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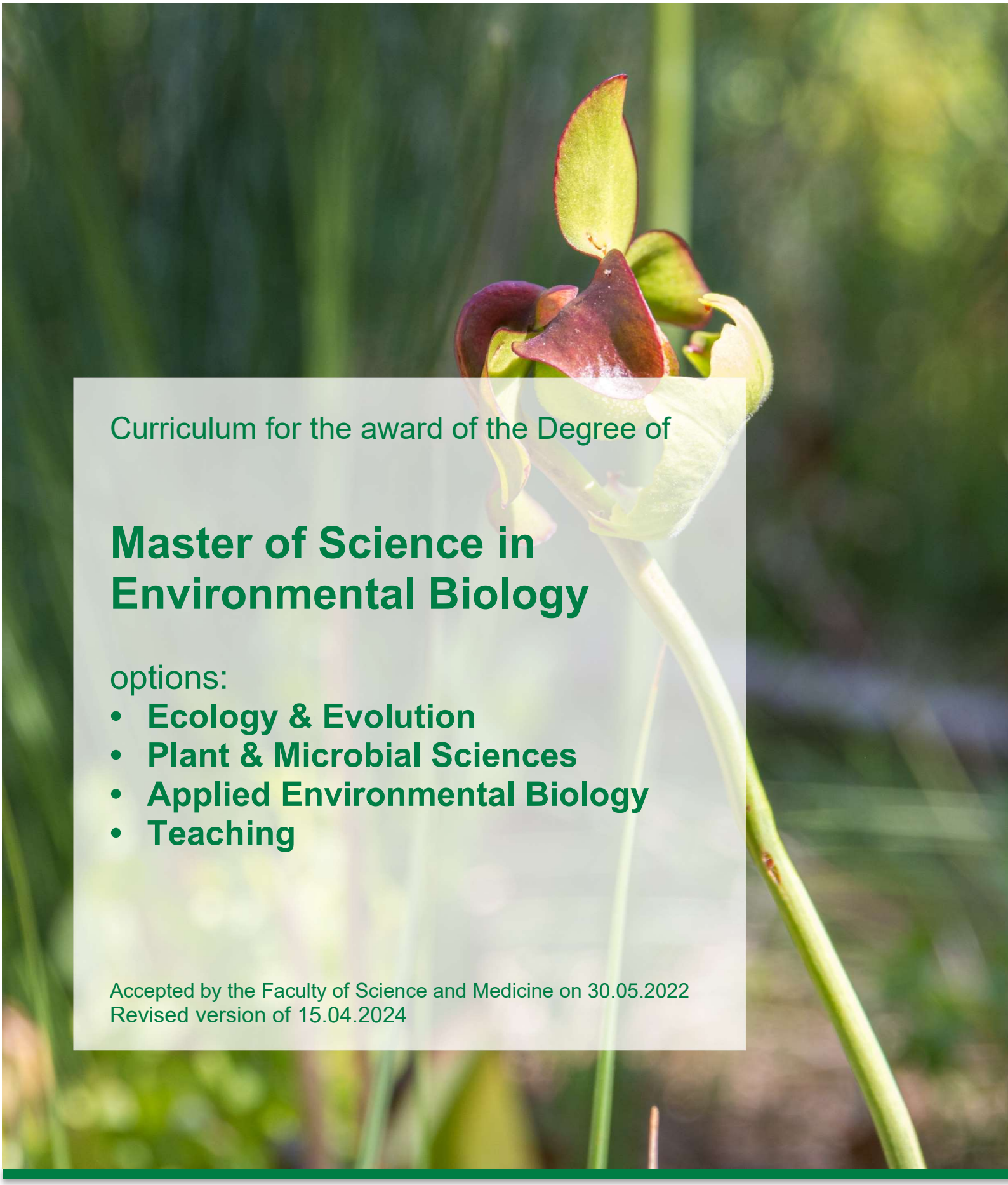

Curriculum for the award of the Degree of

Master of Science in Environmental Biology

options:

- **Ecology & Evolution**
- **Plant & Microbial Sciences**
- **Applied Environmental Biology**
- **Teaching**

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FACULTE DES SCIENCES ET DE MÉDECINE
MATHEMATISCH- NATURWISSENSCHAFTLICHE UND MEDIZINISCHE FAKULTÄT

CONTENTS

1 General Remarks

Major environmental problems, in particular global change and its consequences for biodiversity and ecosystem functioning, are intimately interconnected and pose a threat to our future. Solving these problems requires an integrative and synergistic approach in terms of both fundamental and applied research. The Department of Biology of the Faculty of Science and Medicine offers a multidisciplinary **Master of Science in Environmental Biology**. The program ranges from fundamental concepts in **ecology and evolution**, **molecular aspects of plant and microbial sciences** to **applied solutions for environmental policies and sustainable development**. It provides students with state-of-the-art training and background in conceptual, technical, and applied aspects of environmental biology, from genes to ecosystems.

Master students are integrated into active research teams and can thus gain extensive experience in basic and applied academic research in environmental biology. Students will have the opportunity to choose between four options: **Ecology & Evolution**, **Plant & Microbial Sciences, Applied Environmental Biology**, and **Teaching**.

This curriculum introduces the course structure of the MSc study programme in environmental biology, which offers four options of specialization. It is based on the regulations of the Faculty of Science and Medicine governing the acquisition of the title of Master of Science (hereafter called Regulations).

The Regulation of 30 May 2022 for the award of the Bachelor of Science and Master of Science degrees establishes a limit on the duration of Bachelor's and Master's studies, as well as of the minor study programmes (https://www.unifr.ch/scimed/fr/rules/regulations).

1.1 Academic Titles and Programme of Study

The Faculty of Science and Medicine of the University of Fribourg awards the official academic title of **Master of Science in Environmental Biology**, subsequently called **MSc,** to students who have successfully completed their respective study programme and obtained the title of Bachelor of Science (BSc) or a recognized equivalent.

Graduates of this program will be well prepared for careers inside and outside academia, e.g., in university research and higher education, teaching, agroindustry, federal research institutes and offices (including institution such as Agroscope, FIBL, HAFL, HEPIA, BAFU, BLW, WSL), cantonal offices, private foundations or small-scale businesses. The Master's degree in Environmental Biology also paves the way to doctoral studies (PhD) in this subject area (depending on the institution, additional requirements might apply). When accompanied by a subsidiary subject in a discipline figuring on higher secondary school curricula, the MSc, option Teaching, allows students to follow a complementary didactics programme leading to the qualification as a higher secondary school teacher (*Diplôme d'enseignement pour les écoles de maturité (DEEM) / Lehrdiplom für Maturitätsschule (LDM)*).

Candidates in possession of a BSc in Biology of the University of Fribourg or any other Swiss university are admitted to the MSc course of studies (Art. 8 of the Regulation). This is also the case for Bachelors of biochemistry, provided they have chosen the necessary courses in their BSc curriculum Candidates in possession of a BSc degree from abroad, in a different subject or of equivalent degrees (e.g. after graduating from an engineering school) can also be admitted to the MSc study programme by a decision of the Faculty of Science and Medicine to be made in each individual case. Provisional admission can be granted and depends on the fulfilment of additional requirements set by the Faculty (cf. Section 2.4).

1.2 Course Structure

The MSc study programme in Environmental Biology spans three or four semesters depending on the option corresponding to either 90 or 120 ECTS credits.

