Georg-August-Universität
Göttingen

Modulverzeichnis

Bachelor's degree programme "Ecosystem Sciences" (supplement to the Prüfungs- und Studienordnung für den Bachelor-Studiengang "Molecular Ecosystem Sciences" published in Amtliche Mitteilungen I 37/2022 p. 779)

Module

Übersicht nach Modulgruppen

I. Bachelor's degree programme "Ecosystem Sciences"

Es müssen Leistungen im Umfang von insgesamt wenigstens 180 C erfolgreich absolviert werden.
To successfully complete the Bachelor's degree programme, a total of 180 Credits must be earned.

1. Compulsory Modules

Es müssen folgende 20 Pflichtmodule im Umfang von insgesamt 126 C erfolgreich absolviert werden.
The 20 following modules comprising 126 Credits must be successfully completed.

2. Professionalisation

Es müsen Module im Umfang von insgesamt wenigstens 42 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

A total of 42 Credits have to be earned according to the following regulations.

a. Key competencies

Es müssen folgende zwei Module im Umfang von insgesamt 12 C erfolgreich absolviert werden.

The 2 following modules comprising 12 Credits must be successfully completed.

b. Elective modules

Es müssen mindestens 2 der unten genannten Module im Umfang von mindestens 30 Credits erfolgreich absolviert werden. Die unten genannten Module können durch alternative Module gemäß § 2 Abs. 4 der Prüfungsordnung für diesen Studiengang ersetzt werden. Mit Ausnahme von Satz 2 kann ein Modul durch ein beliebiges Modul zu Schlüsselkompetenzen im Sinne von § 8 a der Allgemeinen Prüfungsordnung im Umfang von mindestens 6 Credits ersetzt werden.

A minumum of 2 modules mentioned below comprising at least 30 Credits must be successfully completed. Modules mentioned below may be substituted with alternative modules according to regulation 2 paragraph 4 of the examination regulations for this degree programme. Save sentence 2, one module may be substituted with any module regarding key competencies in the sense of Regulation 8 a of the General Examination Regulations comprising at least 6 Credits.

3. Bachelor's thesis

Durch die erfolgreiche Anfertigung der Bachelorarbeit werden 12 C erworben.

A total of 12 Credits are awarded for successfully completing the Bachelor's thesis.

Georg-August-Universität Göttingen **Module B.ES-SK.105: Data Analysis and Statistics**	6 C 4 WLH

Learning outcome, core skills: The students will be trained • to solve problems arising during the handling of scientific data and its analysis • how to avoid common pitfalls already during the design of a study • in various statistical approaches useful for the analysis of different types of data The students will acquire knowledge in the fields of: • data types, attributes, scales and definitions • descriptive, exploratory and confirmatory statistics • statistical analysis and tests of hypotheses	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Data Analysis Basics (Lecture) *Contents*: The module will provide the students with a basic understanding of descriptive, exploratory and confirmatory statistics to enable them to understand statistical details in scientific publications, apply statistical methods to their own data and to interpret results from statistical analyses. Furthermore, it will briefly discuss the concepts of statistical predictions and model choice. In addition to the methodological concepts, the lecture will also comprise an introduction to the R language for statistical computing or similar software.	2 WLH
Course: Applied Statistics in Ecosystem Science (Practical course) *Contents*: In this applied part the students are confronted with real world examples and have to understand, apply and interpret statistical methodology that finds the encountered problem.	2 WLH
Examination: Written examination (90 minutes) **Examination requirements:** The students demonstrate their ability to understand, apply and interpret statistical methodology in a statistical analysis. In the exercises, they will solve applied problems while for the term paper they will independently conduct their own statistical analysis and document the corresponding results.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. rer. nat. Dominik Seidel
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 1
Maximum number of students:	

40	

Georg-August-Universität Göttingen **Module B.ES-SK.110: Computer Science and Mathematics**	6 C 4 WLH

Learning outcome, core skills: Understanding of basic notions and methods of mathematics and computer science, including notations from logic and set theory, relations, graphs, functions, vectors, linear transformations, matrices, eigenvalues, limits, derivatives, extreme values, integration, calculation of areas and volumes, number systems, representation of information, databases, the World Wide Web, foundations of programming, simulation, visualization.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Computer science and mathematics (Lecture) *Contents*: Lecture and Exercise	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Understanding of basic notions and methods of mathematics and computer science as listed above, ability to solve small tasks using these notions and methods.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Winfried Kurth
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.101: Forest Botany and Tree Physiology**	6 C 4 WLH

