Georg-August-Universität
Göttingen

Modulverzeichnis

für den konsekutiven Master-Studiengang "Integrated Plant and Animal Breeding" - zu Anlage 3 der Prüfungs- und Studienordnung für Master-Studiengänge der Fakultät für Agrarwissenschaften (Amtliche Mitteilungen I Nr. 26/2023 S. 863)

Module

Übersicht nach Modulgruppen

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

1. Block A - Compulsory Modules

Es müssen die vier folgenden Pflichtmodule im Umfang von insgesamt 27 C erfolgreich absolviert werden:

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

2. Block B - Elective compulsory modules

Es müssen wenigstens vier der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 21 C erfolgreich absolviert werden:

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

3. Block C - Key competencies

Es müssen die folgenden Module im Umfang von insgesamt 12 C erfolgreich absolviert werden:

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

4. Block D - Elective modules

Es müssen weitere 5 Module im Umfang von insgesamt wenigstens 30 C aus dem Lehrangebot eines Master-Studienganges der Fakultät für Agrarwissenschaften in Göttingen oder frei wählbare Module aus den am diesem Studiengang beteiligten Einrichtungen, einer entsprechenden anderen agrarwissenschaftlichen Fakultät oder aus verwandten Studiengängen erfolgreich abgeschlossen werden.

Five additional modules worth overall at least 30 C must be successfully completed. Students can earn the credits through elective modules from any master study programme at the faculty of agriculture, University of Goettingen, from other institutions participating in the programme, or from other agricultural faculties or similar study programmes at other universities.

5. Master's thesis

Durch die erfolgreiche Anfertigung der Masterarbeit werden 24 C erworben.

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

6. Colloquium for the Master's thesis

Durch das erfolgreiche Absolvieren des Kolloquiums zur Masterarbeit werden 6 C erworben.

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

II. Double-Degree Programme "European Master in Animal Biodiversity and Genomics" (EMABG)

Es sind Leistungen im Umfang von insgesamt 120 C erfolgreich zu absolvieren. Leistungen im Umfang von 60 C müssen nach Maßgabe der folgenden Bestimmungen an der Universität Göttingen erfolgreich absolviert werden, weitere 60 C, darunter die Masterarbeit, müssen an einer der Partneruniversitäten erfolgreich absolviert werden.

Modules worth overall 120 C must be successfully completed. Modules worth 60 C must be completed following the regulations of the University of Goettingen. Another 60 C, including the Master's thesis, must be earned and completed at one of the partner universities.

1. Block A - Compulsory modules

Die folgenden 11 Pflichtmodule im Umfang von insgesamt 60 C müssen erfolgreich absolviert werden:

The following 11 compulsory modules worth overall 60 C must be successfully completed:

Georg-August-Universität Göttingen **Modul M.Agr.0020: Genome analysis and application of markers in plantbreeding** *English title: Genome Analysis and Application of Markers in Plantbreeding*	6 C 4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Genome analysis and application of markers in plantbreeding (Vorlesung,Übung) *Inhalte*: 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. Basiskenntnisse im Einsatz molekularer Marker in der Pflanzenzüchtung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Wolfgang Link PD Dr. Wolfgang Ecke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0056: Plant breeding methodology and genetic resources** *English title: Plant Breeding Methodology and Genetic Resources*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden lernen, klassische und molekulare Methoden und Techniken bei der Lösung pflanzenzüchterischer Problemen zu integrieren. Sie lernen, eigene Schlussfolgerungen aus klassischen und neuesten Veröffentlichungen zu ziehen und diese Wissenschaftlern und Studierenden verständlich, knapp und klar zu vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Plant breeding methodology and genetic resources (Vorlesung) *Inhalte*: Grundlagen der Zuchtmethodik: Populationsgenetik, Zuchtmethoden in der Klon-, Linien-, Hybrid- und Populationszüchtung, Marker-gestützte Selektion für monogene und polygene Merkmale. Nutzung pflanzengenetischer Ressourcen: Wildarten, ex-situ und in-situ-Erhaltung, on-farm-Management. Züchtung für marginale Standorte mit Beispielen aus gemäßigten und tropischen Breiten. Dieses Modul und das Modul "Genetic Principles of Plant Breeding" ergänzen sich wechselseitig.	4 SWS
Prüfung: Klausur (Gewicht: 80%, Dauer: 90 Minuten) und Präsentation, Referat oder Korreferat (Gewicht: 20%, Dauer: ca. 20 Minuten) **Prüfungsanforderungen:** Grundlagen zu: Populationsgenetik, Einsatz von Markern in der Pflanzenzüchtung, Konzepte zur Nutzung Pflanzengenetischen Ressourcen. Gute Kenntnisse: 'Pre-Breeding', Kategorien und Methoden der Pflanzenzüchtung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Wolfgang Link
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul M.Agr.0114: Sicherheitsbewertung biotechnologischer Verfahren in der Pflanzenzüchtung** *English title: Biosafety Evaluation of Biotechnological Approaches in Plant Breeding*	6 C 4 SWS

