

Module Catalogue

European Master in Animal Breeding and Genetics

**(Amtliche Mitteilungen I Nr. 7/2019 S. 60,
zuletzt geändert
durch Amtliche Mitteilungen I Nr. 46/2019 S. 1042)**

II. Double-Degree Programme "European Master of Animal Breeding and Genetics" (EMABG)

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

The following five compulsory modules worth overall 33 C must be successfully completed:

M.iPAB.0001: Quantitative genetics and population genetics (6 C, 6 SWS)..... 11729

M.iPAB.0002: Breeding schemes and programs in plant and animal breeding (6 C, 4 SWS).....	11730
M.iPAB.0007: Biotechnology and molecular genetics in plant and animal breeding (6 C, 4 SWS).	11736
M.iPAB.0013: Selection theory, design and optimisation of breeding programs (6 C, 4 SWS).....	11743
M.iPAB.0020: Breeding Lab Internship (9 C).....	11754

2. Block B - Elective compulsory modules

At least four modules worth overall at least 27 C must be successfully completed. From these at least two modules worth overall at least 9 C must be completed from a particular study track (letters a-c).

a. Study Track "Integrative Biology"

M.Cp.0016: Practical Statistics and Experimental Design in Agriculture (6 C, 4 SWS).....	11714
M.iPAB.0006: Breeding informatics (6 C, 4 SWS).....	11735
M.iPAB.0008: Molecular and biotechnological methods in plant and animal breeding (6 C, 4 SWS).....	11738
M.iPAB.0014: Data Analysis with R (3 C, 2 SWS).....	11744
M.iPAB.0016: Applied effective R programming in animal breeding and genetics (3 C, 2 SWS).....	11747
M.iPAB.0017: Applied Bioinformatics with R (6 C, 4 SWS).....	11749

b. Study Track "Genomic selection"

M.iPAB.0003: Statistical genetics, breeding informatics and experimental design (6 C, 4 SWS).....	11731
M.iPAB.0006: Breeding informatics (6 C, 4 SWS).....	11735
M.iPAB.0008: Molecular and biotechnological methods in plant and animal breeding (6 C, 4 SWS).....	11738
M.iPAB.0014: Data Analysis with R (3 C, 2 SWS).....	11744
M.iPAB.0016: Applied effective R programming in animal breeding and genetics (3 C, 2 SWS).....	11747

c. Study Track "Biological and societal context of breeding"

Only one of the moduls M.SIA.E11 and E13M can be chosen.

M.SIA.E11: Socioeconomics of Rural Development and Food Security (6 C, 4 SWS).....	11723
M.SIA.E13M: Microeconomic Theory and Quantitative Methods of Agricultural Production (6 C, 4 SWS).....	11724
M.iPAB.0003: Statistical genetics, breeding informatics and experimental design (6 C, 4 SWS).....	11731

M.iPAB.0010: Legal issues in plant and animal breeding (3 C, 2 SWS).....	11740
M.iPAB.0014: Data Analysis with R (3 C, 2 SWS).....	11744
M.iPAB.0016: Applied effective R programming in animal breeding and genetics (3 C, 2 SWS).....	11747

d. Other modules

M.Cp.0016: Practical Statistics and Experimental Design in Agriculture (6 C, 4 SWS).....	11714
M.SIA.A02M: Epidemiology of international and tropical animal infectious diseases (6 C, 4 SWS).....	11717
M.SIA.E11: Socioeconomics of Rural Development and Food Security (6 C, 4 SWS).....	11723
M.SIA.E13M: Microeconomic Theory and Quantitative Methods of Agricultural Production (6 C, 4 SWS).....	11724
M.iPAB.0003: Statistical genetics, breeding informatics and experimental design (6 C, 4 SWS).....	11731
M.iPAB.0005: Poultry breeding and genetics (6 C, 4 SWS).....	11733
M.iPAB.0006: Breeding informatics (6 C, 4 SWS).....	11735
M.iPAB.0008: Molecular and biotechnological methods in plant and animal breeding (6 C, 4 SWS).....	11738
M.iPAB.0010: Legal issues in plant and animal breeding (3 C, 2 SWS).....	11740
M.iPAB.0012: Journal Club: Key papers in animal and plant breeding (6 C, 4 SWS).....	11742
M.iPAB.0014: Data Analysis with R (3 C, 2 SWS).....	11744
M.iPAB.0015: Applied Machine Learning in Agriculture with R (6 C, 4 SWS).....	11745
M.iPAB.0016: Applied effective R programming in animal breeding and genetics (3 C, 2 SWS).....	11747
M.iPAB.0017: Applied Bioinformatics with R (6 C, 4 SWS).....	11749
M.iPAB.0019: Scientific Project: scientific methods, procedures and practical skills in animal and plant breeding (9 C, 6 SWS).....	11753

e. Alternative modules

In place of the modules listed above, it is also possible to complete other modules (alternative modules) in compliance with the following regulations. As a prerequisite for the consideration of an alternative module, the student must submit a written application addressed to the Studiendekan or Studiendekanin (dean of studies) at the faculty of agriculture. The student must submit the application before attending the respective module. The decision over the notification of acceptance or rejection will be made by the Dean of Study from the faculty of agriculture. Before reaching a decision, he or she will request a written statement from the teaching staff of the respective study programme, on the basis of which to judge the adequacy of requested replacement of modules. The student's application can be rejected without any explicit declaration of reasons; the student possesses no legal claim with respect to the permission of alternative modules.