Learning outcome, core skills: This module provides an overview of functional anatomy and physiology of woody plants. The lectures include the introduction to the molecular construction and physiological functions of the cell, the importance of storage substances, the structure of the root as the major organ of water and nutrient uptake, the stem with emphasis on the transport system, the anatomy of leaves with particularities of adaptation to different habitats, as well as the structure and function of the phloem and of terminal tissues. In the exercises, the content of the lectures will be applied to practical examples. The students will be trained in modern microscopic and histochemical techniques. The students learn to describe their observations objectively.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Forest Botany and Tree Physiology (Lecture)	2 WLH
Course: Exercises in Forest Botany (Exercise)	2 WLH
Examination: Written examination (120 minutes) **Examination requirements:** Students demonstrate that they have acquired knowledge of the functional anatomy of the plant body and important biological processes in trees and can reproduce this knowledge.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in biology
Language: English	**Person responsible for module:** Dr. Ines Teichert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 1
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.102: Biochemistry**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
The objective of this module is to introduce basic knowledge of different classes of biomolecules, including carbohydrates, lipids, proteins and nucleic acids. Students will learn to understand fundamental biochemical reactions as well as the application of biochemical methods. Students will be introduced to the basic in protein chemistry and genetics: DNA, RNA, enzymes, carbohydrates, lipids and cell membranes, metabolism bases and signal transduction. Applications and the context of key biochemical concepts will be introduced with various examples, seminars and exercises. Objective of the course: The purpose of the course is to learn basic concepts and components in biochemistry.	Attendance time: 56 h Self-study time: 124 h

Course: Biochemistry	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Basic knowledge of different classes of biomolecules and their metabolism with examples from soil and plant biochemistry. Basic knowledge of biochemical methods and applications.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. rer. nat. Kai Zhang
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 1
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.103: Ecological Genetics**	6 C 4 WLH

Learning outcome, core skills: Understanding of the importance of intraspecific (genetic) variation for ecosystem processes and functions, in particular • knowledge of modern methods to assess genetic diversity in diverse groups of organisms • understanding of the role of the evolutionary factors to shape genetic diversity with emphasis on selection • understanding of evolutionary processes including adaptation under natural conditions and in managed ecosystems • understanding of the impact of global change on genetic resources	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Ecological genetics (Lecture)	2 WLH
Course: Assessment of genetic variation (Practical course) *Contents*: Laboratory course, Workshops	2 WLH
Examination: Oral examination (approx. 20 minutes) **Examination requirements:** Use of modern methods to assess genetic variation in diverse groups of organisms, evolutionary factors and how they shape genetic diversity, the role of adaptation under natural or managed conditions, impact of global change	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Gailing
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 1
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.104: Chemistry/Physics**	6 C 4 WLH

Learning outcome, core skills: The students gain knowledge of the chemical and physical basics and measurement techniques for studying and understanding ecosystem processes. In chemistry, the topics structure of matter, chemical bonds, state of aggregation, phase transitions, the law of mass action, acid/base and redox reactions and organic chemistry will be covered. In physics, the topics mechanics, thermodynamics, electricity, magnetism and radiative transport will be covered.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Chemistry/Physics	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of chemical and physical principles and measurement methods for understanding processes in ecosystem sciences.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Jens Dyckmans
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 1
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.106: Microbiology and Molecular Biology**	6 C 4 WLH

Learning outcome, core skills: Students will be introduced to molecular, biochemical and physiological aspects in microbiology and molecular biology that are important to Ecosystem Sciences. The acquired knowledge allows the students to address questions and problems in Ecology and Systems Biology on molecular levels and understand the background of modern molecular methods that can be applied to solve such topics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Microbiology and biotechnology (Lecture) *Contents*: Microbial organisms in structure, growth, physiology and function, their diversity and roles in ecosystems, diseases and environmental applications are presented	2 WLH
Course: Molecular biology (Lecture) *Contents*: Prokaryotic and eukaryotic genomes and gene structures, encoded function and regulation on all levels, proteins and enzymes, molecular techniques and applications, transgenes are presented.	2 WLH
Examination: Oral examination (approx. 20 minutes) **Examination requirements:** Basic knowledge on genetics, cytology, physiology, and ecology of microorganisms (especially bacteria and fungi), applications of microorganism in biotechnology generally and with specific focus on ecological tasks, structure and functions of DNA, RNA, proteins and exemplified metabolites, basic concepts and techniques in molecular biology, recombinant DNA technology, DNA transfer techniques, handling of GMOs.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ursula Kües
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.107: Plant Diversity**	6 C 4 WLH