The programme consists of four options:

- Ecology & Evolution (EE) (120 ECTS)
- Plant & Microbial Sciences (PMS) (120 ECTS)
- Applied Environmental Biology (AEB) (120 ECTS)
- Teaching (TE) (90 ECTS)

The three first options are oriented toward research, while the latter is suited for students who want to become school teachers.

Each option consists of three modules:

- Master courses: 50 ECTS for EE, PMS, and AEB; 37.5 ECTS for TE.
- Master thesis related activities: 10 ECTS for EE, PMS, and AEB; 7.5 ECTS for TE.
- Master thesis: 60 ECTS for EE, PMS, and AEB; 45 ECTS for TE.

The course language will be English. An agreement with the Universities of Bern and Neuchâtel (BeNeFri convention) allows students to take elective courses in these institutions and to have them credited for the study program in Fribourg.

The MSc courses can only be assessed and recognized after successful completion of the BSc.

1.2.1 Description of the options

The Master of Science in Environmental Biology offers four options. These options are complementary, but also contain shared courses, and students have the opportunity, next to a set of mandatory courses, to customize their study plan according to their interests. The EE, PMS, and AEB options focus on research; the TE option is appropriate for students who would like to become teachers. The four options are:

1. *Ecology & Evolution* (EE, 120 ECTS). This option is centred on the conceptual and empirical aspects of ecology and evolution. It covers fundamental areas ranging from population, community to ecosystems ecology; theoretical ecology and evolution; eco-evolutionary feedback dynamics; evolutionary and population genetics; evolutionary and ecological genomics; behavioural ecology; the evolution of life histories and aging; as well as phylogenetic analyses of organismal relationships. Research groups in these areas work on a variety of study systems and use a broad range of experimental, observational, and theoretical approaches. Biological systems include various insects; birds; plants and their microorganismal communities; microbial soil communities; relict tree species; threatened aquatic species; invasive species; and alpine vegetation ecosystems. Methods encompass laboratory experiments; field observations and experiments; genomics and bioinformatics; statistical analyses; computer simulations and theoretical modelling.

2. *Plant & Microbial Sciences* (PMS, 120 ECTS). This option focuses on the molecular aspects of plant health and development and includes the study of plant-associated microbiota. It covers an exciting range of subjects such as molecular signalling systems, resistance and tolerance of plants to biotic and abiotic stress, the molecular basis of immunity, interactions between plants and their symbionts, plant microbiota, biological control, chemical communication, as well as plant biotechnology. To address questions in these areas, research teams use various well-established model plants (Arabidopsis, Petunia, tobacco) and plants of agronomical relevance (potato, tomato, grapevine). They rely on a wide array of methods including biochemistry, molecular biology, genetics, genomics, proteomics and metabolomics as well as cellular imaging. For projects oriented towards field application, researchers collaborate with agronomical research institutions such as Agroscope, FiBL (Forschungsinstitut für biologischen Landbau), the agricultural school in Grangeneuve, as well as with industries.

3. *Applied Environmental Biology* (AEB, 120 ECTS). This option addresses important applied facets of environmental biology, especially in terms of biological invasions, conservation biology and sustainable crop protection; it also addresses the consequences of global change. In collaboration with the Environmental Sciences and Humanities Institute, students have the opportunity to learn about major current issues in environmental ethics, policy making and sustainable development. Research methods in this area include for example field and laboratory experiments; database mining and meta-analyses; computer simulations; as well as working out policy recommendations. Researchers in this field (working mostly on applied aspects of ecology and microbiology) collaborate with applied research institutions such as Agroscope, FiBL (Forschungsinstitut für biologischen Landbau), or CABI. This master option also offers the opportunity to carry out either a short research internship or the master project in such a partner research institution.

4. *Teaching* (TE, 90 ECTS). This option combines core courses from the 3 research options and aims at giving a general overview of the Environmental Biology Master programme. It is strictly reserved for students who need to acquire 30 additional ECTS credits in another domain to apply for the education as teachers at secondary level II (DEEM/LDM). These students can also choose one of the 120 ECTS options, or change from the 90 ECTS to a 120 ECTS option while still in their 1st or 2nd semester of Master studies.

1.3 Acquired Skills

The master students in this program will acquire cutting-edge knowledge and skills in basic and applied aspects of environmental biology, from genes to ecosystems. The program emphasizes the development of both scientific and soft skills, e.g., independent analytical thinking, problem-solving, critical evaluation and analysis of data, oral and written communication, and the ability to work in a team. Courses are accompanied by discussions, student presentations and project writing exercises. The master thesis is carried out in one of the research teams, possibly in collaboration with other research institutions, giving students the opportunity to experience all aspects of the daily life of a research scientist. Students also have the opportunity to present their work during a research seminar.

1.4 Assessment of Courses and Acquisition of ECTS Credits

Acquisition of ECTS credits occurs in three steps: assessment of the courses, grouping of courses into validation package, and awarding the respective credits.

Exercises are assessed following the criteria given at the beginning of the course. Admission to the exam corresponding to a lecture course can be subject to meeting the requirements of the corresponding exercise class. **Assessment** of lectures is made by an oral and/or written exam, whose type and duration are regulated in an appendix of this curriculum. Exams take place during the official exam periods (sessions) in winter, summer, and autumn. Students register via the students' web portal MyUniFR (https://my.unifr.ch), within the stipulated delays for each exam according to the on-line procedure. The marks range from 6 (highest mark) to 1 (lowest mark). An exam marked below 4 can be repeated once at the next exam session at the earliest.

Validation packages comprise multiple, separately assessed courses. The Regulation determines the number of these package whereas this curriculum determines their content. There are two validation packages:

- The *first package* consists of the master courses ant the master thesis related activities;
- The *second package* (60 ECTS or 45 ECTS credits) consists of the Master Thesis Module.

The conditions for validation of ECTS credits are described in the Regulation.

Students can acquire more ECTS credits than needed for the *first package* (45 or 60 ECTS), provided these do not exceed 20% of the credits foreseen for a given package. Further additional ECTS credits will be validated separately. The chronological order of validation is decisive.

Changing from one option to another is possible provided that:

1) the average of the grades acquired in the current validation package is at least 4.0.
2) the prerequisites to access the new option are met.

After the validation, upon request, the Dean's office will issue transcripts of records in which exam results and awarded credits are acknowledged, provided the exam fee has been paid.

1.5 Ethics and Science

Ethical principles are an integral part of a scientific education. Accepted international conventions must be respected during research and while documenting all scientific work whether it be a project, a lecture, a thesis, or a report. In particular, every external source of information (articles, lectures, web pages, etc.) must be correctly cited. Every student of the Faculty of Science and Medicine has to sign a formal commitment to restrain herself/himself from plagiarism.

1.6 Regulations and Additional Information

Detailed information about studying Biology can be found in the documents referenced on the web page http://www.unifr.ch/scimed/en/plans which can also be obtained from the Office of the Department of Biology.

2. Master of Science

2.1 Courses Units

For each option, the *Master in Environmental Biology* offers a series of obligatory (O), recommended (R), and elective (E) courses. The courses are divided into research skills and core scientific courses. The research skill courses aim at developing skills in biostatistics and modelling, experimental and laboratory work, bioinformatics, as well as literature study and scientific writing. The core scientific courses provide fundamental and advanced scientific knowledge in environmental biology.