Lernziele/Kompetenzen: 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.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Anwendung und Rechtsrahmen gentechnischer Verfahren (Vorlesung,Exkursion) *Inhalte*: 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.	
Lehrveranstaltung: Anwendung und Rechtsrahmen biotechnologischer Verfahren allgemein (Vorlesung,Exkursion) *Inhalte*: Anwendung und juristische Bewertung biotechnologischer Verfahren in der Pflanzenzüchtung; Sicherheitsforschung, -bewertung und -management; Pflanzen als Produktionsplattform - Perspektiven und Sicherheitsbewertung.	
Lehrveranstaltung: Neue Züchtungsverfahren in der Anwendung (Vorlesung,Exkursion) *Inhalte*: Gene targeting/editing, gene drive; vergleichende Auswirkung „klassischer“ und „neuer“ Züchtungsmethoden; Pflanzengenom- und Transkriptomanalyse, Datenbanken; next generation sequencing, Bioinformatik; Bewertung und Regulierung ausgewählter Züchtungsverfahren	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Anwendung und Rechtsrahmen gentechnischer Verfahren: Vertieftes Verständnis von gentechnischem Arbeiten in Labor und Freiland; Fallstudien; Monitoring und Koexistenz, Planung und Durchführung gentechnischer Versuche im Freiland; Anwendung und Rechtsrahmen biotechnologischer Verfahren allgemein:	6 C

Vertieftes Verständnis von Sicherheitsbewertung und Sicherheitsmanagement biotechnologischer Verfahren in der Pflanzenzüchtung; Fallstudien GV Pflanzen für Futter- und Nahrungsmittelanwendungen, GV Pflanzen als Produktionsplattform für industrielle & pharmazeutische Produkte sowie Energie Neue Züchtungsverfahren in der Anwendung: Vertieftes Verständnis und Sicherheitsbewertung neuer Züchtungsverfahren einschließlich Gentechnik und genome editing; Fallstudien vergleichende Sicherheitsbewertung und Bioinformatik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Ralf Wilhelm
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Module M.Agr.0186: Multivariate Statistics with Applications in Agricultural Sciences**	6 C 4 WLH

Learning outcome, core skills: The students will get a comprehensive overview of multivariate statistics from both a theoretical and applied perspective. This module aims to teach fundamental skill on how to approach analysis of univariate and multivariate datasets and how to interpret results. Practical applications will partially be performed in the software R.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Multivariate statistics with applications in agricultural sciences (Lecture) *Contents*: • Multivariate regression • Multivariate random variables • Multivariate testing • Principal components analysis • Factor analysis • Cluster analysis • Multidimensional scaling • MANOVA • Neural Networks	4 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** Working on 50% of the exercises and presentation of the solution of at least one exercise, as well as active participation in the exercises.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic courses in math or statistics. Examples for this could be M.Agr.0036 (Methodisches Arbeiten: Versuchsplanung und –auswertung), M.Agr.0076 (Statistische Nutztiergenetik), M.iPAB.0015 (Applied Machine Learning in Agriculture in R).
Language: English	**Person responsible for module:** Prof. Dr. Christine Große-Brinkhaus
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Cp.0004: Plant diseases and pests in temperate climate zones**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
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.	Attendance time: 56 h Self-study time: 124 h

Course: Plant Diseases and Pests in Temperate Climate Zones (Lecture,Excursion,Exercise) *Contents*: 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 WLH
Examination: Written examination (45 minutes) **Examination prerequisites:** Teilnahme an Exkursionen und Übungen im Feld **Examination requirements:** Kenntnis und Diagnose von Pflanzenkrankheiten und tierischen Schädlingen an Kulturpflanzen des gemäßigten Klimas, ihrer Entwicklungs- und Lebenszyklen im Feld.	6 C