Learning outcome, core skills: Students acquire basic knowledge of plant morphology and plant systematics, are able to identify plants with confidence in the field and the lab, and know a basic set of native woody and herbaceous plant species.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Plant Diversity (Lecture) *Contents*: Lecture and practical	4 WLH
Examination: Written exam (60 min.; 60%) and Herbarium (max. 80 pages; 40%) **Examination requirements:** Herbarium: Includes 80 species, specimens correctly mounted and identified Written exam: The topics covered in the lecture and in the exercises (morphological description of the species, systematic groups, family characteristics, flower, seed and fruit structure, vegetative characteristics, etc.) will be examined	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Holger Kreft
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.108: Plant and Animal Ecology**	6 C 4 WLH

Learning outcome, core skills: Students are familiar with basic aut-, population- and synecological concepts in plant and animal ecology from the level of the individuals to entire communities. They have acquired knowledge on succession of plant communities after disturbance, the role of plants in carbon, water and nutrient cycling and on key plant interactions. Students know the animal tree of life and understand the functional differentiation among animal taxa. Students are familiar with the functional roles of animals in multitrophic communities as well as with the underlying environmental factors, population-based processes and biotic interactions that structure these communities. Students are able to apply ecological field methods and to perform basic analyses of diversity, ecological functions and community structure.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Plant ecology (Lecture)	2 WLH
Course: Animal ecology (Lecture) *Contents*: Lecture and exercises	2 WLH
Examination: Written examination (90 minutes) **Examination requirements:** • Understanding concepts and methods in plant and animal aut-, population-, and synecology • Knowledge of role of plants in carbon, water and nutrient cycling and interactions • Knowledge of major animal taxa, their biodiversity and their functional role in ecosystems	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas Schuldt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.109: Terrestrial Biogeochemistry**	6 C 4 WLH

Learning outcome, core skills: • Understanding the role of the pedosphere as the interface of biosphere, lithosphere, hydrosphere, and atmosphere on these major element cycles • Advancing knowledge on the major biogeochemical processes of C, N and P cycles • Understanding the anthropogenic changes on these biogeochemical cycles and the mitigation practices • Learning how to assess anthropogenic influences by comparative biogeochemistry of natural and managed ecosystems • Understanding the principles and calculations of indices of soil fertility and nutrient cycling rates	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Terrestrial biogeochemistry *Contents*: Lecture, Calculation exercises	4 WLH
Examination: Written examination (120 minutes) **Examination prerequisites:** Submission of calculation exercises (max. 5 pages) **Examination requirements:** Participation in all calculation exercises, and interactive discussions on interpretation of measured properties and processes. Examination: C, N and P cycles of terrestrial ecosystems, tools for quantifying biogeochemical cycling, soil biochemical reactions, calculations of process rates and turnover time; and scientific writing of a topic within terrestrial biogeochemistry.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Marife Corre
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.111: Forest Pathology**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Recognition of forest damages and choosing the right control method are the basic skills of a forester. This course provides the student with an understanding of the most important bacterial and fungal diseases and how they are controlled in forest ecosystem. The student will know the most important abiotic environmental factors affecting forest systems, recognize the most important fungal diseases and understands their impact to forest trees, as well as understands the epidemiology of these diseases. The student also understands other than pathogenic interactions between microbes and forest trees.	Attendance time: 56 h Self-study time: 124 h

Course: Forest pathology (Lecture) *Contents*: Students are introduced into pathogenic bacteria and fungi, obligate and opportunistic organisms, changes in lifestyles, effects on hosts, effects of diseases onto the forest ecosystem, classical and modern approaches to defeat, how to approach novel diseases and develop possible measures for protection.	2 WLH
Course: Exercises in forest pathology (Lecture) *Contents*: Students will learn in excursions into nature the diversity of disease symptoms on leaves, bark, stems, roots, wood, shall collect material of interest for own analysis in the lab (microscopy, isolation, definition of disease) and report to the other students their findings. Short lectures combined with practical experiences in nature and within the laboratory.	2 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of the most important abiotic environmental factors affecting forest Systems; recognition of the most important fungal and possibly bacterial diseases; control methods; understanding how different damages affect individual tree and at the forest level, the epidemiology of different diseases, interactions with other calamities and between microbes other than pathogenic, and forest trees.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ursula Kües
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.112: Current Topics in Ecosystem Sciences**	6 C 4 WLH

