



GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

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Inhaltsverzeichnis

Seite

Fakultät für Agrarwissenschaften:

Modulverzeichnis zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang „Integrated Plant and Animal Breeding“	1581
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Amtliche Mitteilungen II

Herausgegeben von der Präsidentin der Georg-August-Universität Göttingen

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Fakultät für Agrarwissenschaften:

Nach Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 20.12.2018 hat das Präsidium der Georg-August-Universität Göttingen am 12.03.2019 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang „Integrated Plant and Animal Breeding“ genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Die Neufassung des Modulverzeichnisses tritt nach seiner Bekanntmachung in den Amtlichen Mitteilungen II zum 01.04.2019 in Kraft.

Modulverzeichnis

**zu der Prüfungs- und Studienordnung für
den konsekutiven Master-Studiengang
"Integrated Plant and Animal Breeding" (Amtliche
Mitteilungen I Nr. 7/2019 S. 60, zuletzt geändert
durch Amtliche Mitteilungen I Nr. 15/2019 S. 186)**

Module

B.Bio.117: Genomanalyse.....	1588
M.Agr.0020: Genome analysis and application of markers in plantbreeding.....	1589
M.Agr.0093: Environmental Impact of Genetically Modified Plants.....	1590
M.Agr.0114: Sicherheitsbewertung biotechnologischer Verfahren in der Pflanzenzüchtung.....	1591
M.Agr.0126: Quantitative genetics and population genetics.....	1593
M.Agr.0127: Breeding schemes and programs in plant and animal breeding.....	1594
M.Agr.0128: Statistical genetics, breeding informatics and experimental design.....	1595
M.Agr.0129: Poultry breeding and genetics.....	1597
M.Agr.0130: Breeding informatics.....	1599
M.Agr.0131: Biotechnology and molecular genetics in plant and animal breeding.....	1600
M.Agr.0132: Molecular and biotechnological methods in plant and animal breeding.....	1601
M.Agr.0133: Genetic resources.....	1602
M.Agr.0134: Legal issues in plant and animal breeding.....	1604
M.Agr.0135: Seed marketing.....	1605
M.Agr.0136: Journal Club: Key papers in animal and plant breeding.....	1606
M.Agr.0137: Internship.....	1607
M.Agr.0138: Selection theory, design and optimisation of breeding programs.....	1608
M.Agr.0141: Data Analysis with R.....	1609
M.Agr.0157: Applied Machine Learning in Agriculture with R.....	1610
M.Agr.0164: Applied Bioinformatics with R.....	1612
M.Agr.0165: Introduction to the molecular genetic analysis of plant genetic resources.....	1614
M.Cp.0004: Plant Diseases and Pests in Temperate Climate Zones.....	1616
M.Cp.0016: Practical Statistics and Experimental Design in Agriculture.....	1617
M.Forst.1524: Biotechnology and forest genetics.....	1618
M.SIA.A02M: Epidemiology of international and tropical animal infectious diseases.....	1620
M.SIA.A14: Organic livestock farming under temperate conditions.....	1622
M.SIA.E11: Socioeconomics of Rural Development and Food Security.....	1624
M.SIA.E13M: Microeconomic Theory and Quantitative Methods of Agricultural Production.....	1625
M.SIA.I14M: GIS and remote sensing in agriculture.....	1626

M.SIA.P13: Agrobiodiversity and plant genetic resources in the tropics..... 1628

Übersicht nach Modulgruppen

I. Master-Studiengang "Integrated Plant and Animal Breeding"

1. Block A - Compulsory Modules

The following compulsory modules worth overall 27 C must be successfully completed.

M.Agr.0126: Quantitative genetics and population genetics (6 C, 6 SWS).....	1593
M.Agr.0127: Breeding schemes and programs in plant and animal breeding (6 C, 4 SWS).....	1594
M.Agr.0128: Statistical genetics, breeding informatics and experimental design (6 C, 4 SWS).....	1595
M.Agr.0137: Internship (9 C, 6 SWS).....	1607

2. Block B - Elective compulsory modules A

Out of the following elective compulsory modules at least four modules worth overall at least 21 C must be successfully completed.

B.Bio.117: Genomanalyse (10 C, 7 SWS).....	1588
M.Agr.0020: Genome analysis and application of markers in plantbreeding (6 C, 4 SWS).....	1589
M.Agr.0093: Environmental Impact of Genetically Modified Plants (3 C, 2 SWS).....	1590
M.Agr.0114: Sicherheitsbewertung biotechnologischer Verfahren in der Pflanzenzüchtung (6 C, 4 SWS).....	1591
M.Agr.0129: Poultry breeding and genetics (6 C, 4 SWS).....	1597
M.Agr.0130: Breeding informatics (6 C, 4 SWS).....	1599
M.Agr.0132: Molecular and biotechnological methods in plant and animal breeding (6 C, 4 SWS)..	1601
M.Agr.0133: Genetic resources (6 C, 4 SWS).....	1602
M.Agr.0134: Legal issues in plant and animal breeding (3 C, 2 SWS).....	1604
M.Agr.0135: Seed marketing (6 C, 4 SWS).....	1605
M.Agr.0136: Journal Club: Key papers in animal and plant breeding (6 C, 4 SWS).....	1606
M.Agr.0141: Data Analysis with R (3 C, 2 SWS).....	1609
M.Agr.0157: Applied Machine Learning in Agriculture with R (6 C, 4 SWS).....	1610
M.Agr.0164: Applied Bioinformatics with R (6 C, 4 SWS).....	1612
M.Agr.0165: Introduction to the molecular genetic analysis of plant genetic resources (6 C, 4 SWS).....	1614
M.Cp.0004: Plant Diseases and Pests in Temperate Climate Zones (6 C, 4 SWS).....	1616
M.Cp.0016: Practical Statistics and Experimental Design in Agriculture (6 C, 4 SWS).....	1617

M.Forst.1524: Biotechnology and forest genetics (6 C, 4 SWS).....	1618
M.SIA.A02M: Epidemiology of international and tropical animal infectious diseases (6 C, 4 SWS)..	1620
M.SIA.A14: Organic livestock farming under temperate conditions (6 C, 4 SWS).....	1622
M.SIA.E11: Socioeconomics of Rural Development and Food Security (6 C, 4 SWS).....	1624
M.SIA.E13M: Microeconomic Theory and Quantitative Methods of Agricultural Production (6 C, 4 SWS).....	1625
M.SIA.I14M: GIS and remote sensing in agriculture (6 C, 4 SWS).....	1626
M.SIA.P13: Agrobiodiversity and plant genetic resources in the tropics (6 C, 4 SWS).....	1628

3. Block C - Elective compulsory modules B

At least five elective compulsory modules worth at least 30 C must be successfully completed. Students can earn the credits from elective modules from the other master study programmes of the faculty of agriculture, University of Goettingen, from other agricultural faculties, from similar courses at other universities.

4. Block D - Key competencies

The following two compulsory modules worth overall 12 C must be successfully completed.

M.Agr.0131: Biotechnology and molecular genetics in plant and animal breeding (6 C, 4 SWS).....	1600
M.Agr.0138: Selection theory, design and optimisation of breeding programs (6 C, 4 SWS).....	1608

5. Master's thesis

Completion of the Master's thesis is worth 24 Credits.

6. Colloquium for the Master's thesis

Successful completion of the colloquium for the Master's thesis is worth 6 Credits.