Admission requirements:	**Recommended previous knowledge:**
Sobald das Modul B.Agr.0346 Spezielle Phytomedizin erfolgreich absolviert wurde, kann das Modul M.Cp.0004 Plant Diseases and Pests in Temperate Climate Zones nicht mehr belegt werden.	none
Language: English	**Person responsible for module:** Dr. Birger Koopmann
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 **Module M.Cp.0016: Practical statistics and experimental design in agriculture**	6 C 4 WLH

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) *Contents*: 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 by 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:**
Maximum number of students: 30	

Additional notes and regulations:
This module and M.Agr.0036 "Methodisches Arbeiten: Versuchsplanung und -auswertung" are mutually exclusive.

Georg-August-Universität Göttingen **Module M.FES.324: Environmental Biotechnology and Forest Genetics**	6 C 4 WLH

Learning outcome, core skills: 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.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Tropical Forest Genetics (Lecture)	2 WLH
Course: Environmental Biotechnology (Lecture)	2 WLH
Examination: Oral examination (approx. 15 minutes)	6 C

Examination requirements: Sound knowledge of learning contents, achievement of learning outcomes and proof of aspired core skills.	

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:**
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) *Contents*: 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. Jens Tetens
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

Learning outcome, core skills: *Advances in animal nutrition and animal health:* Students get to know scientific tools for quantifying, assessing and evaluating problems within organic livestock production. *Animal welfare :* 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.	**Workload:** Attendance time: 60 h Self-study time: 120 h

Course: Animal nutrition and animal health (Lecture) *Contents*: Principles and regulations of organic livestock farming in Europe; Nutrition in organic cattle, pigs and poultry; Animal health and production diseases; Production diseases in organic cattle, pigs and poultry; Health management in organic livestock farms	1,33 WLH
Course: Animal welfare (Lecture) *Contents*: Principles of animal welfare in relation to organic farming; scientific methods of welfare assessment	1,33 WLH
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. One written exam with all three parts**.**	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge (B.Sc. level) of animal sciences
Language: English	**Person responsible for module:** Dr. Margret Krieger
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 cattl.e 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.A15M: Scientific writing in natural sciences**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
In the course of their study programme, when compiling their MSc thesis and for their further (academic) career, students have to deliver a variety of scientific texts. Therefore, this module aims at presenting and discussing the main principles of such texts. It provides training in how to write different types of essays, abstracts, grant winning proposals and complex texts (chapters) in preparation and writing of the master thesis research. At successful completion of this module, participants will be able to: • differentiate the structure and format of various types of scientific texts; • search scientific literature, set up and manage an electronic literature database and compile reference lists; • write term papers, grant proposals, conference abstracts, and final thesis (chapters); • compile scientific tables and figures and be able to decide which type of data is best expressed in which format; • apply the rules of good scientific practice; • give and receive constructive feedback on scientific texts.	Attendance time: 56 h Self-study time: 124 h

Course: Scientific writing in natural sciences *Contents*: To provide participants with theoretical basics and practice these, the module will offer a mixture of lecture and exercises. Within the course a variety of facets and techniques of scientific writing will be imparted that graduate SIA students should be able to master. Consequently, participants are introduced to scientific literature search and analysis, good scientific practice and how to avoid plagiarism. Additionally, guidelines for creating concise tables and figures are presented. To be prepared for their master thesis work, students will be taught how to write different scientific text documents such as grant proposals and conference abstracts. By reviewing and discussing a scientific article and peer-reviewing an abstract of a fellow student by using an online tool, module participants will train how to give and receive constructive feedback. Finally, students will choose a topic for their term paper (see below) to further apply the newly acquired knowledge.	
Examination: 3 short written assignments (approx. 4 pages, 50%) are to be handed in during the semester and one major text (term paper, approx. 6 pages 50%) is to be submitted at the end of the semester.	6 C

Admission requirements:	**Recommended previous knowledge:**
none	Basic knowledge of Word (Microsoft or Open Office) and Adobe Acrobat.
Language:	**Person responsible for module:**
English	Prof. Dr. Eva Schlecht

Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 3
Maximum number of students: 30	