Learning outcome, core skills: The objective of the module is to introduce students to current topics in ecosystem sciences and on-going research of the Faculty of Forest Sciences and Forest Ecology. The students will gain the ability to review actual research findings and learn how to present scientific data. Furthermore, they will practice to defend scientific results in an interdisciplinary discussion. Students will learn to question published research results critically and how to lead a constructive discussion in science. Thereby they practice the ability to discuss and take criticism in particular in interaction with other cultures. The aim is to strengthen analytical thinking and strategic project planning further.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Current topics in ecosystem sciences (Lecture)	1 WLH
Course: Literature seminar ecosystem science (Seminar)	3 WLH
Examination: Presentation (approx. 20 minutes) **Examination prerequisites:** Regular attendance at the seminar **Examination requirements:** Understanding and questioning of actual research results. The ability to present scientific results and outcomes. Active and critical participation in seminar discussions.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Gailing
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.113: Ecosystem Management and Conservation**	6 C 4 WLH

Learning outcome, core skills: The course imparts knowledge about the sustainable management of forest ecosystems and about nature conservation. Based on some fundamentals of forest ecology such as the impact of competitive interactions between trees, options of stand management are presented. Mixed stands and their management are of special importance. The course will provide information on how to analyze forest stands and how to derive appropriate silvicultural treatments in order to achieve the goals set by a given forest owner. The nature conservation part will introduce priority goals of conservation biology, the major threats to natural ecosystems and how they can be managed. The use of molecular methods is commonplace in conservation at various levels of biological organization from genes to ecosystems. Students will examine the results of molecular approaches in biodiversity conservation based on selected projects and recent literature. Students will be able to critically evaluate benefits and limitations of molecular studies in a conservation context. Examples will be taken from different geographic and climatic regions.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Forest ecosystem management (Lecture)	2 WLH
Course: Conservation of biodiversity based on molecular tools (Lecture) *Contents*: Lecture and practical exercises	2 WLH
Examination: Written examination (120 minutes) **Examination requirements:** Competition in plant communities, plant – environment interactions, mixed stands, principles of stand management, silvicultural systems, human land-use, climate change, biodiversity, ecosystem functioning. Effective comprehension of scientific literature with regard to conservation of biodiversity, different methods used for conservation of biodiversity and their specific applications, critical evaluation of molecular studies in a conservation context.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Gailing
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.114: Ecological Climatology**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
In this course students will gain insights in the main atmospheric characteristics and how they influence ecosystem processes and fluxes between ecosystem compounds (e.g. air, plants, soil). They will also learn how ecosystems feed back to the atmosphere at local and global scale. This will form the basis for understanding the impact of climate change on ecosystem functions and services. The lecture course will give an overview on atmospheric variables such as radiation, humidity, temperature, and wind and their interactions with terrestrial ecosystems. In the seminar/exercise class, the understanding will be deepened by quantitative exercises. The students will be trained in quantitative and qualitative scientific methods to describe climate-dependent physical, chemical and biological processes in terrestrial ecosystems enabling them to understand and evaluate the current discussion on climate change and its impact on terrestrial ecosystems.	Attendance time: 56 h Self-study time: 124 h

Course: Ecological climatology (Lecture) *Contents*: Lecture, Seminar and Exercise	4 WLH
Examination: Oral examination (approx. 20) **Examination requirements:** Qualitative and quantitative description of radiation, humidity, temperature, wind, their interactions with terrestrial ecosystems, carbon and water cycle, atmospheric chemistry, climate change, climate modelling.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Alexander Knohl
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.115: Ecological Modelling**	6 C 4 WLH

Learning outcome, core skills: Comprehensive knowledge of ecological models, theories and concepts. Development of interdisciplinary analytical thinking. Critical analysis and evaluation of the chances and limitations of different modelling approaches.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Ecological modelling (Lecture) *Contents*: Theoretical foundations and classical and modern models of terrestrial ecology. Application and analysis of classical and modern ecological models and concepts. Lecture and tutorial.	4 WLH
Examination: Oral Presentation (approx. 10 minutes) **Examination prerequisites:** Written examination (30 minutes); ungraded **Examination requirements:** Comprehensive knowledge of ecological models, theories and concepts. Interdisciplinary analytical thinking skills. Ability to critically analyze and evaluate the chances and limitations of different modelling approaches.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Katrin Mareike Meyer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.116: Chemical and Microbiological Methods**	6 C 4 WLH