Georg-August-Universität Göttingen Modul B.Bio.117: Genomanalyse <i>English title: Genome analysis</i>		10 C 7 SWS
Lernziele/Kompetenzen: Die Studierenden lernen grundlegende Methoden der Genomanalyse kennen. Nach erfolgreicher Teilnahme an diesem Modul verfügen sie über Grundkenntnisse in den Bereichen Genomsequenzierung, Funktion und Struktur von Genomen und Algorithmen zur bioinformatischen Genomanalyse. Im praktischen Teil des Moduls erwerben die Studierenden Grundkenntnisse des Betriebssystems LINUX bzw. UNIX und der Programmiersprache PERL bzw. einer vergleichbaren Sprache. Sie sind in der Lage, einfache Programme zu entwerfen und zu implementieren, um grundlegende Aufgaben der Datenverarbeitung selbständig in einer UNIX/LINUX-Umgebung zu lösen.		Arbeitsaufwand: Präsenzzeit: 140 Stunden Selbststudium: 160 Stunden
Lehrveranstaltungen: 1. LINUX und PERL für Biologen (Praktikum) <i>Angebotshäufigkeit:</i> block course in lecture-free time in winter 2. Genomanalyse (Vorlesung, Übung) <i>Angebotshäufigkeit:</i> jedes Sommersemester		3 SWS 4 SWS
Prüfung: Mündlich (ca. 30 Minuten) Prüfungsvorleistungen: Teilnahme am Praktikum mit abschließendem schriftlichem Test Prüfungsanforderungen: Grundlegende Methoden der Genomanalyse, insbesondere Genomassemblierung, Sequenzalignment, und grundlegende Algorithmen zur Rekonstruktion phylogenetischer Bäume auf der Grundlage von Genomsequenzen.		10 C
Zugangsvoraussetzungen: BSc Bio: mindestens 40 C aus dem ersten Studienabschnitt	Empfohlene Vorkenntnisse: keine	
Sprache: Deutsch	Modulverantwortliche[r]: Prof. Dr. Burkhard Morgenstern	
Angebotshäufigkeit: Praktikum jedes WiSe; Vorlesung jedes SoSe	Dauer: 1 Semester	
Wiederholbarkeit: zweimalig	Empfohlenes Fachsemester: 3 - 6	
Maximale Studierendenzahl: 10		
Bemerkungen: Für die Vorlesung werden grundlegende Programmierkenntnisse (wie beispielsweise aus dem Praktikum) erwartet, weshalb der LINUX/PERL-Kurs vor der Vorlesung absolviert werden sollte.		

Georg-August-Universität Göttingen Modul M.Agr.0020: Genome analysis and application of markers in plantbreeding <i>English title: Genome analysis and application of markers in plantbreeding</i>		6 C 4 SWS
Lernziele/Kompetenzen: Studierende erlernen ihre Kenntnisse in klassischer Genetik auf Problemlösungen in züchterischen Situationen anzuwenden. Studierende erlernen selbständig sich Kenntnisse im Umgang mit großen Datensätzen anzueignen und sich in entsprechende Software einzuarbeiten.		Arbeitsaufwand: Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Genome analysis and application of markers in plantbreeding (Vorlesung, Übung) <i>Inhalte:</i> Überblick über verschiedene Typen von molekularen Markern. Schätzung von genetischen Distanzen. Grundlagen der klassischen Genetik zur Kopplungsanalyse. Konstruktion von Kopplungskarten. Markergestützte Rückkreuzung. Kartierung von QTL: Theorie und praktische Übungen mit großen Datensätzen aus früheren Experimenten. Grundlagen der Bioinformatik: Vergleich von DNA Sequenzen.		4 SWS
Prüfung: Klausur (90 Minuten) Prüfungsvorleistungen: Abgabe der Lösung von Übungsaufgaben Prüfungsanforderungen: Grundlagenkenntnisse in klassischen und molekularen Methoden der Kartierung von Genen. Basiskonntnisse im Einsatz molekularer Marker in der Pflanzenzüchtung.		6 C
Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: keine	
Sprache: Englisch	Modulverantwortliche[r]: N. N.	
Angebotshäufigkeit: jedes Wintersemester	Dauer: 1 Semester	
Wiederholbarkeit: zweimalig	Empfohlenes Fachsemester:	
Maximale Studierendenzahl: 20		

Georg-August-Universität Göttingen		3 C 2 WLH
Module M.Agr.0093: Environmental impact of genetically modified plant		
Learning outcome, core skills: Students should gain an understanding on interactions of genetically modified crops and the environment, learn the fundamentals of risk assessment and general surveillance concepts, should be able to evaluate studies on risks of GMOs to the environment		Workload: Attendance time: 22 h Self-study time: 68 h
Course: Environmental Impact of Genetically Modified Plants (Lecture, Seminar) <i>Contents:</i> Overview on genetically modified crop plants, mode of action of transgenic traits, interactions with non target organisms, national legislation procedures, transgenic crops and sustainable agriculture, concepts of environmental risk assessments, resistance management of transgenic traits; biodiversity and genetically modified crops, global perspectives of transgenic crops		2 WLH
Examination: Written examination (45 minutes) Examination prerequisites: Presentation (approx. 15 min.) Examination requirements: Concepts of risk assessment of genetically modified crops, mode of action of genetically modified crops, interactions with the environment, case studies		3 C
Admission requirements: none	Recommended previous knowledge: none	
Language: English	Person responsible for module: Prof. Dr. Stefan Vidal	
Course frequency: each summer semester	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: 20		

<p>Georg-August-Universität Göttingen</p> <p>Modul M.Agr.0114: Sicherheitsbewertung biotechnologischer Verfahren in der Pflanzenzüchtung</p> <p><i>English title: Biosafety evaluation of biotechnological approaches in plant breeding</i></p>	<p>6 C 4 SWS</p>
<p>Lernziele/Kompetenzen:</p> <p>Vertieftes Verständnis von Sicherheitsbewertung und Sicherheitsmanagement biotechnologischer (einschließlich gentechnischer) Verfahren in der Pflanzenzüchtung; Erkennen komplexer Zusammenhänge zwischen Sicherheitsforschung, Sicherheitsbewertung und -management sowie zwischen gesetzlichen Regulierungen und wissenschaftlich-technischem Fortschritt auf nationaler und internationaler Ebene.</p>	<p>Arbeitsaufwand:</p> <p>Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden</p>
<p>Lehrveranstaltungen:</p> <p>1. Anwendung und Rechtsrahmen gentechnischer Verfahren (Vorlesung, Exkursion) <i>Inhalte:</i> Sicherheitsbewertung, Beantragung und Durchführung gentechnischer Arbeiten in Labor und Gewächshaus: Rechtsrahmen, Kriterien, Voraussetzungen; Monitoring der Auswirkungen der Markteinführung gentechnisch veränderter Pflanzen: Zielsetzung, Rechtsrahmen, kritische Betrachtung (Zielstellung, Aufwand, Nutzen) ausgewählter Methoden; Gesetzliche Regelungen/Voraussetzungen für Freisetzungsversuche; Durchführung der Sicherheitsbewertung und Versuchsplanung, Beantragung, Versuchsdurchführung; Bedeutung und Notwendigkeit von Koexistenz, Situation in Deutschland/Europa, Confinement-Strategien.</p> <p>2. Anwendung und Rechtsrahmen biotechnologischer Verfahren allgemein (Vorlesung, Exkursion) <i>Inhalte:</i> Anwendung und juristische Bewertung biotechnologischer Verfahren in der Pflanzenzüchtung; Sicherheitsforschung, -bewertung und -management; Pflanzen als Produktionsplattform - Perspektiven und Sicherheitsbewertung.</p> <p>3. Neue Züchtungsverfahren in der Anwendung (Vorlesung, Exkursion) <i>Inhalte:</i> Gene targeting/editing, gene drive; vergleichende Auswirkung „klassischer“ und „neuer“ Züchtungsmethoden; Pflanzengenom- und Transkriptomanalyse, Datenbanken; next generation sequencing, Bioinformatik; Bewertung und Regulierung ausgewählter Züchtungsverfahren</p>	
<p>Prüfung: Klausur (90 Minuten)</p> <p>Prüfungsanforderungen:</p> <p>Anwendung und Rechtsrahmen gentechnischer Verfahren:</p> <p>Vertieftes Verständnis von gentechnischem Arbeiten in Labor und Freiland; Fallstudien; Monitoring und Koexistenz, Planung und Durchführung gentechnischer Versuche im Freiland;</p> <p>Anwendung und Rechtsrahmen biotechnologischer Verfahren allgemein:</p> <p>Vertieftes Verständnis von Sicherheitsbewertung und Sicherheitsmanagement biotechnologischer Verfahren in der Pflanzenzüchtung; Fallstudien GV Pflanzen für</p>	<p>6 C</p>

