| **Learning outcomes** | 1. Ability to explain what poisons are and how they affect the organisms.<br>2. Ability to explain precautions and protection measures, and proper handling of harmful substances.<br>3. Knowledge about classification of toxic substances.<br>4. Knowledge about methods of extraction and detection of toxic substances, as well as methods of sampling for toxicological analysis.<br>5. Knowledge about basic concepts of ecotoxicology. |

**Link between learning outcomes, teaching and students' activities**

| Learning outcome | Share of ECTS | Form of teaching | Activities of learning and teaching | Assessment | | |
|---|---|---|---|---|---|---|
| | | | | Methods of monitoring and evaluation | Grading Points | |
| | | | | | min | max |
| 1-5 | 0.5 | Lecture | Critical conversation and discussion | Records related to active participation in conversations and discussions | 5 | 10 |
| 1-5 | 0.5 | Seminar | Interpretation of course-related scientific papers | Monitoring of student's interpretations | 15 | 30 |
| 1-5 | 0.5 | Written exam | Preparation for written exam | Written exam | 20 | 30 |
| 1-5 | 0.5 | Oral exam | Preparation for oral exam | Oral exam | 20 | 30 |
| **Total** | **2** | | | | **60** | **100** |

**Final grade:**
**60-70 points: grade 2 (sufficient)**
**71-80 points: grade 3 (good)**
**81-90 points: grade 4 (very good)**
**91-100 points: grade 5 (excellent)**

| | |
|---|---|
| **Consultation hours** | Mondays, 10.00 – 11.00 a.m. |

| Teaching | Lectures | Seminars | Practices |
|---|---|---|---|
| **Hours - total** | 15 | 15 | 0 |
| **Course content / teaching units** | Lectures:<br>• Introduction to toxicology and historical overview of toxicology development<br>• Classification of poisons<br>• Sampling, extraction and detection of toxins<br>• Absorption, distribution, metabolism and excretion of toxicants<br>• Toxicodynamics<br>• Ecotoxicology<br>• Military toxicology<br>Seminars:<br>• Inorganic substances<br>• Gaseous poisons<br>• Industrial organic chemicals<br>• Drugs<br>• Addictive substances<br>• Pesticides<br>• Poisons of living organisms | | |
| **Recommended reading** | Hayes W.A. (2007) Principles and Methods of Toxicology, 5th ed. Informa Healthcare.<br>Plavšić F., Žuntar I. (2006) Uvod u analitičku toksikologiju. Školska knjiga, Zagreb. | | |
| **Optional reading** | Plavšić F. (2009) Bojite li se otrova? Hrvatski zavod za toksikologiju, Zagreb.<br>Hrvatski zavod za toksikologiju (2008) Bez opasnih kemikalija se ne može, ali paziti se mora, Zagreb.<br>Scientific papers and review papers. | | |
| **Conditions for obtaining teacher's signature** | Students are obliged to participate in lectures actively and to fulfil all assignments within the course. | | |
| **Exam passing procedure** | Before taking oral exam, students are obliged to pass written exam. Writing of a seminar paper can be taken as a substitute for written exam. The final grade refers to the points achieved on written and oral exam and the points obtained during lectures. | | |
| **Main language of instruction; other languages** | Croatian language | | |
| **Method of monitoring the quality and efficiency of teaching** | Student survey, possibility to make oral or written remarks after lectures.<br>Monitoring of students' success at exams. | | |