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 and food security 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) *Contents*: This module provides students with an overview of socioeconomic aspects of hunger, malnutrition, and poverty in developing countries. Apart from more conceptual issues and development theories, policy strategies for sustainable rural development and poverty alleviation are discussed and analyzed. Special emphasis is put on problems in the small farm sector. Empirical examples are used to illustrate the main topics.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Concepts and measurement of hunger, malnutrition, and poverty; 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. Liesbeth Colen
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** until 1
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: The course introduces microeconomic theory and quantitative methods applied to the agri-food system. On successful completion of the course, students should be able to: • Apply economic principles to understand consumer and producer decisions in relation to food production and consumption. • Understand different market structures in the agri-food sector. • Use behavioral economic concepts to explain decision-making. • Understand concepts on agricultural investment behavior. • Perform quantitative analysis applied to the agri-food sector.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Microeconomics and Quantitative Analysis for Agri-Food Systems (Lecture,Exercise) *Contents*: Microeconomic theory of agricultural production: This part of the course introduces students to the concepts of microeconomic theory applied to the agri-food sector. Topics include consumer behavior, production and resource use, perfect, imperfect competition and market power, and concepts from behavioral economics. This is complemented with exercises and student presentations on selected economic topics. Quantitative methods in agricultural business economics: This part of the course provides students with the tools for conducting quantitative analysis in the agri-food sector. Topics covered include the process of agricultural decision-making, basic concepts in finance, and investment behavior in agriculture. The theoretical learning is complemented by hands-on exercises and student presentations on peer-reviewed papers.	4 WLH
Examination: Written end-of semester 90 min exam (70 % of grade) and continuous assignments (30%) **Examination requirements:** Consumer and producer theory; Market structure, behavioral economics risk; technological progress; farm household models; agricultural decision-making; investment behavior; quantitative analysis.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Doris Läpple Maria Luísa F. de Araujo
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 the successful conclusion of M.Agr.0060, students can not complete M.SIA.E13M. This module is designed for students without or limited previous knowledge of economics.

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.I14M: GIS and remote sensing in agriculture**	6 C 4 WLH

Learning outcome, core skills: GIS: A broad overview of basic GIS functions and related background knowledge should enable students to explore GIS-Software for relevant commands and prepare functional strategies for spatial data management and analysis. Lecture and exercise examples have predominantly agricultural reference. Remote Sensing The lecture will introduce physical principles (reflectance, transmittance, and absorption), sensor techniques (passive and active sensors, satellites, field spectrometer) and methods of analysis (calibration, validation) in remote sensing applications. This technical framework is presented using agricultural examples, as e.g. the generation of maps for crop yield and protein, assessment of species composition in mixed vegetation (e.g. grassland), like legume content for a calculation of residual nitrogen and crop rotation effects.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Remote sensing in agriculture (Lecture) *Contents*: The lecture will introduce physical principles (reflectance, transmittance, and absorption), sensor techniques (passive and active sensors, satellites, field spectrometer) and methods of analysis (calibration, validation) in remote sensing applications. This technical framework is presented using agricultural examples, as e.g. the generation of maps for crop yield and protein, assessment of species composition in mixed vegetation (e.g. grassland), like legume content for a calculation of residual nitrogen and crop rotation effects.	2 WLH
Course: GIS (Lecture) *Contents*: The course gives an introduction to Geographical Information Systems (GIS). Starting from geodetical background information, a wide range of different GIS- methods and -functions are presented using agricultural examples (e.g. data import, georeferencing, aggregation, (re)classification, interpolation, overlays and image analysis). The students have the opportunity to carry out exercises on the computer themselves for some important GIS-procedures. A special focus is given on data capturing using maps and field data survey with GPS as well as the spatial analysis of site conditions. Finally a particular view on GIS in organic farm management and Precision Farming is given.	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Knowledge about basic GIS functions and the preparations of functional strategies for spatial data management. Knowledge of physical principles, methods of analysis and sensor techniques.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Jayan Wijesingha
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 andRandolph H. Wynne (2011)

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) *Contents*: 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. Smithsonia Books, Washington, USA; Wood, D., Lenne, J.M. 1999: Agrobiodiversity: Characterization, utilization and

management. CABI Publishing, Wallingford, UK.