<p>Futter- und Nahrungsmittelanwendungen, GV Pflanzen als Produktionsplattform für industrielle & pharmazeutische Produkte sowie Energie</p> <p>Neue Züchtungsverfahren in der Anwendung:</p> <p>Vertieftes Verständnis und Sicherheitsbewertung neuer Züchtungsverfahren einschließlich Gentechnik und genome editing; Fallstudien vergleichende Sicherheitsbewertung und Bioinformatik</p>	
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<p>Zugangsvoraussetzungen: keine</p>	<p>Empfohlene Vorkenntnisse: keine</p>
<p>Sprache: Deutsch</p>	<p>Modulverantwortliche[r]: Dr. Ralf Wilhelm</p>
<p>Angebotshäufigkeit: jedes Sommersemester</p>	<p>Dauer: 1 Semester</p>
<p>Wiederholbarkeit: zweimalig</p>	<p>Empfohlenes Fachsemester:</p>
<p>Maximale Studierendenzahl: 50</p>	

Georg-August-Universität Göttingen		6 C 6 WLH
Module M.Agr.0126: Quantitative genetics and population genetics		
Learning outcome, core skills: Advanced knowledge of the basic model of quantitative genetics, genetic effects and parameters, breeding values and variances. Similarity between relatives, inbreeding, crossbreeding and heterosis. Dynamics of genetic variability in limited populations.		Workload: Attendance time: 84 h Self-study time: 96 h
Course: Quantitative genetics and population genetics (Lecture, Exercise) <i>Contents:</i> The genetic composition of a population in a single locus model, changes of gene and genotype frequencies, the polygenic model, components of phenotypic variance, relationship and inbreeding, heterosis and inbreeding depression, genetic drift, linkage disequilibrium, selection signatures. All contents are initially taught in theory and are consolidated in practical computer exercises (some with real data). Literature: Falconer & Mackay, Introduction to Quantitative Genetics (Prentice Hall), Lynch and Walsh, Genetics and Analysis of Quantitative Traits (Sinauer)		6 WLH
Examination: Written examination (90 minutes) Examination requirements: Advanced knowledge of the quantitative-genetic and population genetic basics of breeding, ability to apply appropriate methods to real data sets. Final exam with practical examination on computer.		6 C
Admission requirements: none	Recommended previous knowledge: Basic knowledge of plant and animal breeding	
Language: English	Person responsible for module: Prof. Dr. Henner Simianer	
Course frequency: each winter semester	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester: Master: 1	
Maximum number of students: 20		

Georg-August-Universität Göttingen Module M.Agr.0127: Breeding schemes and programs in plant and animal breeding	6 C 4 WLH
Learning outcome, core skills: Students will learn the basic elements and structures of breeding programs in plant and animal breeding. They understand the relationship between biological characteristics of the crop or livestock species and the specific design of the breeding program. The students know the four breeding categories and design possibilities of breeding programs for self-pollination, cross-pollination and vegetative and clonally propagated crops. They learn breeding programs for major crops and livestock species.	Workload: Attendance time: 56 h Self-study time: 124 h
Course: Breeding schemes and programs in plant and animal breeding (Lecture, Excursion) <i>Contents:</i> Design of breeding programs. Basic elements of breeding programs: Breeding objectives and breeding planning, performance testing, selection and mate selection, use of biotechnologies, transfer of breeding progress in the production level, monitoring of the breeding progress. Breeding program structures in the most important crop species: cereals, corn, rape, sugar beet, specialty crops. Breeding program structures in the main livestock species: dairy cattle, pigs, poultry, beef cattle, small ruminants. Breeding program structures in forest genetics.	4 WLH
Examination: Written exam (45 minutes, 50%) and Presentation (about 20 minutes) with written outline (max. 10 pages) (50%) Examination requirements: Profound knowledge of basic breeding program structures and elements of breeding programs and their concrete implementation to various crops and livestock. Elaboration of the breeding planning for a livestock or crop species.	6 C
Admission requirements: none	Recommended previous knowledge: none
Language: English	Person responsible for module: Prof. Dr. Henner Simianer
Course frequency: each summer semester	Duration: 1 semester[s]
Number of repeat examinations permitted: twice	Recommended semester: Master: 1
Maximum number of students: 20	
Additional notes and regulations: Mandatory excursions to practical plant breeding and animal breeding programs.	

Georg-August-Universität Göttingen		6 C 4 WLH
Module M.Agr.0128: Statistical genetics, breeding informatics and experimental design		
Learning outcome, core skills: Novel biotechnological methods allow the production of very large data sets (gene sequences, genotypes, transcriptomes) at decreasing costs. Students learn about statistical and computational methods to use these records for breeding issues. Furthermore, the main experimental designs to plan, implement, and evaluate targeted and efficient experiments for data generation will be treated.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Statistical genetics, breeding informatics and experimental design (Lecture, Exercise) <i>Contents:</i> <ul style="list-style-type: none"> • Gene Expression Analysis • Genome-wide association analysis • QTL mapping • Statistical hypothesis testing • Regression methods • Analysis of variance • Multiple testing • Experimental designs (block designs, randomized designs, Latin squares) • Sample size estimation • Introduction to programming • Fundamentals of databases Literature: Andrea Foulkes: Applied Statistical Genetics with R		4 WLH
Examination: Written examination (60 minutes) Examination requirements: Profound knowledge of statistics and informatics methods to use them for breeding issues.		6 C
Admission requirements: none	Recommended previous knowledge: Basics in statistics and genetics	
Language: English	Person responsible for module: Prof. Dr. Armin O. Schmitt	
Course frequency: each summer semester	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester: Master: 2	
Maximum number of students: 20		
Additional notes and regulations: Course frequency:		

Summer 2019 and winter 2019/20. Afterwards only winter.

Georg-August-Universität Göttingen		6 C
Module M.Agr.0129: Poultry breeding and genetics		4 WLH
Learning outcome, core skills: The module teaches substantiated and application-orientated understandings of the poultry breeding sector. The main organizational and technological elements of the current breeding programs as well as their optimization to future breeding challenges will be provided. Thereby, breeding strategies of relevant economic traits will be shown concentrating on the development of selection strategies to improve functional traits (adaption to climate, disease resistance, behavior, reproduction, product quality, metabolic dysfunction). Students will learn the application of quantitative and molecular genetic technologies for the applied research in poultry breeding.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Poultry breeding and genetics (Lecture, Excursion) <i>Contents:</i> <ul style="list-style-type: none"> • Structure, Organization and Economics of Poultry Breeding • Breeding Strategies for primary and functional traits in poultry and water fowl (genetics and breeding in reproduction, feed conversion, growth, product quality, immune system, disease resistance, behavior and well-being, environmentaladaption and metabolic stability). This includes particularly: <ul style="list-style-type: none"> • Methods of phenotyping and performance testing • Estimation of breeding values (conventional and genomic) • Selection index and BLUP • Genome-wide association studies (GWAS) and QTL mapping • Omics • Software application 		4 WLH
Examination: Written examination (90 minutes) Examination prerequisites: Attendance to the mandatory two-day excursion Examination requirements: Profound knowledge about applied poultry breeding.		6 C
Admission requirements: none	Recommended previous knowledge: Grundlagen der Tierzucht	
Language: English	Person responsible for module: Dr. Ahmad Reza Sharifi	
Course frequency: each winter semester	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: 30		

Additional notes and regulations:

Attendance to the mandatory two-day excursion.