The students follow the obligatory courses (O) according to the options they have chosen. They then complete their list of courses (50 ECTS for the EE, PMS, and AEB options; 37.5 ECTS for the TE option) with recommended (R) and elective (E) courses. It is advised to choose courses from the list of recommended (R) courses, but elective (E) courses can be chosen as well. Section 3 provides a table summarising the list of all course (O, R, and E)

If prerequisites are met, students can also replace ECTS credits from recommended courses by ECTS credits from elective courses among those offered in the study plans of the *Master in Molecular Life and Health Sciences* and the *Master in Bioinformatics and Computational Biology*. For the full list of courses offered in these master programs, please see the respective study plans. In addition, master level courses at the Universities of Berne and Neuchâtel can also be chosen as elective courses through the BeNeFri convention. An elective course not listed in the study programme may also be taken. In this latter case, the student must consult the study advisor.

Note that some courses require prerequisites, which are explicitly stated at the end of the descriptions (sections 2.2.1 and 3). Some courses are also given in alternance every two year (biennially) with another course. It is recommended to attend the courses given annually during the 1st year of the master.

2.1.1 Option Ecology & Evolution

[Version 2024, validation packages : PV-SBL.0000109, PV-SBL.0000110]

Code		Semester	Tot. h.	ECTS
Obligatory courses				
Research skills				
SBL.20001	Biostatistics I - generalized linear models and mixed effects models	AS	28	3
SBL.20002	Biostatistics II - multivariate analysis	AS	28	
	The students must follow at least one of the two *Biostatistics* courses. They can follow both courses; in this case, they will be credited 3 ECTS for obligatory courses and 3 ECTS for recommended courses.			
SBL.06002	Classical models in biology (lecture)	SS	28	3
SBL.06003	Classical models in biology (exercises)	SS	14	1
SBL.20005	Critical reading	AS+SS	28	3
SBL.00410	Scientific writing	AS	28	3
Scientific core courses				
SBL.20031	Community ecology	SS	28	3
SBL.20032	Population and evolutionary dynamics	SS	28	3
SBL.20034	Evolutionary genomics	SS	28	3
SBL.00205	Ecological field course	Summer	11 days	5
Total ECTS for obligatory courses				**27**
Recommended courses				
Beside the following list of recommended courses, students can also choose elective courses.				
Research skills				
SBL.00504	Basics in Biostatistics	AS	14	1.5
SBL.00427	Visual communication of data	SS	8	1
SBL.30001	Introduction to R	AS	24	2
SBC.07110	Introduction to UNIX and BASH	AS	40	2.5
UniBe	Introduction to high-performance computing	AS	2 days	1
SBC.07107	Bioinformatics (practical + in silico)[1]	AS	42	3
Scientific core courses				
SBL.30004	Organization and annotation of Eukaryote genomes[2]	AS	6 days	3
SBL.20036	Global change	AS	28	3
SBL.20037	Invasion biology	AS	28	3
SSE.00433	Principles of environmental ethics (advanced)	AS	28	3
SBL.20038	Research internship	Summer	1 month	4
Minimum ECTS for recommended and elective courses				**23**
Thesis-related activities				
SBL.20083	Research group meetings in environmental biology (4 sem.)	3 sem.	3x14	3

[1] Prerequisite: SBC.07110*, Introduction to UNIX and BASH,* and *HPC* from UniBe
[2] Prerequisite: SBC.07110*, Introduction to UNIX and BASH.*

Code		Semester	Tot. h.	ECTS
SBL.20081	Research seminars in environmental biology (4 sem.)	4 sem.	4x14	5
SBL.00431	Seminars in biology (4 sem.)	4 sem.	4x14	2
Total ECTS for thesis-related activities				**10**
Master thesis				
SBL.05001	Master thesis (3 sem.)	18 months		**60**
Total ECTS				**120**

2.1.2 Option Plant & Microbial Sciences

[Version 2024, validation packages : PV-SBL0000111, PV-SBL.0000112]

Code		Semester	Tot. h.	ECTS
Obligatory courses				
Research skills				
SBL.20001	Biostatistics I - generalized linear models and mixed effects models	AS	28	3
SBL.20002	Biostatistics II - multivariate analysis	AS	28	
	The students must follow at least one of the two *Biostatistics* courses. They can follow both courses; in this case, they will be credited 3 ECTS for obligatory courses and 3 ECTS for recommended courses.			
SBL.20003	Methods in plant pathogen interactions	AS	50	4
SBL.20004	Introduction to metabolomics: data acquisition and processing	SS	30	2
SBL.00125	Light and fluorescence microscopy for life sciences	AS	28	3
SBL.00451	Introduction to mass spectrometry and proteomics	AS	8	1
SBL.20005	Critical reading	AS+SS	28	3
SBL.00410	Scientific writing	AS	28	3
Scientific core courses				
SBL.20035	Structure and functions of host-associated microbiota	SS	28	3
SBL.00323	Plant biotechnology	SS	28	3
SBL.00308	Plant development: the life of a sessile organism	SS	12	1.5
SBL.00307	Symbiosis: how plants and microbes communicate	SS	12	1.5
Total ECTS for obligatory courses				**28**

Recommended courses

Beside the following list of recommended courses, students can also choose elective courses.

Research skills				
SBL.00504	Basics in biostatistics	AS	14	1.5
SBL.00427	Visual communication of data	SS	8	1
SBL.30001	Introduction to R	AS	24	2
SBL.06002	Classical models in biology (lecture)	SS	28	3
SBL.06003	Classical models in biology (exercises)	SS	14	1
SBL.00419	Advanced imaging[3]	SS	8	1
SBL.00452	Advanced quantitative proteomics[4]	SS	8	1
SBC.07110	Introduction to UNIX and BASH	AS	40	2.5

[3] Prerequisite: SBL.00125, *Light and fluorescence microscopy for Life Sciences*.
[4] Prerequisite: SBL.00451, *Introduction to mass spectrometry and proteomics*.

Code		Semester	Tot. h.	ECTS
SBC.07107	Bioinformatics (practical + in silico)[5]	AS	42	3
UniBe	Introduction to high-performance computing	AS	2 days	1
SBL.00425	Metagenomics data analysis[6]	SS	14	1
Scientific core courses				
SBL.00418	Microbial metabolism and genetics	SS	8	1
SBL.20039	In vivo biochemistry: visualization of transport	AS	12	1.5
SBL.00411	Signalling and Transport	AS	8	1
SBL.20036	Global change	AS	28	3
SSE.00433	Principles of environmental ethics (advanced)	AS	28	3
SBL.20038	Research internship	Summer	1 month	4
Minimum ECTS for recommended and elective courses				**22**
Thesis-related activities				
SBL.20083	Research group meetings in environmental biology (4 sem.)	3 sem.	3x14	3
SBL.20081	Research seminars in environmental biology (4 sem.)	4 sem.	4x14	5
SBL.00431	Seminars in biology (4 sem.)	4 sem.	4x14	2
Total ECTS for thesis-related activities				**10**
Master thesis				
SBL.05001	Master thesis (3 sem.)	18 months		**60**
Total ECTS				**120**

[5] Prerequisite: SBC.07110*, Introduction to UNIX and BASH*, and *HPC* from UniBe
[6] Prerequisite: SBC.07110*, Introduction to UNIX and BASH.*

2.1.3 Option Applied Environmental Biology

[Version 2024, validation packages : PV-SBL.0000113, PV-SBL.0000114]

Code		Semester	Tot. h.	ECTS
Obligatory courses				
Research skills				
SBL.20001	Biostatistics I - generalized linear models and mixed effects models	AS	28	3
SBL.20002	Biostatistics II - multivariate analysis	AS	28	
	The students must follow at least one of the two *Biostatistics* courses. They can follow both courses; in this case, they will be credited 3 ECTS for obligatory courses and 3 ECTS for recommended courses.			
SBL.20005	Critical reading	AS+SS	28	3
SBL.00410	Scientific writing	AS	28	3
Scientific core courses				
SBL.00205	Ecological field course	Summer	11 days	5
SBL.20036	Global change	AS	28	3
SBL.20037	Invasion biology	AS	28	3
SSE.00433	Principles of environmental ethics (advanced)	AS	28	3
Total ECTS for obligatory courses				**23**

Recommended courses

Beside the following list of recommended courses, students can also choose elective courses.