Learning outcome, core skills: In order to understand the biotic and abiotic interactions, roles and the growth of living organisms in the ecosystem, their various physical/chemical structures will be examined with various analytical methods in lab. Various analytical methods for the understanding will be used, e.g. the formation of compounds within the tree trunk, the biosynthesis of extractives, isolation of microorganisms and of DNA, protein techniques, microscopy, and so on. Objective of the course: The purpose of the course is to learn and get hand-on experience with analytical methods and handling of biological material in details.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Chemical and mechanical analysis (Practical course) *Contents*: Introduction to various analytical methods, e.g. gravimetric, spectroscopic, thermal and mechanical, and other analytical methods for practical experiment on selected relevant samples.	2 WLH
Course: Microbiological and molecular methods (Practical course) *Contents*: Introduction to microbial isolation and cultivation techniques, DNA isolation, PCR, protein tests, gel-electrophoresis, microscopy on selected relevant samples.	2 WLH
Examination: Protocol (max. 20 pages; 50%) and term paper (max. 20 pages; 50%) **Examination requirements:** Principles of diverse analytical methods, hand-on application	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. rer. nat. Kai Zhang
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.117: Physiological and Genetic Methods**	6 C 4 WLH

Learning outcome, core skills: Genetic methods: Students will learn to investigate the dynamics of intraspecific diversity in different types of ecosystems. This involves field sampling of important plants, DNA extraction from different tissues, laboratory analyses with various types of molecular markers, data analyses and interpretation. Students will learn practical steps to assess genetic diversity, and will be able to evaluate the use of DNA-based methods for applications in breeding, conservation, and ecosystem management. Physiological methods: Students will learn how to determine the physiological aspects of nutrient allocation and wood formation of different tree species using quantitative methods to evaluate metabolites and enzyme activities. Students will further learn how to study the physiological aspects of mycorrhizal symbiosis. This involves handling and preparation of samples, calibration and use of standards, performance and documentation of biochemical assays, cultivation of plants and fungi, measuring physiological parameters, assessment of results and teamwork to resolve experimental problems.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: DNA-Based Methods to Study Biodiversity (Practical course) *Contents*: Workshops, laboratory exercise	2 WLH
Course: Quantitative Methods to Study Tree Physiology (Practical course) *Contents*: Workshops, laboratory exercise	2 WLH
Examination: Lab Report (max. 15 pages) **Examination requirements:** DNA markers and techniques, estimation of intraspecific diversity in different types of ecosystems, methods used for experimental sampling, DNA extraction from different tissues, quantitative photometry, biochemical assays, laboratory techniques, data analyses and interpretation and application of results.	6 C

Admission requirements: none	**Recommended previous knowledge:** Forest Botany and Tree Physiology; Ecosystem management and Conservation; Ecological Genetics
Language: English	**Person responsible for module:** Dr. Ines Teichert
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 4

Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.118: Soil Science and Bioclimatology Methods**	6 C 4 WLH

Learning outcome, core skills: • Understanding the experimental design of field-based quantification of soil properties and biochemical processes • Enabling to quantify/measure soil properties and biochemical processes • Familiarizing the principles of chemical analysis and calculations of soil GHG fluxes, element stocks, and plant-available nutrients in the soil • Learning how to measure, analyze and interpret meteorological variables (e.g. air temperature, air humidity, wind velocity, air pressure, radiation, precipitation, soil water content and temperature) • Understanding the impact of land-use change on meteorological variables • Familiarizing field installation of meteorological station • From the data of this field practical, the students will learn statistical analysis on land-use change effects, how to give an oral scientific presentation, and how to write a scientific report	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Bioclimatology field methods (Practical course)	2 WLH
Course: Soil science field methods (Practical course)	2 WLH
Examination: Presentation (approx. 30 min.; 40%) with written outline (max. 10 pages; 60%) **Examination prerequisites:** Participation in all field measurements, analytical instructions/practices, calculation exercises, statistical analysis, interactive discussions on interpretation of measured properties and processes, and able to demonstrate scientific presentation and writing. Examination: Scientific report (10 pages max.) from each student written either for Soil Science or Bioclimatology; and group presentation of the field data (1 group on soil science; 1 group on Bioclimatology, each 30 minutes including discussions)	6 C