Georg-August-Universität Göttingen **Module M.iPAB.0001: Quantitative genetics and population genetics**	6 C 6 WLH

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) *Contents*: 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. Christine Große-Brinkhaus
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.iPAB.0002: Breeding schemes and programs in plant and animal breeding**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
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.	Attendance time: 56 h Self-study time: 124 h

Course: Breeding schemes and programs in plant and animal breeding (Lecture,Excursion) *Contents*: 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 an Essay (45 minutes, 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:** Dr. Birgit Jutta Zumbach
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1
Maximum number of students: 30	

Additional notes and regulations:
Mandatory excursions to practical plant breeding and animal breeding programs.

Georg-August-Universität Göttingen **Module M.iPAB.0003: Statistical genetics, breeding informatics and experimental design**	6 C 4 WLH

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) *Contents*: • 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 Schmitt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0004: Internship**	9 C 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) *Contents*: 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 (approx. 20 minutes, 50%), not graded **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. Stefan Scholten
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0005: Poultry breeding and genetics**	6 C 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) *Contents*: • 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: • 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 excursion **Examination requirements:** Profound knowledge about applied poultry breeding.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics of animal breeding
Language: English	**Person responsible for module:** Prof. 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 excursion.

Georg-August-Universität Göttingen **Module M.iPAB.0006: Breeding informatics**	6 C 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) *Contents*: • Bascics 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, programing
Language: English	**Person responsible for module:** Prof. Dr. Armin Schmitt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0007: Biotechnology and molecular genetics in plant and animal breeding**	6 C 4 WLH

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) *Contents*: 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.iPAB.0008: 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) *Contents*: 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 prerequisites:** M.iPAB.0007 Biotechnology and molecular genetics in plant and animal breeding or M.Agr.0131 Biotechnology and molecular genetics in plant and animal breedin **Examination requirements:** The examinees should provide detailed information in their term paper (writen 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.iPAB.0007 M.iPAB.0007 Biotechnology and molecular genetics in plant and animal breeding or M.Agr.0131 Biotechnology and molecular genetics in plant and animal breeding	**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:	**Recommended semester:**

twice	Master: 2
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0010: Legal Issues in Plant and Animal Breeding: Intellectual Property Protection, Welfare and Global Trade**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
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.	Attendance time: 26 h Self-study time: 64 h

Course: Legal issues in plant and animal breeding (Lecture,Seminar) *Contents*: 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. Ahmad-Reza Sharifi
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0012: 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) *Contents*: 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:** Dr. Alexander Charles Mott
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0013: 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 and Exercises) *Contents*: Introduction to the selection theory, direct and correlated breeding progress , single- and multiple trait selection , multi-path models , multiple-path selection, gene flow, 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 simulation software (e.g. MoBPS.), 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 minuntes, 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.	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:**
Maximum number of students:	

30	

Georg-August-Universität Göttingen **Module M.iPAB.0014: Data Analysis with R**	3 C 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) *Contents*: 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. Literature: 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: Written examination (90 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:** Thomas Martin Lange
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 24	

Georg-August-Universität Göttingen **Module M.iPAB.0015: Applied Machine Learning in Agriculture with R**	6 C 4 WLH

Learning outcome, core skills: Modern agricultural research involves more and more the analysis of large datasets comprising mesaurements 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: • clustering • artificial neural networks • support vector machine • decision trees • random forests • feature selection Involved mathematical formalism will be avoided. The focus is rather on: • 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 The teaching will be based on the analysis of published real data sets from agricultural research projects as far as possible.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Applied Machine Learning in Agriculture with R (Block course) *Contents*: 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.	4 WLH
Examination: Oral examination (approx. 20 minutes, 60%) and term paper (max. 10 pages, 40%) **Examination requirements:** • 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	6 C

Admission requirements: Recommended previous knowledge: Basic knowledge of R	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Felix Heinrich
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 **Module M.iPAB.0016: Applied effective R programming in animal breeding and genetics**	3 C 2 WLH

Learning outcome, core skills: The students will be able to efficiently use the programing language R on big animal datasets and to implement automated workflows for animal data analysis. They also will be enabled to distribute their implementations to end users.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Applied effective R programming in animal breeding and genetics (Lecture,Exercise) *Contents*: Effective usage of the programming language R applied to animal breeding and genetics examples. This includes detailed knowledge about the use of different data types and objects in R, automation and optimization of workflows, connection to third party software. • Data input/ output • Matrix algebra in R • Effective data management • Profiling/ Benchmarking • String modifications • Parallelization • Running self-executable R scripts via the command line	2 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Regular attendance of course **Examination requirements:** The term paper must include the code; self-executable application for a predefined task with focus on efficiency and usability, short description on how the task was solved.	3 C