Research skills				
SBL.00504	Basics in biostatistics	AS	14	1.5
SBL.00427	Visual communication of data	SS	8	1
SBL.30001	Introduction to R	AS	24	2
SBL.06002	Classical models in biology (lecture)	SS	28	3
SBL.06003	Classical models in biology (exercises)	SS	14	1
SBL.20003	Methods in plant pathogen interactions	AS	50	4
SBL.20004	Introduction to metabolomics: data acquisition and processing	SS	30	2
SBL.00125	Light and fluorescence microscopy for Life Sciences	AS	28	3
SBC.07110	Introduction to UNIX and BASH	AS	40	2.5
SBC.07107	Bioinformatics (practical + in silico)[7]	AS	42	3
UniBe	Introduction to high-performance computing	AS	2 days	1
SBL.00425	Metagenomics data analysis	SS	14	1
Scientific core courses				
SBL.20031	Community ecology	SS	28	3

[7] Prerequisite: SBC.07110*, Introduction to UNIX and BASH*, and *HPC* from UniBe

Code		Semester	Tot. h.	ECTS
SBL.20035	Structure and functions of host-associated microbiota	SS	28	3
SBL.00323	Plant biotechnology	SS	28	3
SBL.00308	Plant development: the life of a sessile organism	SS	12	1.5
SBL.00307	Symbiosis: how plants and microbes communicate	SS	12	1.5
SBL.20038	Research Internship	Summer	1 month	4
Minimum ECTS for recommended and elective courses				**27**
Thesis-related activities				
SBL.20083	Research group meetings in environmental biology (4 sem.)	3 sem.	3x14	3
SBL.20081	Research seminars in environmental biology (4 sem.)	4 sem.	4x14	5
SBL.00431	Seminars in biology (4 sem.)	4 sem.	4x14	2
Total ECTS for thesis-related activities				**10**
Master thesis				
SBL.05001	Master thesis (3 sem.)	18 months		**60**
Total ECTS				**120**

2.1.4 Option Teaching

[Version 2024, validation packages : PV-SBL.0000115, PV-SBL.0000116]

Code		Semester	Tot. h.	ECTS
Obligatory courses				
Research skills				
SBL.20005	Critical reading	AS+SS	28	3
SBL.00410	Scientific writing	AS	28	3
Scientific core courses				
SBL.20035	Structure and functions of host-associated microbiota	SS	28	3
SBL.00323	Plant biotechnology	SS	28	
	The students must follow at least one of these two courses. They can follow both courses; in this case, they will be credited 3 ECTS for obligatory courses and 3 ECTS for recommended courses.			
SBL.20036	Global change	AS	28	3
SBL.00502	General concepts for biology teachers	SS	8	1
SSE.00433	Principles of environmental ethics (advanced)	AS	28	3
Total ECTS for obligatory courses				**16**
Recommended courses				
Beside the following list of recommended courses, students can also choose elective courses.				
Research skills				
SBL.00504	Basics in biostatistics	AS	14	1.5
SBL.20001	Biostatistics I - generalized linear models and mixed effects models	AS	28	3
SBL.20002	Biostatistics II - multivariate analysis	AS	28	3
SBL.00427	Visual communication of data	SS	8	1
SBL.06002	Classical models in biology (lecture)	SS	28	3
SBL.06003	Classical models in biology (exercises)	SS	14	1
SBL.00125	Light and fluorescence microscopy for life sciences	AS	28	3
Scientific core courses				
SBL.20031	Community ecology	SS	28	3
SBL.00205	Ecological field course	Summer	11 days	5
SBL.20037	Invasion biology	AS	28	3
Minimum ECTS for recommended and elective courses				**21.5**
Thesis-related activities				
SBL.20084	Research group meetings in environmental biology (3 sem.)	2 sem.	2x14	2
SBL.20082	Research seminars in environmental biology (3 sem.)	3 sem.	3x14	4
SBL.00432	Seminars in biology (3 sem.)	3 sem.	3x14	1.5

Code		Semester	Tot. h.	ECTS
Total ECTS for thesis-related activities				**7.5**
Master thesis				
SBL.05002	Master thesis (2 sem.)	12 months		**45**
Total ECTS				**90**

2.2 Course Contents of the Master Programme

2.2.1 Lecture Courses

2.2.1.1 Research skills

Statistics and modelling:

- ***Basics in biostatistics*** (SLB.00504; 1.5 ECTS; lecture with exercises). This course aims at teaching basic knowledge in data management, statistics, and analysis. Specifically, it introduces fundamental concepts such as population, sample, standard error, confidence interval, Type I and Type II errors and p-value. We then look at the statistical tools most commonly used in biology, such as Student's t-test, ANOVA (1 and 2 factors; repeated measures), correlation, linear regression, sample size determination, and more. This course cannot be taken together with SBL.00075, or if SBL.00075 has already been validated.
- ***Biostatistics I - generalized linear models and mixed effects models*** (SBL.20001; 3 ECTS, lecture with exercises). Students will learn basic and advanced techniques in biostatistics, they will perform exercises with data from ecological experiments. Specifically, the following topics will be introduced: linear, Poisson, and Binomial regression; AIC, BIC, model selection, and model averaging; random effects and mixed effects models; correlation structure (e.g., time series, spatial, phylogeny). This course is given biennially and alternates with *Biostatistics II - multivariate analysis.*
- ***Biostatistics II - multivariate analysis*** (SBL.20002; 3 ECTS, lecture with exercises). Students will learn basic and advanced techniques in multivariate analyses, they will perform exercises with data from ecological experiments. Specifically, the following topics will be introduced: data type and transformation; similarity and distance matrices; Mantel and partial Mantel tests; clustering technics; principal component analysis (PCA), correspondence analysis (CA), and non-metric multidimensional analysis (NMDS); redundancy analysis (RDA) and canonical correspondence analysis (CCA); multivariate analysis of variance (MANOVA); co-correspondence analysis (COCA); the fourth-corner problem. This course is given biennially and alternates with *Biostatistics I - generalized linear models and mixed effects models.*
- ***Visual communication of data*** (SBL.00427; 1 ECTS, lecture). The goal of the course *Visual communication of data* is to provide students with the theoretical background and practical skills needed to design and create efficient graphics that fairly present quantitative data. The course content includes an overview of classical and less classical graphic types available, guidelines on how to choose the best representation based on the type of data, tricks to emphasize specific messages without inducing bias, as well as major pitfalls to avoid. Practical exercises are carried out using Excel and other simple software.
- ***Classical models in biology (lecture)*** (SBL.06002; 3 ECTS; lecture). The use of simple models to describe the behaviour of biological phenomena has been of great help for their understanding and has often driven researchers to new ideas. Here we will show how to go from the phenomenon to a model and what can be learned using this process. In particular, some of the following models will be introduced: the Malthus and the Verhulst growth models of population; ages-structured population and the Leslie matrix; the Kermack-McKendrick model in epidemiology; Bernoulli's model on vaccination; the Lotka-Volterra model; the Luria-Delbrück model.
- ***Classical models in biology (exercises)*** (SBL.06003; 3 ECTS; exercises). The students will learn how to implements in R some of the models seen during the lecture *Classical models in biology.*