Georg-August-Universität Göttingen		6 C
Module M.Agr.0130: Breeding informatics		4 WLH
Learning outcome, core skills: Students acquire their knowledge of informatics methods to evaluate large datasets for breeding issues.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Breeding informatics (Lecture, Exercise) <i>Contents:</i> <ul style="list-style-type: none"> • Basics of Linux operating system • Basic data structures • Programming in R • Regular expressions • Design and implementation of pipelines for data analysis • Shell scripts on Linux (gawk, sed) • Relation of genotype - phenotype • Basic concepts of bioinformatics 		4 WLH
Examination: Written examination (90 minutes) Examination requirements: Profound knowledge of informatics methods to evaluate large datasets for breeding issues.		6 C
Admission requirements: none	Recommended previous knowledge: Basic knowledge of molecular genetics, statistics, programming	
Language: English	Person responsible for module: Prof. Dr. Armin O. Schmitt	
Course frequency: each winter semester	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: 20		
Additional notes and regulations: Course frequency: Winter 18/19 and summer 2020. Afterwards only summer.		

Georg-August-Universität Göttingen		6 C 4 WLH
Module M.Agr.0131: Biotechnology and molecular genetics in plant and animal breeding		
Learning outcome, core skills: Profound knowledge of biotechnologies to decipher phenotypes and traits for plant and animal breeding. Skills to use appropriate molecular genetic tools to elucidate the genetic basis of traits. Development of creativity and independent as well as globally thinking to solve complex breeding challenges; effective communication skills (both orally and written); self-learners.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Biotechnology and molecular genetics in plant and animal breeding (Lecture, Excursion) <i>Contents:</i> Basics of genetics (Mendelian inheritance; karyograms; DNA, RNA and protein; gene structure; epigenetics), Biotechnologies for animal breeding (Artificial Insemination; Spermsexing; embryo transfer and associated techniques such as in vitro fertilization, embryo sexing, stem cells, cloning), Biotechnologies for plant breeding (in vitro cloning, induction of haploids, direct and indirect genetic transformation, interspecific sexual and somatic hybridization), Molecular genetics (PCR; qPCR; Recombinant DNA Technology; DNA markers; miRNA; Sanger sequencing; expression analysis; Next Generation Sequencing; array techniques; cytogenetics; proteomics; genome editing techniques). Literature: Clark & Pazdernik: Biotechnology (Academic Cell Publishing); Pineda & Dooley: Veterinary Endocrinology and Reproduction (Blackwell Publishing); Squires: Applied Animal Endocrinology (CABI); Krebs, Kirkpatrick, Goldstein: Lewin's Gene XI (Jones and Bartlett Publishing); Brown: Gene cloning and DNA analysis (Blackwell Science); Journal: Trends in Plant Science (Elsevier Ltd.)		4 WLH
Examination: Written examination (90 minutes) Examination requirements: The examinee should show the potential to solve breeding challenges applying the best biotechnologies and most accurate molecular genetic tools.		6 C
Admission requirements: none	Recommended previous knowledge: Basics in animal and plant breeding	
Language: English	Person responsible for module: Prof. Dr. Jens Tetens	
Course frequency: each winter semester	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester: Master: 1	
Maximum number of students: 20		

Georg-August-Universität Göttingen Module M.Agr.0132: Molecular and biotechnological methods in plant and animal breeding	6 C 4 WLH
Learning outcome, core skills: In addition to the theoretical background (Module M.Agr.0131 (Biotechnology and molecular genetics in plant and animal breeding)), the students should improve their basic knowledge in biotechnologies and molecular genetics by learning hand-on skills in the lab. The students should be capable to perform experiments on their own and to present them in an adequate manner.	Workload: Attendance time: 56 h Self-study time: 124 h
Course: Molecular and biotechnological methods in plant and animal breeding (Block course, Practical course) <i>Contents:</i> Sample collection; DNA and RNA isolation; Sanger Sequencing including the usage of appropriate software programs; Separation and visualization of nucleic acids; qualitative and quantitative PCR; ELISA assays to determine hormone profiles or as a pregnancy/non pregnancy testing system; microsatellites; SNP; AFLP; storage of DNA and RNA; semen evaluation; in vitro generation and genetic analyses of embryos; direct and indirect transformation; protoplasts, in vitro propagation, androgenesis and gynogenesis; gene cloning. Literature: e.g. Current Protocols in molecular biology; A practical guide to basic laboratory endocrinology: Introduction to Plant Biotechnology	4 WLH
Examination: Term paper (max. 40 pages, 80%) and presentation (about 10 minutes, 20%) Examination requirements: The examinees should provide detailed information in their term paper (written as protocols) including the biological background of the methods. The examinee should show its independent ability to conduct experiments in the lab.	6 C
Admission requirements: M.Agr.0131	Recommended previous knowledge: none
Language: English	Person responsible for module: Prof. Dr. Jens Tetens
Course frequency: each summer semester	Duration: 1 semester[s]
Number of repeat examinations permitted: twice	Recommended semester: Master: 2
Maximum number of students: 20	

Georg-August-Universität Göttingen		6 C
Module M.Agr.0133: Genetic resources		4 WLH
Learning outcome, core skills: Students learn the value of genetic resources for crop and livestock and know the history, political meaning and the institutions of the global system for the conservation of plant and animal genetic resources. They know methods for molecular and phenotypic characterization, and different statistical methods to evaluate and quantify genetic diversity. The students are familiar with different technological approaches (in vivo, in vitro) for the conservation and management of genetic resources. They know principles for prioritization in the conservation of genetic resources and can apply them to a practical example. The students understand principles and methods for the utilization of genetic resources in breeding programs.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Genetic resources (Lecture, Seminar) <i>Contents:</i> Definition of genetic resources and gene pools at different hierarchical levels. Centers of diversity and domestication, concepts of conservation. Methods for molecular and phenotypic characterization in plants and animals. Crossability, genetic differentiation and adaptation of plant and animal genetic resources. Measures of genomic diversity within and between animal populations. Wright's F-statistics, genetic distances and different approaches of cluster analyses, principal component analysis, phylogenetic trees and model-based clustering. Prioritization for conservation. Implementation of analytical methods with appropriate software. Utilization of genetic resources in breeding programs, cross breeding and introgression via breeding or molecular introgression. <i>Mandatory excursion to the gene bank at Gatersleben</i> <i>Mandatory excursion to the German gene bank of farm animals at FLI-ING Mariensee</i> <i>Literature:</i> FAO (2015) The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture		4 WLH
Examination: Written exam (45 minutes, 50%) and presentation (about 20 minutes, 50%) Examination requirements: Presentation of an overview of genetic resources and their use in a livestock or crop species. Profound knowledge of the underlying principles and methodological approaches to assess, conserve, prioritize and use genetic diversity in crops and livestock.		6 C
Admission requirements: none	Recommended previous knowledge: Basics of plant and animal breeding, Molecular Genetics	
Language: English	Person responsible for module: Prof. Dr. Nils Stein	
Course frequency: each winter semester; Start WS19/20	Duration: 1 semester[s]	

Number of repeat examinations permitted: twice	Recommended semester:
Maximum number of students: 20	

Georg-August-Universität Göttingen		3 C 2 WLH
Module M.Agr.0134: Legal issues in plant and animal breeding		
Learning outcome, core skills: The students know the relevant laws, regulations and procedures for plant and animal breeding in the areas of patent law, plant variety rights, plant variety protection, animal breeding, animal protection. Students know the legal basis for genetically modified organisms in the EU and globally. The students gain a deeper understanding of the importance of legal issues in breeding.		Workload: Attendance time: 26 h Self-study time: 64 h
Course: Legal issues in plant and animal breeding (Lecture, Seminar) <i>Contents:</i> Legal issues in plant and animal breeding (Lecture and Seminar) Contents: International intellectual property rights, biological patents, agreements on genetic resources, GMO laws and regulations incl. The preparatory phase of European legislation for modern biological breeding tools for genome editing. In terms of plant breeding, the module covers the following topics: plant breeders 'rights, European and German breeders' rights and marketing rights for seeds including procedures for testing and acceptance of varieties and operating license obtained seed. Regarding the animal breeding, the module covers the following topics: German animal breeding law, European legal framework, animal breeding related aspects of animal welfare legislation, legal regulations on animal testing, legal regulations of international trade with breeding animals and breeding products. Literature: Plant Variety Protection Law, Animal Breeding Law, Patent Law, regulation on genetically modified food and feed		2 WLH
Examination: Written examination (45 minutes) Examination requirements: Profound knowledge of all aspects of the legal basis of plant and animal breeding. Preparation of a case study on legal issues.		3 C
Admission requirements: none	Recommended previous knowledge: none	
Language: English	Person responsible for module: Prof. Dr. Henner Simianer	
Course frequency: each winter semester; ab WS19/20	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: 20		