Admission requirements: none	**Recommended previous knowledge:** Terrestrial Biogeochemistry Ecological Climatology
Language: English	**Person responsible for module:** Dr. Marife D. Corre
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.119: Field Methods in Forest Ecology, Silviculture and Vegetation Science**	6 C 4 WLH

Learning outcome, core skills: • Understanding the design of field trials in forest ecology, silviculture and vegetation science • Understanding how to investigate links between vegetation, site conditions and management • Learning how to measure, analyze and interpret basic forest structural attributes • Learning how to conduct, analyze and interpret vegetation relevés • From this field practical, students will learn how to design field studies, collect relevant data, analyze it statistically and report on it in a scientific report	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Field methods in forest ecology, silviculture (Exercise) *Contents*: Exercises and lectures	2 WLH
Course: Field methods in vegetation science (Exercise) *Contents*: Exercises and lectures	2 WLH
Examination: Term Paper (max. 15 pages) **Examination requirements:** Knowledge about the design and implementation of a field study and the statistical analysis, interpretation, and discussion of data. The term paper follows the structure of a scientific report.	6 C

Admission requirements: none	**Recommended previous knowledge:** Plant Diversity Plant & Animal Ecology Ecosystem Management & Conservation
Language: English	**Person responsible for module:** Prof. Dr. Holger Kreft
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.120: Scientific Writing**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
• Writing well-structured scientific texts • Using appropriate language for scientific texts • Knowing the production process of scientific papers including good scientific practice	Attendance time: 56 h Self-study time: 124 h

Course: Scientific Writing (Course) *Contents*: • How to structure scientific texts into commonly used sections (Title, Abstract, Introduction, Methods, Results, Discussion, References, Acknowledgements) • How to improve readability via structure at the sentence and paragraph levels as well as effective wording • How to report results in text, tables and figures • How to write scientific texts in practice: General advice and best practice examples for writing scientific texts, which will be directly applied to developing and improving the texts of the participants • Scientific writing as a collaborative and iterative process: Giving and receiving feedback, proof reading and editing • Addressing language issues in own scientific writing • How to efficiently read scientific texts and assess the quality of scientific outlets • When, what and how to cite in scientific texts • How to write research proposals • How to design scientific posters • Good scientific practice: Dos and Don’ts in scientific cooperation, publication and peer review This module should be done in parallel to or after the modules of the fourth semester.	4 WLH
Examination: Presentation (approx. 5 minutes) with written outline (max. 1 page) **Examination prerequisites:** Term paper (max. 15 pages); ungraded **Examination requirements:** Demonstration of the ability to structure and write clear scientific texts in the English language. Examination: Presentation (approx. 5 minutes) with handout in form of a scientific poster (1 page). Examination prerequisites: will be a written term paper in the form of a research proposal (max. 15 pages) completed in class and outside class.	6 C

Admission requirements:	**Recommended previous knowledge:**
none	none
Language:	**Person responsible for module:**
English	Prof. Dr. Kerstin Wiegand

Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.121: Scientific Methods and Project Design**	12 C 8 WLH

Learning outcome, core skills: This module is an interactive training in preparation for the bachelor thesis. It consists of two parts, which are tightly connected. Part (1) consists of the acquisition of theoretical and conceptual skills to implement a bachelor thesis project. Part (2) contains practical training in laboratory or field work to collect and analyze data. Part (1) includes: literature acquisition and management, citation techniques, research hypothesis development and research planning. The students learn how to strategically plan their bachelor thesis project, starting from the selection of a topic and title to the development of an individual research proposal up to the critical discussion of actual scientific publications in related fields. Part (2) includes: training in laboratory and field methods that can be applied to their Bachelor work. The students work on a small project and receive hands-on training in modern ecological techniques conducted under supervision. Finally, the students will present their own scientific work in an interdisciplinary discussion.	**Workload:** Attendance time: 112 h Self-study time: 248 h

Course: Theory and Concepts (Seminar)	2 WLH
Course: Advanced Methods (Practical course) *Contents*: Project with practical training and theory	6 WLH
Examination: Presentation (15 minutes, 30%) and term paper (max. 20 pages, 70%) **Examination requirements:** Presentation of the concept of the bachelor thesis and application of the acquired knowledge to a project. This requires knowledge on structural issues, literature acquisition, electronic literature sources and abilities to describe methods, report results, interpret results and correct citation.	12 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the study course recommended for semester 1, 2 and 3 of the program. Knowledge in statistics.
Language: English	**Person responsible for module:** Dr. Ines Teichert
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 6
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.122: Global Change**	6 C 4 WLH