Experimental:

- ***Methods in plant pathogen interactions*** (SBL.20003; 4 ECTS; practical). This practical course gives an overview of the different methodological approaches used to study plant pathogen interactions and plant diseases. It includes the setup and monitoring of infection assays, the observation of different developmental stages of pathogenic organisms, and the analysis of the plant defense reactions (staining/microscopy of pathogen progress and of the production of reactive oxygen species; q-PCR analysis of defense gene expression; HPLC analysis of defense-related hormones).
- ***Introduction to metabolomics: data acquisition and processing*** **(**SBL.20004; 2 ECTS; lecture with practical**)**. This course is a theoretical and practical introduction to metabolomics (the large-scale study of small molecules in complex mixtures). It will cover extraction methods, sample preparation, separation techniques and chromatography, detection procedures and data analysis (quantitative and qualitative). A particular focus will be given to mass spectrometry-based metabolomics of specialized metabolomes and its applications in environmental biology and natural products research. The course includes a practical part on GC or LC-MS (Gas Chromatography or Liquid Chromatography coupled to Mass Spectrometry) and data processing.
- ***Light and fluorescence microscopy for Life Sciences*** (SBL.00125; 4 ECTS; lecture). Fluorescence microscopy has become one of the core techniques in biological research. Its applications range from the study of the expression of specific molecular markers with high spatial resolution in single cells to the probing of cell functions in living organisms. Constant progress in microscope design and in fluorescent probe development has led to a large choice of applications based on the principles of fluorescence microscopy. This course will aim at giving an understanding of key concepts of the main techniques used in life sciences. It will also insist on practical issues essential for a productive use of these techniques in biological and biomedical research.
- ***Advanced imaging*** (SBL.00419; 1 ECTS; lecture). Fluorescence microscopy has become the preferred imaging tool for biological systems due to its capability to visualize specifically the target biomolecules under conditions compatible with life, like room temperature, liquid environment and irradiation with visible light. Fluorescence microscopy also provides very high sensitivity down to the detection of single molecules. As drawback, as it happens with any a far-field optical technique, the spatial resolution is limited by the wavelength of light to a few hundreds of nanometres (the so-called diffraction limit). Remarkably, in the mid 2000s, a series of imaging methods using fluorescence readout were developed that deliver images with resolution beyond the diffraction limit. These methods, called super-resolution fluorescence microscopy or far-field fluorescence nanoscopy and whose pioneers were awarded with the Nobel Prize in Chemistry in 2014, have revolutionized biological imaging and continued to be developed until the present day. In this lecture we will revise the working principles of super-resolution microscopy and its development from the first generation of methods up to the newest methods capable of achieving 1 nm resolution under ambient conditions. We will discuss the performance and technical aspects of the necessary hardware and sample preparation for each one of the different modalities of super-resolution microscopy existing today. Also, we will perform experiments hands-on to obtain super-resolved fluorescence images, including the acquisition and analysis of data. Prerequisite: SBL.00125, *Light and fluorescence microscopy for Life Sciences*.
- ***Introduction to mass spectrometry and proteomics*** (SBL.00451; 1 ECTS; practical). This course teaches theoretical and practical principles of mass spectrometry (MS)-based proteomics. It introduces principals of MS analysis of peptides and proteins. Current mass analysers and underlying physical principals are introduced in lectures. Hands-on analyses of mass spectra are performed in a practical course.
- ***Advanced quantitative proteomics*** (SBL.00452; 1 ECTS; practical). This course follows *Introduction to mass spectrometry and proteomics* (prerequisite). It introduces quantitative MS-based proteomics principles in lectures. In a practical course proteomics experiments are performed and data is analysed by current bioinformatics approaches. After both courses, the

participants will be able to design and perform MS-based proteomics experiments and to analyse respective data. Prerequisite: SBL.00451, *Introduction to mass spectrometry and proteomics*.

Bioinformatics:

- ***Introduction to R*** (SBL.30001; 2 ECTS; lecture with exercises). This course introduces the basic usage of the statistical programming language R. The focus will be on data structures (vectors, matrices and data frames), import / export of data, basic plotting, writing of functions and scripts for reproducible data analysis. The course will be largely "hands-on" and does not require any prior knowledge on R.
- ***Introduction to UNIX and BASH*** (SBC.07110; 2.5 ECTS; lecture with exercises). The students will learn the basics of computing and programming, with an emphasis on UNIX operating system and command-line examples. They will learn BASH scripting using modern tools, including regular expressions. This course is a prerequisite for SBC.07107 (*Bioinformatics (practical + in silico*), SBL.00425 (*Metagenomics data analysis*), and SBL.30004 (*Organization and annotation of Eukaryote genomes*). Note that this course aims at introducing the computer skills needed for bioinformatics and, therefore, the students are highly encouraged to complete it with one of the three courses mentioned above.
- ***Bioinformatics (practical + in silico)*** (SBC.07107; 3 ECTS; practical). This course will allow the students to sequence a genome and analyse real genomic data. The goal is to identify potential mutations responsible for the phenotype. Prerequisite: SBC.07110, *Introduction to UNIX and BASH* and *Introduction to high-performance computing* (UniBe).
- ***Metagenomics data analysis*** (SBL.00425; 1.5 ECTS; lecture with exercises). Students will learn the basic principles of metagenomics data analysis and their associated methods. The course will cover the targeted methods (16S, ITS) as well as the Whole Genome/Transcriptome Sequencing methods, both in prokaryotes and eukaryotes. Students will learn which kind of data could be extracted from metagenomics analysis and how to analyse and represent these data. Prerequisite: SBC.07110, *Introduction to UNIX and BASH*.
- ***Introduction to high-performance computing*** (also listed as "HPC" in this study plan). This lecture with exercises introduces the use of high-performance computing centers, with a focus on the IBU cluster. Prerequisite: SBC.07110, *Introduction to UNIX and BASH.*

Soft skills:

- ***Critical reading*** (SBL.20005; 3 ECTS; seminar). In this seminar, MSc students in Environmental Biology will discuss recent literature in the field and learn how to review papers. Students will participate in scientific discussions and reviewing of original research articles, and acquire skills in presenting and defending scientific arguments in a group. This seminar has to be taken for two semesters.
- ***Scientific writing*** (SBL.00410; 3 ECTS; lecture with exercises). In a first part consisting of a few lectures, students will be introduced to the publication business and the art of writing scientific articles. In a second part, they will practice writing a scientific text.
- ***English course for Master students***. We do not provide a specific title, as this can vary depending on the current offer from the Language Center and the student's proficiency. The selected course(s) help(s) Master's students in scientific disciplines develop the English language skills relevant to their studies and future careers. Target level must be B2-C2. An online placement test is necessary to find the right course for your level.