Georg-August-Universität Göttingen		6 C
Module M.Agr.0135: Seed marketing		4 WLH
Learning outcome, core skills: Students can apply the tools of marketing to the specifics of the researchintensive seed market. They will be able to apply modern research methods in order to collect information on agricultural procurement processes and public settings. On this basis they can develop targeted strategies for national and international markets. They know customized concepts and methods of distribution.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Seed marketing (Seminar) <i>Contents:</i> The marketing of seed is a hitherto largely unexplored field of research. In the researchoriented master's degree program, the students will learn the basics of the businessto- business marketing (positioning, market segmentation, competitive strategies, international marketing, marketing tools, sales management) and its application to the purchasing behavior of farmers. Since the seed market is a socially critical debated topic, fundamentals of public relations and the corporate social responsibility are taught. In a project report in the second part of the seminar, students will elaborate their own studies on current aspects of the seed marketing and present it in a presentation.		4 WLH
Examination: Written exam (60 minutes, 50%) and presentation (about 30 minutes, 50%) Examination requirements: Students show in the exam that they know the basics of seed marketing. In a scientific presentation they can demonstrate that they can apply this knowledge to current problems of the subject and are able to transfer their knowledge.		6 C
Admission requirements: none	Recommended previous knowledge: Basic knowledge of marketing and market research (incl. statistics)	
Language: English	Person responsible for module: Prof. Dr. Achim Spiller	
Course frequency: Every 4 Semester. Begin WS 2017/2018	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester: Master: 2 - 4	
Maximum number of students: 30		

Georg-August-Universität Göttingen Module M.Agr.0136: Journal Club: Key papers in animal and plant breeding	6 C 4 WLH
Learning outcome, core skills: Students gain competences in the opening and discussion of a scientific topic by using the literature in the field of plant and animal breeding. They also obtain skills in oral and written presentation of their investigation.	Workload: Attendance time: 56 h Self-study time: 124 h
Course: Journal Club: Key papers in animal and plant breeding (Lecture, Seminar) <i>Contents:</i> Teaching of methods for collecting and using of scientific contents and papers for a specific topic. Ability to discuss scientific texts in a deepened substantive way on the basis of a comprehensive literature review.	4 WLH
Examination: Presentation (about 20 minutes) with written outline (max. 10 pages) Examination prerequisites: Regular participation in 10 seminars Examination requirements: Preparation of a literature based seminar presentation including discussion and a short draft, preparation of a co-moderation and discussion leading, attendance to seminars.	6 C
Admission requirements: none	Recommended previous knowledge: none
Language: English	Person responsible for module: Prof. Dr. Jens Tetens
Course frequency: each semester	Duration: 2 semester[s]
Number of repeat examinations permitted: twice	Recommended semester:
Maximum number of students: 20	

Georg-August-Universität Göttingen		9 C
Module M.Agr.0137: Internship		6 WLH
Learning outcome, core skills: Specialized knowledge of the respective field, social competences (working organization, teamwork, interdisciplinary working, flexibility), applied methodical competences.		Workload: Attendance time: 240 h Self-study time: 30 h
Course: Internship (Internship) <i>Contents:</i> Practical working in different areas of plant and animal breeding (industry, departmental research, consulting). Insights to working methods, areas of responsibility and the everyday professional life in plant and animal breeding. Acquisition of practical and applied knowledge and skills. Duration of Internship: 6 weeks		6 WLH
Examination: Term paper (max. 20 pages, 50%) and presentation (about 20 minutes, 50%) Examination requirements: Practical working in different areas of plant and animal breeding, internship report and presentation.		9 C
Admission requirements: none	Recommended previous knowledge: none	
Language: English	Person responsible for module: Prof. Dr. Henner Simianer	
Course frequency: each semester; Start WS17/18	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: 20		

Georg-August-Universität Göttingen Module M.Agr.0138: Selection theory, design and optimisation of breeding programs	6 C 4 WLH
Learning outcome, core skills: Students are familiar with the theoretical basics of the selection theory even for complex cases (direct and correlated breeding progress, single- and multiple trait selection, multiple-path selection, gene flow method, optimum genetic contribution theory). Students are able to estimate the expected breeding progress for specific cases. They know the basic designs of breeding programs in plant and animal breeding and are able to model, calculate and optimize practical breeding programs by using suitable software programs.	Workload: Attendance time: 56 h Self-study time: 124 h
Course: Selection theory, design and optimisation of breeding programs (Lecture, Exercise) <i>Contents:</i> Introduction to the selection theory, direct and correlated breeding progress , single- and multiple trait selection , multi - path models , multiplepath selection, gene flow method, optimum genetic contribution theory; Explanation of typical breeding program structures in plant and animal breeding, principles of experimental design and optimal allocation of resources, introduction to breeding planning software (ZPLAN+, Genecont etc.), impact of selection on allele frequencies (Wright-model) and genetic variance (Bulmer effect), optimization of breeding programs under constraints (eg. conservation of genetic diversity). Literature: Walsh&Lynch: Evolution and Selection of Quantitative Traits	4 WLH
Examination: Written exam (45 minutes, 50%) and presentation (about 20 minutes, 50%) Examination requirements: Profound knowledge of all aspects of the selection theory, application of methods for estimating the breeding progress, assessing the impact of different selection strategies to progress in breeding, inbreeding development and preservation of genetic variance. Modeling and optimization of a given breeding program with appropriate software.	6 C
Admission requirements: none	Recommended previous knowledge: Good knowledge of quantitative genetics and statistics
Language: English	Person responsible for module: N. N.
Course frequency: each summer semester	Duration: 1 semester[s]
Number of repeat examinations permitted: twice	Recommended semester: Master: 2
Maximum number of students: 20	

Georg-August-Universität Göttingen		3 C
Module M.Agr.0141: Data Analysis with R		2 WLH
Learning outcome, core skills: The students will be able to use methods provided by the statistical package R to perform the analysis of data sets that are typical in the life sciences. A core skill is the identification, usage and evaluation of online resources (e.g. packages and data sets).		Workload: Attendance time: 28 h Self-study time: 62 h
Course: Data Analysis with R (Block course, Lecture, Exercise) <i>Contents:</i> The fundamental concepts of the programming package R will be presented and deepened during practical exercises. Statistical methods will be recapitulated if necessary. Special emphasis is put on visualization methods. <i>Literature:</i> Wiki-book "R programming" https://en.wikibooks.org/wiki/R_Programming "R for Beginners" by Emanuel Paradis https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf "R tips" by Paul E. Johnson http://pj.freefaculty.org/R/Rtips.pdf		2 WLH
Examination: Oral examination (approx. 20 minutes) Examination requirements: Ability to analyze typical data sets with the statistical package R and interpretation of the results.		3 C
Admission requirements: none	Recommended previous knowledge: Knowledge of basic statistics concepts	
Language: English	Person responsible for module: Dr. Mehmet Gültas	
Course frequency: each semester	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester: Master: 4	
Maximum number of students: 24		