Learning outcome, core skills: At the end of this course the students are expected to • have insight in the major components of the earth system and how they are connected, • understand how environmental processes and biogeochemical cycles are regulated by biosphere-hydrosphere-atmosphere feedbacks and how they are affected by global change through natural and anthropogenic processes, • be able to understand and evaluate simple biogeochmical models.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Global change (Lecture) *Contents*: Lecture, Modelling exercises, Seminar	4 WLH
Examination: Presentation (approx. 15 minutes; 50%) with written outline (max. 8 pages; 50%) **Examination requirements:** Knowledge about major global biogeochemical cycles, their components, fluxes and their interconnection; calculation/modelling exercises, statistical analysis, interactive discussions on interpretation of global biogeochemical cycles, being able to demonstrate scientific presentation and writing.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Edzo Veldkamp
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 6
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.701: Resource Assessment in Ecosystems**	6 C 4 WLH

Learning outcome, core skills: **The students will be trained** • to identify different types of resources in terrestrial ecosystems and forests in particular, • how to assess those resources (abundance, quality, etc.), • and how to design and conduct a scientifically sound study that aims at assessing an exemplary resource. **The students will acquire knowledge in the fields of:** • ecosystem assessment, resource identification • sampling approaches and measurement techniques • statistical analysis and scientific reporting of results • systemic approaches to ecosystems, incl. cybernetics and thermodynamics in biology	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Resource assessment in ecosystems (Lecture) *Contents*: The lecture will introduce various types of resources and present differences in their provision by different terrestrial ecosystems. Examples from several spatial scales will be used to create an understanding of possible challenges and scientific methods during resource assessment. Sampling techniques and instruments will be presented, quality and consistency of datasets will be addressed and statistical analysis techniques we be introduced. Basic principles of scientific reporting will be presented based on the datasets obtained from the laboratory course. System theory, cybernetics and holistic ecosystem approaches and thermodynamics in ecosystems will be introduced.	2 WLH
Course: Resource assessment in ecosystems (Practical course) *Contents*: During the lab course the students will plan, conduct and evaluate the assessment of exemplary resources. They will learn how to perform a scientifically sound study, beginning at an initial idea and ending with the evaluation of the results. During this process the students will learn to design a study under consideration of its feasibility, potential outcome, financial and technical restrictions, legal issues, statistical limitations, as well as ethics and practical knowledge when it comes to publishing the results.	2 WLH
Examination: Written examination (120 minutes) **Examination requirements:** Knowledge of resource types, definitions, basic statistics, sampling designs, data quality control, factors that need to be considered in study planning, basic principles of scientific reporting, basic knowledge in cybernetics, system theory, thermodynamics in ecosystems.	6 C

Admission requirements:	**Recommended previous knowledge:**
none	none

Language: English	**Person responsible for module:** Prof. Dr. rer. nat. Dominik Seidel
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 5
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.ES.702: Special Topics in Plant Ecophysiological Methods and Applications**	6 C 4 WLH

Learning outcome, core skills: Students will get advanced knowledge of scientific methods and procedures. They will acquire practical skills by active participation in a research project conducted under supervision. The students can choose one among several projects. They learn to develop the research question by literature research and discussion with the supervisor. They decide on the appropriate methods (e.g. field analyses, sterile multiplication and cultivation of plants for controlled experiments, tissue culture, application of stresses, analyses of plant responses by various analytical tools). The students will learn to collect, arrange and analyze relevant scientific data. They will learn how to interpret and present these results.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Plant Methods and Ecophysiological Applications (Practical course)	4 WLH
Examination: Term Paper (max. 20 pages) **Examination requirements:** Scientific hypotheses, experimental design, laboratory techniques, analysis, interpretation and scientific interpretation of research results	6 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course “Forest Botany and Tree Physiology”
Language: German, English	**Person responsible for module:** Dr. Ines Teichert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 5
Maximum number of students: 10	

Georg-August-Universität Göttingen **Module B.ES.703: Intraspecific Diversity of Plants**	6 C 4 WLH