  More info: https://www.unifr.ch/centredelangues/en/courses/semester/

2.2.1.2 Scientific core courses

Ecology and evolution:

- ***Community ecology*** (SBL.20031; 3 ECTS; lecture). This course will start with a reminder of basic concepts (ecological niche, integrated community model) and the introduction of a more recent theory (Vellend's theory of ecological communities). The following topics will then be discussed: communities in a changing environment; species interactions and coexistence; biodiversity ecosystem-functioning relationships; ecological networks; and metacommunities. This course is given biennially and alternates with *Population and evolutionary dynamics.*
- ***Population and evolutionary dynamics*** (SBL.20032; 3 ECTS; lecture). This course focuses on the ecological and evolutionary dynamics of populations. In the 1st part students will study basic and advanced concepts of population dynamics, including population growth and growth rates, age-structured models (Leslie matrix; Euler-Lotka equation), limiting factors and density-dependence, and demographic principles of life-history evolution. In the 2nd part, students will be introduced to evolutionary dynamics, including replicator dynamics in population genetics, the principles of evolutionary game theory and adaptive dynamics. Students will learn, for example, the key concept of fitness landscapes and how they are defined from the underlying population dynamics. They will then study the evolution of fitness landscapes and, in particular, how selection acts on different evolutionary strategies. The students are expected to have a basic knowledge (BSc level) of ecology, evolutionary biology, and population genetics. This course is given biennially and alternates with *Community ecology.*
- ***Evolutionary genomics*** (SBL.20034): This course (lecture with exercises) examines the main factors that shape the evolution of plant and animal genomes. In particular, it discusses various approaches for assessing patterns of genomic variation in natural populations and the evolutionary and ecological processes affecting them. Students will population genetical statistics and about computational tools for analysing genetic variation at the genome-level, including for example the estimation of genome-wide population structure and tests of selection.
- ***Organization and annotation of Eukaryote genomes*** (SBL.30004; 3 ECTS; lecture with exercises) This course examines the main evolutionary processes shaping the organization plant and animal genomes. It compares and operates complementary approaches to characterize gene models as well as transposable element in model and non-model organisms. Using adequate tools to identify duplicated sequences and 'junk DNA', it will also address how to benefit from genomic variation. A mix of lectures and practical exercises will enable students to take advantage of current approaches to robustly describe and understand Eukaryote genomes. Prerequisite: SBC.07110, *Introduction to UNIX and BASH*.
- ***Evolution workshop in Guarda*** (SBL.20040; 3 ECTS; lecture with exercises; block course of 5 days). This course is an extramural block course (1 week) involving Swiss and foreign graduate students, as well as invited professors. As part of small working groups that are centred on common scientific interests, and in interaction with the teachers, the students design research projects and write and present grant proposals. The goal is to learn to discuss science, develop scientific arguments and questions, develop a research plan, and write research proposals. Students who are interested in following this course should contact Prof. Thomas Flatt ahead of time (thomas.flatt@unifr.ch). More information, as well as the registration deadline can be found at http://evolution.unibas.ch/teaching/guarda/index.htm.
- ***Ecological field course*** (SBL.00205; 5 ECTS; practical with excursions; block course of 11 days usually after June exam session). It is a project-oriented field course taking place at a research field station. With the support of the teachers, the students learn to develop their own research projects, carry them out, and present and write up the results. Participants must have followed at least one course on general ecology (SBL.00013 or similar). For logistic reasons, the number of participants is limited to 12 persons.
- ***Tropical biology association (TBA) field course*** (XAF.00001; 10 ECTS; internship; block course of 28 days). This is a project-oriented international summer field course in tropical Africa or

Southeast Asia. It is organised by the Tropical Biology Association (http://www.tropical-biology.org/). The courses take place in summer / fall every year. Each year TBA runs month-long courses in tropical ecology and conservation for students at advanced undergraduate or early postgraduate level who have a keen interest, but little experience, in tropical biology. The TBA courses provide practical training and experience in the tropics with an emphasis on building skills and understanding. The Department of Biology can support 2 students per year to attend this course. There is no guaranteed admission to this course. Students who are interested in attending a TBA course should please contact and make an appointment with Prof. Thomas Flatt ahead of time (thomas.flatt@unifr.ch). This course can be used as a replacement for the *Ecological field course*. Note that in the case where the student would like to follow the *Ecological field course* as well, she/he cannot be credited the ECTS points for the *Ecological field course*. Note that it is not possible to cumulate the ECTS credits for the *Tropical biology association (TBA) field course* and of the *Research internship*; in case a student follows both courses, she/he will be credited 10 ECTS in total.

Plant & Microbial Sciences:

- ***Structure and functions of host-associated microbiota*** (SBL.20035; 3 ECTS; lecture). Students will be introduced to the concept of holobionts and metaorganisms. They will learn how microbiomes are assembled and structured in different host organisms, including plants, animals and humans. They will discover the functions these microbiomes fulfil for their hosts and how we can leverage on these microbiome-encoded functions to address current challenges, e.g. in plant and human health.
- ***Plant biotechnology*** (SBL.00323; 3 ECTS; lecture). In this course your memory of the basic methods and associated problems of plant transformation will be refreshed. This is followed by an introduction of new methods and technology related to genome engineering. Finally, we will have a look at selected examples of plant biotechnology in commercial applications as well as basic science. This course is given biennially and alternates with *Plant development: the life of a sessile organism* and *Symbiosis: how plants and microbes communicate.*
- ***Plant development: the life of a sessile organism*** (SBL.00308; 1.5 ECTS; lecture). This course describes central issues of developmental programmes involved in embryogenesis, root, shoot, and flower development. The emphasis will be on hormonal control of morphogenesis and pattern formation, and on the determinants of organ identity. This course is given biennially and alternates with *Plant biotechnology.*
- ***Symbiosis: how plants and microbes communicate*** (SBL.00307; 1.5 ECTS; lecture). This course deals with the mutual recognition between the plant and the microbial partner, and with the coordination of their development. In general, the course consists of short introductory lectures followed by critical examination of the recent literature on the topic. The goal is to show how scientific knowledge is generated and interpreted. This course is given biennially and alternates with *Plant biotechnology.*
- ***Microbial metabolism and genetics*** (SBL.00418; 1 ECTS; lecture). This course treats various aspects of microbial genetics with the focus on bacteria, fungi, and oomycetes. It deals with fundamental aspects of microbial genetics and applied aspects related to disease or beneficial mutualistic interactions. Furthermore, important examples of metabolic pathways will be discussed in the context of microbial life and interactions with the biotic and/or abiotic environment.
- ***In vivo biochemistry: Visualization of transport*** (SBL.20039; 1.5 ECTS; lecture) This course is meant for Master students that have a strong interest in understanding protein functionality on a biochemical and cell biological level. Contents will cover chemical indicators, reporters, sensors, fluorescently labelled substrates, click-chemistry of transport substrates, imaging of radiolabelled substrates and Immunolocalization of transport substrates. The course will offer a theoretical introduction into the methods currently used for the visualization of membrane transport using mainly examples from the plant field but is also accessible for “non-plant” master students.

- ***Signalling and Transport*** (SBL.00411; 1 ECTS; lecture). This course will focus on plant signal transduction at first place but will also compare bacterial and plant signalling pathways over membrane. Students will learn functional differences between the plant receptors and bacterial sensors. As a side effect they will be also be taught how structural models can be visualized. By comparing typical mammalian signal transduction pathways, such as G-protein coupled receptors or Toll-like innate immune receptors, with leucine-rich repeat (LRR) receptor(-like) kinases, it will be explained how plants differently sense steroid hormones over membranes. This course will compare eukaryotic signal transduction in plant, bacterial and mammalian systems, and is thus also recommended also for "non-plant" master students.