<p>Georg-August-Universität Göttingen Module M.Agr.0157: Applied Machine Learning in Agriculture with R</p>	<p>6 C 4 WLH</p>
<p>Learning outcome, core skills: Modern agricultural research involves more and more the analysis of large datasets comprising measurements of several variables. This module aims to teach interested students fundamental analysis skills that permit them to cope with such data sets. In more detail, the techniques that will be treated include:</p> <ul style="list-style-type: none"> • clustering • artificial neural networks • support vector machine • decision trees • random forests • feature selection <p>Involved mathematical formalism will be avoided. The focus is rather on:</p> <ul style="list-style-type: none"> • gaining an intuitive understanding of the techniques • to develop an understanding about which type of problem can be treated with which technique • the application of the techniques using machine learning-functions under R • the graphical visualisation of the results • and the interpretation of the results <p>The teaching will be based on the analysis of published real data sets from agricultural research projects as far as possible.</p>	<p>Workload: Attendance time: 56 h Self-study time: 124 h</p>
<p>Course: Applied Machine Learning in Agriculture with R (Block course) <i>Contents:</i> The course consists of lectures, exercises and project work. After the lectures and the exercises the students will have to carry out a project work that must be finished within eight weeks after the end of the lectures. The students as well as the other research groups are welcome to suggest topics, possibly questions related to their master thesis can be treated. The project work should be a concise written report of about ten pages in which one or several of the techniques that were treated in the course are applied.</p>	<p>4 WLH</p>
<p>Examination: Oral examination (approx. 20 minutes, 60%) and term paper (max. 10 pages, 40%) Examination requirements:</p> <ul style="list-style-type: none"> • Knowledge about the analysis of big-data sets with the statistical package R and interpretation of the results. • Knowledge about different clustering algorithms • Analysis of real agricultural data sets by applying different machine learning-functions under R • Knowledge about feature selection approaches 	<p>6 C</p>
<p>Admission requirements:</p>	<p>Recommended previous knowledge:</p>

Recommended previous knowledge: Basic knowledge of R	none
Language: English	Person responsible for module: Dr. Mehmet Gültas
Course frequency: each winter semester	Duration: 1 semester[s]
Number of repeat examinations permitted: twice	Recommended semester:
Maximum number of students: 25	

Georg-August-Universität Göttingen		6 C 4 WLH
Module M.Agr.0164: Applied Bioinformatics with R		
<p>Learning outcome, core skills: This module will cover the fundamental concepts of bioinformatics. Topics will include usage of relevant/modern biological databases and tools that are required to perform different analyses. Further, an introduction to multi-omics-data will be given, including genome, transcriptome and proteome analysis. This module aims to teach interested students fundamental analysis skills to evaluate biological data using bioinformatic techniques, and to become proficient in performing such analyses.</p> <p>In more detail, following topics will be treated:</p> <ul style="list-style-type: none"> • Analysis of multi-omics data • Standard databases in bioinformatics • DNA sequence and genome analysis • Variant calling techniques • Sequence alignment • Gene regulatory network analysis • Clustering <p>The lecture will be based on the analysis of real data sets from agricultural research projects as far as possible.</p>		<p>Workload: Attendance time: 56 h Self-study time: 124 h</p>
<p>Course: Applied Bioinformatics with R (Lecture, Exercise) <i>Contents:</i> The course consists of lectures, exercises and a project work. After the lectures and the exercises the students will have to carry out a project work that must be finished within ten weeks after the end of the lectures. The students as well as the other research groups are welcome to suggest topics, possibly questions related to their master thesis can be treated. The project work should be a concise written report of about ten pages in which one or several of the techniques that were treated in the course are applied.</p>		4 WLH
<p>Examination: Oral examination (approx. 20 minutes, 75%) and term paper (max. 10 pages, 25%)</p> <p>Examination requirements:</p> <ul style="list-style-type: none"> • Knowledge about the fundamental concepts of bioinformatics • Knowledge about different databases in bioinformatics • Analysis of biological data, interpretation and modeling of biological information and applying this to the solution of biological problems in any area involving molecular data. 		6 C
<p>Admission requirements: none</p>	<p>Recommended previous knowledge: Basic knowledge of R</p>	
<p>Language: English</p>	<p>Person responsible for module: Dr. Mehmet Gültas</p>	
<p>Course frequency: each winter semester</p>	<p>Duration: 1 semester[s]</p>	

Number of repeat examinations permitted: twice	Recommended semester:
Maximum number of students: 30	

<p>Georg-August-Universität Göttingen</p> <p>Modul M.Agr.0165: Introduction to the molecular genetic analysis of plant genetic resources</p> <p><i>English title: Introduction to the molecular genetic analysis of plant genetic resources</i></p>	<p>6 C 4 SWS</p>
<p>Lernziele/Kompetenzen:</p> <p>Students apply knowledge acquired in Module M.Agr.0133: Genetic Resources (GenRes). They have a broad overview of available molecular marker technologies for characterisation and quality management of GenRes. They familiarize by own hands-on experience with next-generation-sequencing based characterization of plant genetic resources. They apply computational tools for raw data acquisition and perform basic analytical steps in population characterization, genetic diversity analysis and/or genetic mapping.</p>	<p>Arbeitsaufwand:</p> <p>Präsenzzeit: 56 Stunden</p> <p>Selbststudium: 124 Stunden</p>
<p>Lehrveranstaltung: Introduction to the molecular genetic analysis of plant genetic resources (Blockveranstaltung, Exkursion, Seminar)</p> <p><i>Inhalte:</i></p> <p>Introduction into Molecular Marker and Next Generation Sequencing Technologies: principle of methodology, sample preparation requirements, infrastructure requirements for data storage and analysis.</p> <p><u>Wet lab experiments</u> (performed in teams of two at IPK): NGS library preparation, NGS sequencing and data acquisition.</p> <p><u>Data analysis experiments</u></p> <ol style="list-style-type: none"> 1. individually and as a team, at IPK: existing training datasets will be used for performing basic steps of raw data processing and downstream data analysis (read mapping, SNV calling, allele frequency test, mapping, GWAS, PCA) 2. group work/homework: NGS samples processed during the practical course will be analysed in team work by the participants based on the acquired knowledge. Results will be presented and discussed during the literature seminar day at GAU. <p>Literature seminar: every participant will select an original paper on the topic during the course and present a seminar to the group at a later timepoint during the same semester.</p> <p><u>Excursion to IPK Genebank:</u> this excursion to IPK will give insights into in field collection management during replication cycles for self-, cross-pollinating crops or vegetatively propagated species including practices of acquisition of legacy data.</p> <p><i>Literature:</i></p> <p>FAO (2015) The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture;</p>	<p>4 SWS</p>
<p>Prüfung: Written report (max. 10 pages, 50%) and presentation (approx. 20 minutes; 50 %)</p> <p>Prüfungsanforderungen:</p> <p>Submission of written reports (lab protocols and analysis results); knowledge of molecular marker and NGS technology for collection characterisation and management</p>	<p>6 C</p>

Zugangsvoraussetzungen: Module M.Agr.0133 Genetic Resources	Empfohlene Vorkenntnisse: Basics of plant and animal breeding, Molecular Genetics
Sprache: Englisch	Modulverantwortliche[r]: Prof. Dr. Nils Stein
Angebotshäufigkeit: jedes Sommersemester	Dauer: 1 Semester
Wiederholbarkeit: zweimalig	Empfohlenes Fachsemester:
Maximale Studierendenzahl: 10	