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 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: N. N.	
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.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
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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
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Course: 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 WLH
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Course: Quantitative methods in agricultural business economics (Lecture) <i>Contents:</i> Budgeting, accounting, annual balance sheets, linear programming, finance, investment analysis	2 WLH
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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
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Admission requirements: none	Recommended previous knowledge: none
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Language: English	Person responsible for module: Prof. Dr. Matin Qaim
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Course frequency: each winter semester; Göttingen	Duration: 1 semester[s]
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Number of repeat examinations permitted: twice	Recommended semester:
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Maximum number of students: 40	
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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

Georg-August-Universität Göttingen		6 C 6 WLH
Module M.iPAB.0001: 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		6 C 4 WLH
Module M.iPAB.0002: Breeding schemes and programs in plant and animal breeding		
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. Timothy Mathes Beissinger	
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.iPAB.0003: 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; Francis O'Donnel: Statistical Experiment Design and Interpretation; An Introduction with Agricultural Examples		4 WLH
Examination: Written examination (60 minutes) Examination requirements: Profound knowledge of statistic 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		6 C 4 WLH
Module M.iPAB.0005: Poultry breeding and genetics		
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, environmental adaption 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 excursion Examination requirements: Profound knowledge about applied poultry breeding.		6 C
Admission requirements: none	Recommended previous knowledge: Basic knowledge of animal breeding	
Language: English	Person responsible for module: Dr. sc. agr. 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.iPAB.0006: Breeding informatics		4 WLH
Learning outcome, core skills: Students deepen 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"> • Design and implementation of databases with mySQL • Basic data structures • Programming in R and Perl • Regular expressions • Design and implementation of pipelines for data analysis • Shell scripts on Linux (gawk, sed) • Relation of genotype - phenotype • Measures to detect selection signatures • Basic concepts of bioinformatics 		4 WLH
Examination: Written examination (90 minutes) Examination requirements: Profound knowledge of informatic 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 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		6 C 4 WLH
Module M.iPAB.0007: 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		
Additional notes and regulations: The module includes a mandatory excursion to a DNA/Transcriptomics core facility or a breeding		

organisation.

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) <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: Protocol (max. 40 pages, 80%) and presentation (about 10 minutes, 20%) Examination requirements: The examinees should provide detailed information in their 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		3 C
Module M.iPAB.0010: Legal issues in plant and animal breeding		2 WLH
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 4 WLH
Module M.iPAB.0012: Journal Club: Key papers in animal and plant breeding		
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 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) <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: Prof. Dr. Timothy Mathes Beissinger
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.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) <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		

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

Admission requirements: Recommended previous knowledge: Basic knowledge of R	Recommended previous knowledge: 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 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 programming 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) <i>Contents:</i> 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. <ul style="list-style-type: none"> • 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: Term paper (max. 30 pages) (max. 30 pages) 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 <ul style="list-style-type: none"> • 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. Henner Simianer
Course frequency: each summer semester	Duration: 1 semester[s]
Number of repeat examinations permitted:	Recommended semester:

twice	Master: 2
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		6 C 4 WLH
Module M.iPAB.0017: Applied Bioinformatics with R		
<p>Learning outcome, core skills:</p> <p>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:</p> <p>Attendance time: 56 h</p> <p>Self-study time: 124 h</p>
<p>Course: Applied Bioinformatics with R (Lecture, Exercise)</p> <p><i>Contents:</i></p> <p>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:</p> <p>none</p>	<p>Recommended previous knowledge:</p> <p>Basic knowledge of R</p>	
<p>Language:</p> <p>English</p>	<p>Person responsible for module:</p> <p>Dr. Mehmet Gültas</p>	
<p>Course frequency:</p> <p>each winter semester</p>	<p>Duration:</p> <p>1 semester[s]</p>	

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

Georg-August-Universität Göttingen		9 C 6 WLH
Module M.iPAB.0019: Scientific Project: scientific methods, procedures and practical skills in animal and plant breeding		
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 <i>Contents:</i> 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: Dr. Mehmet Gültas	
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		9 C
Module M.iPAB.0020: Breeding Lab Internship		
Learning outcome, core skills: 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.		Workload: Attendance time: 160 h Self-study time: 110 h
Course: Breeding Lab Internship (Internship, Seminar) <i>Contents:</i> 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. 30 minutes, 50%) with written report (max. 15 pages, 50%) 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.		
Admission requirements: Only EMABG Students	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: from 2	
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.