Applied environmental biology:

- ***Global change*** (SBL.20036; 3 ECTS; lecture). How is biodiversity affected by environmental challenges? Describing the evolutionary ecology of organisms from local to global scales, this course provides an overview of processes that shape the origin, expansion and extinction of species in space and time. Through series of lectures and personal work, it compares the biodiversity and biogeography of varied ecosystems such as drought-related deserts, long-populated Mediterranean regions and alpine ranges in order to organize main drivers of variation in a coherent framework. Such an integrated approach to species responses to environmental changes is key to interpret the current distribution of biodiversity and to appraise and manage future challenges. This course is given biennially and alternates with *Invasion biology.*
- ***Invasion biology*** (SBL.20037; 3 ECTS; lecture). Biological invasions are a global phenomenon and are considered as one of the major drivers of global change. Alien species can threaten native species and ecosystems, as well as human economy and well-being. This course covers the ecological, evolutionary and socio-economic implications of biological invasions. In particular, the following topics are covered: the invasion process, transport, pathways, introduction, establishment, persistence, evolution, spread, impacts, management. This course is given biennially and alternates with *Global Change.*
- ***Principe of environmental ethics (advanced)*** (SSE.00433; 3 ECTS; lecture). In the field of the environment, ethical studies generally focus on the justification of environmental measures, but rarely on the ethical problems that arise during their implementation. This lecture presents the method of principlism and analyses the implementation of certain environmental challenges. These change each semester the course is taught.
- ***Research internship*** (SBL.20038; 4 ECTS; internship). During the course of their master curriculum (preferably between semesters), students have the opportunity to increase their practical work experience by carrying out a research internship of four weeks. To discover other research environments, students are encouraged to carry out this internship at an external research institution (e.g. Agroscope, FiBL, CABI). In such cases of external hosting institution, the internship should be co-supervised by a group leader from the Department of Biology. A report should be written at the end of the internship, summarizing the research question, the work carried out and the results obtained. Note that it is not possible to cumulate the ECTS credits for the *Tropical biology association (TBA) field course* and of the *Research internship*; in case students follows both courses, they will be credited 10 ECTS in total. This course cannot be taken by the students following the Teaching option.
- The teaching unit *General concepts for biology teachers* (**SBL.00502**) consists in a personal work aimed at refreshing the knowledge in biology acquired at Bachelor and Master levels. The student reviews his or her course notes with the aim of being able to explain general concepts **simply, concisely and clearly**. The questions are of a general nature and cover the following teaching units: SBL.00001 ; SBL.00002 ; SBL.00040 ; SBL.00041 ; SBL.00074; SBL.00013, SBL.00021 ; SBL.00045 ; SBL.00063 ; SBL.00014 and SBL.00019. The exam can also be taken in German or in French.

2.2.2 Master thesis related activities

The master thesis related activities include the ***Research group meetings in environmental biology***, the ***Research seminars in environmental biology***, and the ***Seminars in biology***. The *Research group meetings* are an immersion into the daily life of the research group chosen by the students for their master thesis. The *Master in Environmental Biology* organises a weekly *Research seminar*. This is an internal seminar where researchers (including the master students, PhD students, post-doctoral researchers) present their research progress. During the *Seminars in biology*, which is shared with the *Master in Molecular Life and Health Sciences*, national and international speakers are invited to present their research.

Students are expected to participate regularly to these meetings and seminars. They must present the advancement of their master thesis at least once during the ***Research seminars in environmental biology.*** It is recommended to give the presentation during the 2nd or the 3rd semester of study.

For the EE, PMS, and AEB options, the students follow the following variations: ***Research group meetings in environmental biology (4 sem.)*** (SBL.20083, 3 ECTS) during 3 semesters; ***Research seminars in environmental biology (4 sem.)*** (SBL.20081, 5 ECTS) during 4 semesters; and ***Seminars in biology (4 sem.)*** (SBL.00431, 2 ECTS) during 4 semesters.

For the TE option, the students follow the following variations: ***Research group meetings in environmental biology (3 sem.)*** (SBL.20084, 2 ECTS) during 2 semesters; ***Research seminars in environmental biology (3 sem.)*** (SBL.20082, 4 ECTS) during 3 semesters; and ***Seminars in biology (3 sem.)*** (SBL.00432, 1.5 ECTS) during 3 semesters.

2.2.3 The Master Thesis

The master thesis is a scientific project carried out by the student under the supervision of a group leader with research activities related to environmental biology within the Department of Biology.

Students must choose a research group and be accepted during the first semester of their master studies. The group leader will be their supervisor for the master thesis. To facilitate this choice, students are encouraged to familiarize themselves with the research carried out in the different research groups either before starting their studies or during the first weeks of their master study, e.g., by following the *Research seminars in Environmental Biology*, or by talking to the group leader or to the group members. If students wish to carry out their master thesis in an external research institute (e.g. Agroscope, FiBL, CABI), they need to be co-supervised by a group leader form the Department of Biology.

In general, students are expected to establish a research strategy, plan the project, carry out the research, analyse the results, write a report (which can be in the form of a scientific publication), and make an oral presentation of their thesis. The master thesis is evaluated with a grade, which includes the practical work, the written report, and the final oral presentation.

If a thesis is evaluated as insufficient (less than 4.0), students have the option to begin a new master thesis in another research group. In this case, students need to continue to attend and participate to the master thesis related activities.

For the EE, PMS, and AEB options the Master thesis is credited 60 ECTS (Master thesis (3 sem.), SBL.05001). For the TE option the Master thesis is credited 45 ECTS (Master thesis (2 sem.), SBL.05002). The duration of the Master thesis work is counted according to the calendar year, not the academic year: SBL.05001 takes 18 months and SBL.05002 takes 12 months full time, including 5 weeks of vacation per year, and the time that students spend to take lectures and seminars of the corresponding study plan. The duration of the Master thesis can be slightly extended, provided that both the student and the group leader mutually agree, and that the achievement of the project requires an extension of a few months.

2.3 Examinations of the MSc and Validation

The teaching units of the Master programme can only be examined (and the ECTS credits acquired) after students have completed all requirements for their Bachelor degree.

The **Validation Package MScBL1** comprises the master courses and the master thesis related activities. **Validation Package MScBL2** comprises the master thesis. With the validation of the **MScBL1 and MScBL2** packages, students obtain the degree of Master of Science in Environmental Biology, option Ecology & Evolution, Plant and Microbial Sciences, Applied Environmental Biology, or Teaching.

2.4 Admission Procedure to the Master Programme

The acceptance to a Master program in Environmental Biology may be granted provided the following two conditions have been met by the applicant:

- Satisfying the University admission requirements as defined in the *Règlement concernant l'admission à l'Université de Fribourg* that can be found at: https://www.unifr.ch/apps/legal/fr/document/274904
- The student possesses a Bachelor of Science in Biology from the University of Fribourg, a Bachelor of Science in Biochemistry from the University of Fribourg (provided they have chosen the necessary courses in their BSc curriculum), or an academic degree judged equivalent by the Faculty of Science and Medicine.