Georg-August-Universität Göttingen Modul M.Cp.0004: Plant Diseases and Pests in Temperate Climate Zones <i>English title: Plant diseases and pests in temperate climate zones</i>		6 C 4 SWS
Lernziele/Kompetenzen: Kenntnis and Diagnose von Krankheiten und tierischen Schädlingen an Kulturpflanzen. Verständnis der Entstehung, Verbreitung und Dynamik von Schaderregern im Feld als Grundlage für die Entwicklung von Bekämpfungsmaßnahmen.		Arbeitsaufwand: Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Plant Diseases and Pests in Temperate Climate Zones (Vorlesung, Exkursion, Übung) <i>Inhalte:</i> Es werden die in gemäßigten Zonen an Kulturpflanzen auftretenden, wichtigsten Schadorganismen (Viren, Bakterien, Pilze, Nematoden, Milben, Insekten, u.a.) eingehend behandelt. Neben der Erkennung und Diagnose der Schadorganismen und der typischen Befallssymptome stehen die wirtschaftliche Bedeutung, die Biologie, die Prognose und die verschiedenen Möglichkeiten der Bekämpfung, insbesondere unter Beachtung von Bekämpfungs- und Schadensschwellen, im Vordergrund.		4 SWS
Prüfung: Klausur (45 Minuten) Prüfungsvorleistungen: Teilnahme an Exkursionen und Übungen im Feld Prüfungsanforderungen: Kenntnis und Diagnose von Pflanzenkrankheiten und tierischen Schädlingen an Kulturpflanzen des gemäßigten Klimas, ihrer Entwicklungs- und Lebenszyklen im Feld.		6 C
Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: keine	
Sprache: Englisch	Modulverantwortliche[r]: Dr. Birger Koopmann	
Angebotshäufigkeit: jedes Sommersemester	Dauer: 1 Semester	
Wiederholbarkeit: zweimalig	Empfohlenes Fachsemester: Master: 2	
Maximale Studierendenzahl: 30		

Georg-August-Universität Göttingen		6 C 4 WLH
Module M.Cp.0016: Practical statistics and experimental design in agriculture		
Learning outcome, core skills: The aim of the course is to familiarize students with the basic concepts of statistics and their application in agricultural science. The second goal is to learn the use of software packages like SAS.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Practical Statistics and Experimental Design in Agriculture (Lecture, Exercise) <i>Contents:</i> In the beginning of the course, students are introduced to the basic concepts of statistics like frequency distributions, the normal distribution and hypothesis testing. They are also introduced to software packages like SAS, that are used for the practical exercises. Regression and correlation analysis are then introduced. Different experimental designs like randomized block, latin square, and split plot are described and analyzed by one-way analysis of variance or as factorial experiments. Generalized Linear Models will be used and multivariate data will be analyzed by cluster and principal component methods. A large amount of examples and exercises constitute an important aspect of the course, enabling the students to understand and assimilate the theoretical content. Practical analyses of example data sets also provide the students with the required experience and skills for future statistical tasks in the context of Mastertheses.		4 WLH
Examination: Written examination (90 minutes) Examination requirements: Knowledge of the basic concepts of statistics and their application in agricultural science and in the use of software packages like SAS.		6 C
Admission requirements: none	Recommended previous knowledge: Mathematics, statistics	
Language: English	Person responsible for module: Dr. Christian Kluth	
Course frequency: each summer semester	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester: Master: 2	
Maximum number of students: 30		

Georg-August-Universität Göttingen	6 C 4 WLH
Module M.Forst.1524: Biotechnology and forest genetics	

<p>Learning outcome, core skills: Biotechnology is a fast developing field with many aspects and options in efficient and environmentally friendly bioresource production and utilization of bioresources including plant biomass.</p> <p>Sustainable management of tropical forests requires an understanding of the spatial and temporal dynamics of genetic information both in natural and man-made tropical forest ecosystems.</p> <p>The teaching module gives introductory lectures into biotechnology and into forest genetics.</p>	<p>Workload: Attendance time: 56 h Self-study time: 124 h</p>
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<p>Course: Biotechnology (Lecture) <i>Contents:</i> Students will be introduced into subjects of microbiology, biochemistry and molecular biology being basics for biotechnology. With the gained knowledge, modern biotechnological applications in the forest and the wood industry sectors and the progress of biotechnological biomass conversion will be discussed, as well as other environmental problems that might be solved by biotechnological approaches on industrial scales and, particularly in tropical countries, also by small family business.</p>	2 WLH
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Examination: Oral examination (approx. 15 minutes)	3 C
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<p>Course: Tropical forest genetics (Lecture) <i>Contents:</i> Basic principles of population genetics are introduced, factors shaping genetic diversity of tropical forest species are discussed with emphasis on the reproduction system of tropical forest plants, and genetic diversity patterns of tropical forest trees are described. Main applications of forest genetics are mentioned: provenance research and tree breeding, genetic implications of forest management, forest reproductive material, and conservation of forest genetic resources.</p>	2 WLH
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Examination: Oral examination (approx. 15 minutes)	3 C
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<p>Examination requirements: Kenntnis der beschriebenen Lehrinhalte, Erreichung der festgelegten Lernziele und Nachweis der angestrebten Kompetenzen.</p>	
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Admission requirements: none	Recommended previous knowledge: none
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Language: English	Person responsible for module: Prof. Dr. Ursula Kües
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Course frequency: each summer semester	Duration: 1 semester[s]
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Number of repeat examinations permitted:	Recommended semester:
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cf. examination regulations	
Maximum number of students: not limited	

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.A02M: Epidemiology of international and tropical animal infectious diseases	6 C 4 WLH
Learning outcome, core skills: Based on a scientific and practical up-to-date level, students know to evaluate and develop modern and effective livestock hygiene and husbandry concepts and to integrate them into complex quality management programs. Graduates are trained to be competent in implementing and communicating their knowledge in a multidisciplinary occupational setting that establishes epizootic control programs.	Workload: Attendance time: 84 h Self-study time: 96 h
Course: Epidemiology of international and tropical animal infectious diseases (Lecture, Exercise) <i>Contents:</i> Infectious diseases play an enormous role in international animal health control. National health and veterinary authorities, as well as international organizations (WHO, FAO) are very much involved in the surveillance of epidemics and establishment of health and hygiene monitoring programs. These efforts will increase in future, because of a further globalization of international markets, and will require well-educated experts collaborating worldwide in this multidisciplinary field. This module will give a generalized view of current epidemics together with a specialized understanding of infectious diseases and hygienic programs in subtropical and tropical countries. Characteristics of the biology of relevant infectious agents like parasites, fungi and bacteria together with their toxins, viruses, and prions will be presented in detail. Some of these germs included in this unit cause severe zoonotic diseases with a lethal danger for humans. Immunological host-defence mechanisms of wild and domestic farm animals against pathogens will be discussed together with modern strategies of active and passive immunizations. Diagnostic methods presently available and new biotechnological approaches in future assay and vaccine development will be demonstrated. The adaptation of practical health and standardized quality management processes to various animal production systems (ruminants, pigs, poultry) and the corresponding management measurements will be explained. The view will deeply focus on environmental impacts (water, soil, air hygiene), epizootiology and modern tools in epizootiological research. It will include biology and eradication of vectors (insects, ticks) transmitting pathogens of animal and zoonotic diseases, as well as biological and chemical methods for vector control. In the laboratory course, this module will also communicate well-established techniques of microbiological and parasitological diagnostics. Students will be practically trained in classical methods and in modern biochemical, immunological, biotechnological and molecular biological techniques for the detection of infectious agents, toxins and noxious substances. Tissue culture procedures for vaccine or antibody development are also used. Modification of livestock-environment interactions through human management are discussed.	4 WLH
Examination: Oral examination (approx. 90 minutes)	6 C

Examination requirements: Knowledge of current veterinary epidemic and infectious diseases inclusive emerging diseases. Background of hygiene and eradication programs. Profound knowledge in important infectious agents (parasites, fungi, bacteria, viruses) as well as toxins and prions. Skills in immunologic defense mechanisms of wildlife, zoo and domesticated animals in connection with modern active and passive vaccination strategies and biotechnological vaccine development. Knowledge in modern diagnostic tools as well as in biology and control of biological vectors (ticks, midges).		
Admission requirements: none	Recommended previous knowledge: Basic knowledge (B.Sc. level) of soil, plant and animal sciences	
Language: English	Person responsible for module: Prof. Dr. Dr. Claus-Peter Czerny	
Course frequency: each winter semester; Göttingen	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: 30		
Additional notes and regulations: Literature: Lecture based materials.		