Admission requirements: Basic knowledge of the programming language R, for example proven by the successful participation in the modules • M.Agr.0141: Data Analysis with R • B.Agr.0375: Bioinformatik • B.Agr.0308: Biometrie or comparable modules or proofs of knowledge.	**Recommended previous knowledge:** Basic command of R
Language: English	**Person responsible for module:** Prof. Dr. Christine Große-Brinkhaus
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	
Maximum number of students: 30	

Additional notes and regulations:
EMABG students will be taken preferred before all others. iPAB and M.Agr. Animal Science before others.

Georg-August-Universität Göttingen **Module M.iPAB.0019: Scientific Project: scientific methods, procedures and practical skills in animal and plant breeding**	9 C 6 WLH

Learning outcome, core skills: Advanced knowledge of scientific methods, procedures and practical skills in the field of animal as well as plant breeding acquired by the active participation in a research project. Students also gain key competencies such as team working, interdisciplinary working, and self-organization.	**Workload:** Attendance time: 60 h Self-study time: 210 h

Course: Scientific Project: scientific methods, procedures and practical skills in animal and plant breeding *Contents*: Working on a scientific project in the different fields of breeding research. Testing of scientific hypotheses, experimental design, analysis of genotyping data, data analysis, interpretation and presentation of the research results.	6 WLH
Examination: Term paper (max. 20 pages) **Examination requirements:** Active and independent working on a plant or animal breeding related scientific issue.	9 C

Admission requirements: The students, who are enrolled in the “Integrated plant and animal breeding (IPAB)” program, must get an approval from the program coordinator at least one month prior to the desired start date of the project.	**Recommended previous knowledge:** Basics of plant and animal breeding, statistics, and scientific writing
Language: English	**Person responsible for module:** Thomas Martin Lange
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.iPAB.0020: Breeding Lab Internship**	9 C

Learning outcome, core skills:	**Workload:**
Students acquire professional and social skills to successfully execute a team project in complex international animal breeding business conditions. Students gather, select, and analyze information and integrate it into a viable R&D proposition, aimed at value creation. Students attain the ability to systematically evaluate information following a systematic structure, as well as take complexity (such as cultural and social awareness) into account during decision making. Furthermore, students practice professional behavior and habitus in a competitive international environment. They are able to discuss and defend their viewpoints and conclusions in a professional and academically correct way before industry representatives.	Attendance time: 160 h Self-study time: 110 h

Course: Breeding Lab Internship (Internship,Seminar) *Contents*: Management structures, communication and collaboration techniques when working in diverse groups, conflict management, product concept development, industry methods and practices, as well as insights into areas of responsibility and the everyday professional life of an animal breeder. Students experience a specialized animal breeding working environment outside of a university setting. Placement in non-university setting approx.4 weeks	
Examination: Presentation (approx. 15 minutes, 50%) with written report (max. 15 pages, 50%), not graded **Examination prerequisites:** Practical work in non-university animal breeding field. Regular attendance during the four weeks. **Examination requirements:** Reflection on learning outcomes and personal experiences, as well as problem-solving capabilities and working in a diverse group outside of a university setting.	9 C

Admission requirements: Only EMABG Students	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ahmad-Reza Sharifi
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 1
Maximum number of students: 20	

Additional notes and regulations:

Students are present approx. 4 weeks at an associated partner (non-university organization) to gain insights and establish contact regarding R&D proposition. The students have extended time (approx. 4 weeks) to work on their project upon leaving the associated partner. Whenever possible, the result will be presented to and co-graded by a representative from the associated partner.

Georg-August-Universität Göttingen **Module M.iPAB.0021: Plant in vitro Cultures and Somatic Cell Genetics**	6 C 4 WLH