For candidates with degrees that are not judged equivalent by the Faculty of Science and Medicine, the Commission for Students' Requests will decide on eligibility (*Commission des requêtes des étudiant·e·s*, Dean's Office, Faculty of Science and Medicine, Chemin du Musée 8, CH-1700 Fribourg, Switzerland).

Based on the candidate's academic qualification, the Commission for Students' Requests can accept the application on the condition that additional requirements are fulfilled, provided they are of a minor scope and can be completed simultaneously with the Master studies. Otherwise, access is denied, or applicants can be admitted to a *pre-master programme* and can begin the Master programme only after having fulfilled the requirements initially set for the pre-master. Final acceptance to the Master programme for a qualifying student depends on the successful completion of the additional requirements.

The MSc in Molecular Life and Health Sciences and the MSc in Environmental Biology are formally considered as two distinct programmes of a **MSc in Biology**. Students who have been excluded from either a Master in Biology, a MSc in Molecular Life and Health Sciences, a MSc in Environmental Biology, or equivalent, are not eligible to apply.

3. Appendix: Table summarizing all master courses

EE = Ecology & Evolution
PMS = Plant & Microbial Sciences
AEB = Applied Environmental Biology
TE = Teaching

The courses are O (obligatory), R (recommended), E (elective), - not possible

The biennial courses are paired: biennial AX with biennial BX
biennial AX: given for the 1st time during the academic year 2021/2022 and then every two years
biennial BX: given for the 1st time during the academic year 2022/2023 and then every two years

Code	Type	Title of the teaching unit	ECTS	EE	PMS	AEB	TE	Semester	Annual / Biennial	Prerequisite
	Research skills									
	Statistics and modelling									
SBL.00504	lecture with exercises	Basics in biostatistics	1.5	R	R	R	R	Autumn	annual	Cannot be taken with SBL.00075
SBL.20001	lecture with exercises	Biostatistics I - generalized linear models and mixed effects models	3	O / R	O / R	O / R	R	Autumn	biennial A1	SBL.00075 or SBL.00504
SBL.20002	lecture with exercises	Biostatistics II - multivariate analysis	3	O / R	O / R	O / R	R	Autumn	biennial B1	SBL.00075 or SBL.00504
SBL.00427	lecture	Visual communication of data	1	R	R	R	R	Spring	annual	
SBL.06002	lecture	Classical models in biology (lecture)	3	O	R	R	R	Spring	annual	
SBL.06003	exercises	Classical models in biology (exercises)	1	O	R	R	R	Spring	annual	
	Experimental									
SBL.20003	practical	Methods in plant pathogen interactions	4	E	O	R	E	Autumn	annual	
SBL.20004	lecture with practical	Introduction to metabolomics: data acquisition and processing	2	E	O	R	E	Spring	annual	
SBL.00125	lecture	Light and fluorescence microscopy for Life Sciences	3	E	O	R	R	Autumn	annual	
SBL.00419	lecture	Advanced imaging	1	E	R	E	E	Spring	annual	SBL.00125 obligatory
SBL.00451	practical	Introduction to mass spectrometry and proteomics	1	E	O	E	E	Autumn	annual	
SBL.00452	practical	Advanced quantitative proteomics	1	E	R	E	E	Spring	annual	SBL.00451 obligatory
	Bioinformatics									
SBL.30001	lecture with exercises	Introduction to R	2	R	R	R	E	Autumn	annual	
SBC.07110	lecture with exercises	Introduction to UNIX and BASH	2.5	R	R	R	E	Autumn	annual	
SBC.07107	practical	Bioinformatics (practical + in silico)	3	R	R	R	E	Autumn	annual	SBC.07110; HPC (UniBe) obligatory
SBL.00425	lecture with exercises	Metagenomics data analysis	1	E	R	R	E	Spring	annual	SBC.07110 obligatory
UniBe	Lecture with exercices	Introduction to high-performance computing	1	R	R	R	E	Autumn	annual	SBC.07110 obligatory
	Soft skills									
SBL.20005	seminar	Critical reading (2 semesters)	3	O	O	O	O	Spring + Autumn	biennial A2	
SBL.00410	lecture with exercises	Scientific writing	3	O	O	O	O	Autumn	biennial B2	

UniFr Language Center	-	English course(s) for Master students	Max 6	E	E	E	E	Spring + Autumn	annual	Check your level online

Scientific core courses

Ecology & Evolution

SBL.20031	lecture	Community ecology	3	O	E	R	R	Spring	biennial A3	
SBL.20032	lecture	Population ecology and evolutionary dynamics	3	O	E	E	E	Spring	biennial B3	
SBL.20034	Lecture with exercices	Evolutionary genomics	3	O	E	E	E	Spring	annual	
SBL.30004	lecture with exercises	Organization and annotation of Eukaryote genomes	3	R	E	E	E	Autumn	annual	SBC.07110 obligatory
SBL.20040	internship	Evolution workshop in Guarda	3	E	E	E	E	Summer	annual	
SBL.00205	practical with excursion	Ecological field course	5	O	E	O	R	Summer	annual	SBL.00013 or similar
XAF.00001	internship	Tropical Biology Association (TBA) field course	10	E	E	E	E	Summer	annual	

Plant & Microbial Sciences

SBL.20035	lecture	Structure and functions of host-associated microbiota	3	E	O	R	O / R	Spring	biennial A7	
SBL.00323	lecture	Plant biotechnology	3	E	O	R	O / R	Spring	biennial B6	
SBL.00308	lecture	Plant development: the life of a sessile organism	1.5	E	O	R	E	Spring	biennial A6.1	
SBL.00307	lecture	Symbiosis: how plants and microbes communicate	1.5	E	O	R	E	Spring	biennial A6.2	
SBL.00418	lecture	Microbial metabolism and genetics	1	E	R	E	E	Spring	Annual	
SBL.20039	lecture	In vivo biochemistry: visualization of transport	1.5	E	R	E	E	Autumn	biennial A8	
SBL.00411	lecture	Signalling and Transport	1	E	R	E	E	Autumn	annual	

Applied Environmental Biology

SBL.20036	lecture	Global change	3	R	R	O	O	Autumn	biennial A5	
SBL.20037	lecture	Invasion biology	3	R	E	O	R	Autumn	biennial B5	
SSE.00433	lecture	Principles of environmental ethics (advanced)	3	R	R	O	O	Autumn	biennial B	
SBL.20038	internship	Research internship	4	R	R	R	-	Summer	annual	

General

SBL.00502	Personal work	General concepts for biology teachers	1	-	-	-	O	Spring	annual	

Master thesis-related activities

SBL.20083	seminar	Research group meetings in Environmental Biology (4 sem.)	3	O	O	O	-	All	annual	
SBL.20084	seminar	Research group meetings in Environmental Biology (3 sem.)	2	-	-	-	O	All	annual	
SBL.00431	seminar	Seminars in Biology (4 sem.)	2	O	O	O	-	All	annual	
SBL.00432	seminar	Seminars in Biology (3 sem.)	1.5	-	-	-	O	All	annual	
SBL.20081	seminar	Research Seminars in Environmental Biology (4 sem.)	5	O	O	O	-	All	annual	
SBL.20082	seminar	Research Seminars in Environmental Biology (3 sem.)	4	-	-	-	O	All	annual	

Master Thesis

SBL.05001	master work	Master Thesis (3 sem.)	60	O	O	O	-	all		
SBL.05002	master work	Master Thesis (2 sem.)	45	-	-	-	O	all		