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.A14: Organic livestock farming under temperate conditions	6 C 4 WLH
<p>Learning outcome, core skills: <i>Advances in animal nutrition and animal health:</i> Students get to know scientific tools for quantifying, assessing and evaluating problems within organic livestock production.</p> <p><i>Animal welfare :</i> Students have a basic understanding of animal welfare, familiarize with different organic husbandry systems, practical problems and scientific concepts including how to assess animal welfare both at farm and system level.</p> <p><i>Sustainable forage production systems:</i> Students are able to assess the relationships between sward management and structural (yield, botanical composition) and functional (nutrient efficiency) sward characteristics.</p>	<p>Workload: Attendance time: 60 h Self-study time: 120 h</p>
<p>Courses:</p> <p>1. Advances in animal nutrition and animal health (Lecture) <i>Contents:</i></p> <ul style="list-style-type: none"> • Organic livestock production in Europe • Possibilities and limitations within organic farming to ensure a high level of animal health • Strategies within animal nutrition to increase the efficiency in the use of limited resources • System-oriented versus technical approaches <p>2. Animal welfare (Lecture) <i>Contents:</i></p> <ul style="list-style-type: none"> • Principles of animal welfare in relation to organic farming; scientific methods of welfare assessment <p>3. Sustainable forage production systems (Lecture) <i>Contents:</i></p> <ul style="list-style-type: none"> • Design and management of a sustainable forage production • Management of forage quality and biodiversity on grassland • Minimizing nutrient losses towards water and atmosphere 	<p>1,33 WLH</p> <p>1,33 WLH</p> <p>1,33 WLH</p>
<p>Examination: Written examination (90 minutes) Examination requirements: Knowledge of basic terms relevant to organic livestock systems; insights into aspects of feeding, healthcare, welfare, forage production and forage quality assessment; linkages and interdependencies between the discussed fields.</p>	6 C

One written exam with all three parts.	
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Admission requirements: none	Recommended previous knowledge: Basic knowledge (B.Sc. level) of animal sciences
Language: English	Person responsible for module: Prof. Dr. Albert Sundrum
Course frequency: each summer semester; Witzenhausen	Duration: 1 semester[s]
Number of repeat examinations permitted: twice	Recommended semester:
Maximum number of students: 35	

Additional notes and regulations:**Literature:***Advances in animal nutrition and animal health:*

- Vaarst, M., Roderick, S., Lund, V., Lockeretz, W. (eds.) 2004: Animal health and welfare in organic agriculture. CABI Publishing

Animal welfare:

- Appleby, M.C., Hughes, B.O. (eds) 1997: Animal welfare. CAB International, Wallingford;
- Vaarst, M. et al. (eds.) 2004: Animal health and welfare in organic Agriculture. CAB International, Wallingford

Sustainable forage production systems:

- Hopkins, A. 2000: Grass, its production and utilization. Blackwell Science, Oxford, UK;
- Cherney J.H. 1998: Grass for dairy cattle CABI Publishing, Exon, UK;
- Frame, J. 1992: Improved Grassland Management. Farming Press Books, Ipswich, UK.

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.E11: Socioeconomics of rural development and food security		6 C 4 WLH
Learning outcome, core skills: Students learn concepts of development and problem-oriented thinking in a development policy context. The identification of interdisciplinary linkages is trained. Building on case-study analyses, course participants can pinpoint appropriate economic and social policies and assess their impacts. These qualifications can also be transferred to unfamiliar situations.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Socioeconomics of rural development and food security (Lecture) <i>Contents:</i> This module provides students with an overview of socioeconomic aspects of hunger and poverty in developing countries. Apart from more conceptual issues and development theories, policy strategies for rural development and poverty alleviation are discussed and analyzed. Special emphasis is put on problems in the small farm sector. Numerous empirical examples are used to illustrate the main topics.		4 WLH
Examination: Written examination (90 minutes) Examination requirements: Concepts and measurement of hunger and poverty; development theory; classification and evaluation of rural development policies		6 C
Admission requirements: none	Recommended previous knowledge: Prior knowledge of microeconomics at the BSc level is useful	
Language: English	Person responsible for module: Prof. Dr. Matin Qaim	
Course frequency: each winter semester; Göttingen	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: 120		
Additional notes and regulations: Literature: Text books, research articles and lecture notes.		

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.E13M: Microeconomic theory and quantitative methods of agricultural production		6 C 4 WLH
Learning outcome, core skills: Microeconomic Theory of Agricultural Production Students are familiar with microeconomic approaches and can apply them to analyze issues related to agriculture and rural development. Quantitative Methods in Agricultural Business Economics Students are familiar with quantitative methods used for the analysis and planning of farms and enterprises in the agricultural sector.		Workload: Attendance time: 56 h Self-study time: 124 h
Courses: 1. Microeconomic theory of agricultural production (Lecture) <i>Contents:</i> Consumer theory, producer theory, markets, monopoly situations, risk and uncertainty, economics of technical change, farm household models, sharecropping contracts. 2. Quantitative methods in agricultural business economics (Lecture) <i>Contents:</i> Budgeting, accounting, annual balance sheets, linear programming, finance, investment analysis.		2 WLH 2 WLH
Examination: Written examination (120 minutes) Examination requirements: Consumer theory; producer theory; risk; technological progress; farm household models; budgeting and accounting; linear programming; finance; investment analysis.		6 C
Admission requirements: none	Recommended previous knowledge: none	
Language: English	Person responsible for module: Prof. Dr. Matin Qaim	
Course frequency: each winter semester; Göttingen	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: 40		
Additional notes and regulations: Literature: Text books, research articles and lecture notes. After successful conclusion of M.Agr.0060 students can not complete M.SIA.E13M		

sensor techniques.	
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Admission requirements: none	Recommended previous knowledge: none
Language: English	Person responsible for module: Dr. Thomas Möckel
Course frequency: each winter semester; Witzenhausen	Duration: 1 semester[s]
Number of repeat examinations permitted: twice	Recommended semester:
Maximum number of students: 20	

Additional notes and regulations: Literature: Principles of Geographical Information Systems by Peter A. Burrough and Rachael A. McDonnell (2015) Introduction to Remote Sensing by James B. Campbell and Randolph H. Wynne (2011)
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Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.P13: Agrobiodiversity and plant genetic resources in the tropics		6 C 4 WLH
Learning outcome, core skills: Students are able to understand the role of agrobiodiversity in tropical agro-ecosystems, to present approaches of functional biodiversity analysis and to discuss the needs and strategies of on-farm (in situ) and off-farm conservation of plant genetic resources.		Workload: Attendance time: 56 h Self-study time: 124 h
Course: Agrobiodiversity and plant genetic resources in the tropics (Lecture, Seminar) <i>Contents:</i> Case-study based analysis of the role of biodiversity for selected crops in different agroecosystems from the arid to the humid climate zones; importance of biodiversity for the stability / sustainability of smallholder (subsistence) versus commodity-oriented commercial agriculture in the Tropics, assessment and utilization of diversity, principles and practices in conservation of genetic resources, role of homegardens and indigenous wild fruit trees for in situ conservation of biodiversity, causes and consequences of genetic erosion, approaches of germplasm collection.		4 WLH
Examination: Oral exam (about 15 minutes, 60%) and presentation (about 20 minutes, 40%) Examination requirements: Students should be able to understand the role of agrobiodiversity in tropical agroecosystems, to present basic approaches to functionally analyse biodiversity and to discuss the need of and strategies for in and ex situ conservation of genetic resources.		6 C
Admission requirements: none	Recommended previous knowledge: Basic knowledge in plant and soil sciences	
Language: English	Person responsible for module: Prof. Dr. Gunter Backes	
Course frequency: each winter semester; Witzenhausen	Duration: 1 semester[s]	
Number of repeat examinations permitted: twice	Recommended semester:	
Maximum number of students: not limited		
Additional notes and regulations: Literature: Altieri, M. 1987: Agroecology: the scientific basis of alternative agriculture. Westview Press, Boulder, Colorado, USA; Eyzaguirre, P.B., Linares, O.F. 2004: Home gardens and agrobiodiversity. Smithsonian Books, Washington, USA; Wood, D., Lenne, J.M. 1999: Agrobiodiversity: Characterization, utilization and		

management. CABI Publishing, Wallingford, UK.