Learning outcome, core skills: Students will learn to investigate the dynamics of intraspecific diversity in different types of ecosystems. This involves field sampling of important plants, DNA extraction from different tissues, laboratory analyses with various types of molecular markers, data analyses and interpretation. Students will learn practical steps to assess genetic diversity, and will be able to evaluate the use of DNA-based methods for applications in breeding, conservation, and ecosystem management.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Intraspecific diversity of plants (Lecture)	1 WLH
Course: DNA based methods to study biodiversity (Practical course) *Contents*: Workshops, laboratory exercise	3 WLH
Examination: Term Paper (max. 20 pages) **Examination requirements:** DNA markers and techniques, estimation of intraspecific diversity in different types of ecosystems, methods used for experimental sampling, DNA extraction from different tissues, laboratory techniques, data analyses and interpretation and application of results.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Gailing
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 5
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.704: Research Practicum**	6 C 4 WLH

Learning outcome, core skills: Students have a possibility to participate in a research work at an institution of their choice (also abroad) to learn new scientific methods and get additional experiences about variety of research topics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Research practicum (Practical course)	3 WLH
Course: Research practicum (Seminar)	1 WLH
Examination: Term Paper (max. 20 pages) **Examination requirements:** Laboratory methods, analysis, interpretation and scientific presentation of research results. In case of abroad practicum: a confirmation letter from the supervisor with a grade (if possible, in the German grade system)	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Gailing
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 5
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.705: Scientific Project**	12 C 3 WLH

Learning outcome, core skills: Advanced knowledge of scientific methods and procedures, and practical skills acquired by active participation in a research project conducted under supervision of a lecturer of the programme at the University of Goettingen or a respective supervisor at a foreign institution. Ability to analyze, interpret and present relevant scientific data. Duration: 6 weeks.	**Workload:** Attendance time: 60 h Self-study time: 300 h

Course: Scientific project (Practical course)	2 WLH
Course: Scientific project (Seminar)	1 WLH
Examination: Term PaperTerm paper (30 pages max.) (max. 30 pages) **Examination requirements:** Scientific hypotheses, experimental design, laboratory techniques, analysis, interpretation and scientific presentation of research results. In case of abroad practicum: a confirmation letter from the supervisor with a grade (if possible, in the German grade system).	12 C

Admission requirements: Conducted only together with the module B.ES.706 “Practical training in laboratory techniques”. Each student must get an approval from the ES programme’s coordinator 3 months before the start of work.	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Gailing
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 5
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.706: Practical Training in Laboratory Techniques**	18 C 4 WLH

Learning outcome, core skills: Advanced knowledge of scientific methods and procedures, and practical skills acquired by active participation in a research project conducted under supervision of a lecturer of the programme at the University of Goettingen or a respective supervisor at a foreign institution. Ability to analyze, interpret and present relevant scientific data. Duration: 6 weeks.	**Workload:** Attendance time: 90 h Self-study time: 450 h

Course: Practical training in laboratory techniques (Practical course)	3 WLH
Course: Practical training in laboratory techniques (Seminar)	1 WLH
Examination: Minutes / Lab report (max. 10 pages), not graded **Examination requirements:** Experimental design, laboratory techniques, analysis and interpretation of research results. In case of abroad practicum: a confirmation letter from the supervisor with a result.	18 C

Admission requirements: Conducted only together with the module B.ES.705 “Scientific project”. Each student must get an approval from the ES programme’s coordinator 3 months before the start of work.	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Gailing
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 5
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.ES.707: System Science and Knowledge Transfer**	6 C 4 WLH

Learning outcome, core skills: In this module, students acquire the ability to analyse forestry issues using the systems approach and transfer the scientific results to policy and practice.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Systems Thinking and Systems Dynamics (Lecture) *Contents*: Lecture, Exercise by integrated case study. System thinking is analysing socio-ecological systems by looking for emergent behaviour from interacting components (holistic approach). Students become familiar with cause-effect relationships and feedback systems and conduct a case study.	2 WLH
Course: Management of research and knowledge transfer (Lecture) *Contents*: Lecture, Exercise by integrated case study. Multidisciplinary management techniques are shown for linking system modelling with different disciplines. In addition transdisciplinary management based on the RIU model approach is applied to transfer the scientific information into policy and practice. The integrated case study is linking both parts of the module.	2 WLH
Examination: Oral presentation (15 minutes, 50%) and term paper (max. 10 pages 50%) **Examination requirements:** Understanding the basic concepts of Systems Thinking, modelling dynamical systems using causal-loop-diagrams, application of the gained knowledge to a real world system. Basic knowledge in management of inter- and transdisciplinary research and in transfer of scientific information into practice.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Ronald Bialozyt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:** 5
Maximum number of students: 20	