Learning outcome, core skills: The students are able to plan and perform plant bio- and gene-technological procedures independently and to assess their suitability for breeding related questions considering scientific and economic issues.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Plant in vitro Cultures and Somatic Cell Genetics (Block course,Lecture,Exercise) *Contents*: *Lecture Contents* • Overview on bio- and gene-technological methods • Theoretical basis, genetics and epigenetics of plant tissue culture methods • Focus on Somatic Hybridization-, Doubled-Haploid- and Genome Editing-related plant tissue culture technology • Methodology and strategies in genome editing and its verification • Applications in applied breeding and plant research • Scientific standards of lab work documentation *Practical Contents* • Design and cloning of gene specific guide-RNA • Protoplast fusion and transformation • Mutation detection and analysis • Biolistic Transformation • Embryo rescue and germination Basics and context of biotechnological practical work by means of discrete, consecutive project work on CRISPR/Cas9 based genome editing including vector design, cloning and activity validation. The project sequence includes: • *In silico* design of gene specific guide RNA • Cloning of CRISPR/Cas9 vectors • Transient transformation of the vectors in protoplasts • Determination of the mutation efficiency by endonuclease assays	
Examination: Protocol (max. 25 pages, 70%) and oral examination (approx. 15 min., 30%). **Examination requirements:** Regular attendance of practical (minimum of 90%). Formal protocol with scientifically sound lab work documentation including introduction, methods, results and discussion. Knowledge on practical implementation, execution and applicability of molecular and cell culture methods in research and breeding	6 C

Admission requirements: none	**Recommended previous knowledge:** Units of applied molecular biology and its conversion
Language: English	**Person responsible for module:** Prof. Dr. Stefan Scholten
Course frequency: each winter semester	**Duration:**
Number of repeat examinations permitted: twice	**Recommended semester:** until 3
Maximum number of students: 12	

Georg-August-Universität Göttingen **Module M.iPAB.0022: Molecular Genetics and Genomics**	6 C 4 WLH

Learning outcome, core skills: The students are able to plan and perform complex molecular techniques independently and to assess their suitability for breeding related questions considering scientific and economic factors.	**Workload:** Attendance time: 80 h Self-study time: 100 h

Course: Molecular Genetics and Genomics (Block course,Lecture,Exercise) *Contents*: *Lecture Contents* • Overview on molecular methods in gene and genome analysis • Theoretical basis of classical and new marker technologies • Methodology, areas of use, and automation of sequencing technologies • Applications in applied breeding and breeding research *Practical Contents* Basics of molecular biology practical work with nucleic acids by means of discrete performing polymerase chain reactions (PCR), short sequence repeats (SSR) and single nucleotide polymorphism (SNP) marker protocols. Robotics for high-throughput and miniaturization of molecular biology methods by means of using pipetting robots for single steps of the custom procedures. Custom procedures for genome and transcriptome analysis: • Production of sequencing libraries for genotyping DNA by sequencing (GBS). • Production of sequencing libraries for strand specific 3’ targeted gene expression analysis by Digital Gene Expression RNA sequencing (3’ DGE RNA-seq).	
Examination: Protocol (max. 25 pages, 70%) and oral examination (approx. 15 min., 30%) **Examination requirements:** Regular attendance of practical (minimum of 90%). Formal protocol with scientifically sound lab work documentation including introduction, methods, results and discussion. Knowledge on practical implementation, execution and applicability of molecular marker and sequencing technology in research and breeding	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Scholten
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	
Maximum number of students: 12	

Georg-August-Universität Göttingen **Modul M.iPAB.0023: Journal Club: Evolutionary Genetics and Breeding** *English title: Journal Club: Evolutionary Genetics and Breeding*	3 C 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Students gain competences in comprehension and discussion of scientific topics by critically reading published literature in the field of evolutionary genetics and breeding. They also obtain skills in oral and written presentation of their investigation	Präsenzzeit: 26 Stunden Selbststudium: 64 Stunden

Lehrveranstaltung: Journal Club: Evolutionary Genetics and Breeding (Vorlesung,Seminar) *Inhalte*: 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.	2 SWS
Prüfung: Active participation and consistent attendance, unbenotet **Prüfungsvorleistungen:** Regular reading of the assigned literature in advance of the weekly course meetings **Prüfungsanforderungen:** Regular and meaningful contributions to the group discussion. Demonstration of critical thinking via postulating valuable questions that demonstrate comprehension of the assigned literature.	3 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birgit Jutta Zumbach
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0024: Farm animal genetic resources**	3 C 2 WLH

Learning outcome, core skills: Students learn the value of animal genetic resources and know the history, origin and domestication of several farm animal species. They know their degree of endangerment and the reasons why genetic diversity is at risk. They know the political framework of conservation activities and the global system for the conservation of animal genetic resources. They learn methods for molecular characterization, and different statistical methods to evaluate and quantify genetic diversity. The students are familiar with different technological approaches for the conservation and management of genetic resources. They know principles for prioritization in the conservation of genetic resources. The students understand principles and methods for the utilization of genetic resources in breeding programs.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Farm animal genetic resources *Contents*: Definition of farm animal genetic resources, centers of domestication and diversity, current risk status and global concepts of conservation. Methods for molecular characterization and measures of genomic diversity within and between animal populations: Wright's F-statistics, genetic distances and different approaches of cluster analyses, i.e. phylogenetic trees and model-based clustering. Concept of effective population size and inbreeding. Prioritization for conservation. Implementation of analytical methods with appropriate software. Methods for cryopreservation of material in a gene bank. Utilization of genetic resources in breeding programs, cross breeding and introgression via breeding or molecular introgression. One-time relocation to Neustadt-Mariensee Visit to the German Genebank for Farm Animals at FLI-ING - Participation voluntary (optional) FAO (2015) Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture; FAO (2023) Genomic characterization of animal genetic resources; FAO (2023) Innovations in cryoconservation of animal genetic resources	2 WLH
Examination: seminar presentation (about 10 minutes, 50%), oral examination (15 minutes, 50%) **Examination requirements:** Presentation of an overview of genetic resources and their use in a farm animal species. Profound knowledge of the underlying principles and methodological approaches to assess, conserve, prioritize and use genetic diversity in livestock. Items to be covered: • centre of origin/centre of diversity • current risk status and reasons for endangerment • status of diversity studies using molecular information	3 C

• conservation and current use and practical impact • any other aspect of interest	

Admission requirements: none	**Recommended previous knowledge:** Basics of animal breeding, Molecular Genetics
Language: English	**Person responsible for module:** apl. Prof. Dr. Steffen Weigend
Course frequency: each winter semester1	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0025: Root Biology-from genes to functions**	6 C 4 WLH

Learning outcome, core skills: Students can compare different root system architectural and anatomical features, describe root responses to biotic and abiotic stress, and explain key root-rhizosphere interactions. Students can apply image analysis and phenotyping techniques to answer scientific questions related to root biology. Students can describe the opportunities and challenges in root research.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Root Biology-from genes to functions (Block course,Lecture,Excursion,Exercise) *Contents*: This module aims to introduce students to root biology including both the genetics and physiology of root development and complex interactions among plant roots, soil constituents, and microorganisms. Students will gain hands on experience phenotyping root architecture, anatomy, and physiology and handing and processing phenotype data. Students will also gain hands on experience with functional-structural plant modeling to investigate root architecture and anatomy. Introductory lectures and exercises will prepare students for an individualized experimental project investigating the function of root traits for soil resource capture and interactions with soil microorganisms. Mandatory excursion to the phenotyping facilities at the IPK Gatersleben will give insights into the latest technological advancements in root phenotyping. N/A	4 WLH
Examination: Presentation (approx. 20 minutes; 75%) and Oral examination (approx. 15 minutes; 25%)	6 C

Admission requirements: Knowledge about root physiology and genetics.	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Hannah Schneider
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2 - 4
Maximum number of students: 10	

Georg-August-Universität Göttingen **Module P.AG.0085: Computing in Science - Basics of Computational Biology**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Die Studierenden erlernen den Umgang mit dem Linux Betriebssystem sowie die Grundlagen im Schreiben von Shell Skripten. Mithilfe der Skriptsprache Python werden die Studierenden an die Analyse biologischer Hochdurchsatzdaten herangeführt.	Attendance time: 28 h Self-study time: 62 h

Course: Computing in Science - Basics of Computational Biology (Lecture,Exercise) *Contents*: Umgang mit der Linux Kommandozeile und das Automatisieren von Abläufen mithilfe von Shell Skripten. Auswertung und Analyse umfangreicher Datensätze aus Hochdurchsatzmethoden wie Next Generation Sequencing unter Anwendung publizierter Programme und der Skriptsprache Python.	2 WLH
Examination: Term Paper (max. 20 pages) **Examination requirements:** Im Rahmen einer Hausarbeit soll ein Datensatz aus einem Hochdurchsatzexperiment mithilfe der erlernten Methoden ausgewertet werden. Die Hausarbeit soll die erstellten Skripte und Programmcodes, Ergebnisse der Auswertung sowie einen kurzen Bericht umfassen.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Clemens Falker-Gieske
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 15	