Study guide 2012

European Master in Animal Breeding and Genetics

EMABG consortium
Wageningen University (the Netherlands), University of Natural Resources and Life Sciences (Austria), AgroParisTech (France), Swedish University of Agricultural Sciences (Sweden), and The Norwegian University of Life Sciences (Norway)

Preface

This study guide contains information on the European Master in Animal Breeding and Genetics (EMABG). It gives an overview of the study program and the subjects offered by the different universities in the domain of animal breeding and genetics. The overview of subjects is based on the study programs of students in recent years. For information on other subjects: please contact the study advisor at your university.

Dieuwertje Lont, EMABG secretariat

Johan van Arendonk, (WU, EMABG coordinator)

Birgitta Malmfors (SLU)

Gabor Meszaros and Johann Sölkner (BOKU)

Grégoire Leroy and Etienne Verrier (APT)

Gunnar Klemetsdal (UMB)

August, 2012

Contents

1. Objective of EMABG

In 2007, six European universities started the "European Master in Animal Breeding and Genetics (EMABG)". The large number of applicants and the excellent job opportunities for EMABG graduates prove that the course serves a clear need. The EMABG has created an unique opportunity for the universities to exchange teaching experiences and to strengthen not only their own courses but also the joint curriculum. The first edition of 23 students graduated in 2009.

Integrating education in a joint course offers students a better opportunity to specialize in a certain aspect, as well as to have access to a broad range of subjects, bringing about a holistic view to the sustainable use of animal genetic resources. The course has proven to be highly relevant for EU and third-country students who wish to be employed in organizations working in the field of animal breeding and genetics.

The EMABG provides an European dimension to the knowledge-intensive area of farm animal breeding, which is operating internationally. European animal breeding organisations are world leaders, with global market shares of up to 90%. There is an increased need for people with a MSc degree in animal breeding, but the number of graduates is currently decreasing. The EMABG, therefore, provides a response not only to the need for highly-qualified graduates but also to the need to adapt education systems to the demands of society, to enhance the attractiveness and visibility of European higher education world-wide, and to stimulate the process of convergence of degree structures across Europe. The EMABG aims to train students who wish to contribute to the development of sustainable farm animal breeding. Graduates find positions in and outside Europe, in training, research or development in a wide range of organisations related to animal breeding and genetics.

The EMABG overall aim is:

- to offer quality higher education with a European perspective in the field of animal breeding and genetics, which is attractive to EU citizens and third-country nationals;

- to enhance the quality of training in animal breeding and genetics and to strengthen the position of Europe as a centre of excellence in teaching; and

- to contribute to needs of societies by developing the qualifications of women and men so they possess the appropriate skills, and are open-minded and internationally experienced.

We want to realise this aim by offering a joint study program that attracts the most talented students and academics from Europe and third countries.

2. Content of the course

The course objective is summarized in the Figure 1 below, which illustrates the scientific expertise and scopes that are used in the course to develop the appropriate expertise and competences required to address the societal issues. The learning outcomes of the course are specified in section 3.

The EMABG concentrates on the development of **scientific expertise** in the areas of quantitative, population and molecular genetics related to animal breeding. This involves **four scopes**:

• Breeding and society

• Biodiversity

• Breeding program

• Genetic analysis and (genome) functioning

The EMABG involves a range of species: farm animals (ruminants, pigs, poultry, and horses), fish and companion animals (dogs, cats, and horses), as well as natural populations (in the wild or in zoos). For farm animals and fish, the genetic concepts will be discussed in a holistic view, considering the role of animal breeding in the production system and the global use of animal genetic resources for agricultural and societal needs. The knowledge of genetics and genomics is used in the context of sustainable animal breeding strategies. For farm animals and fish, attention is to breeding schemes that contribute to improving food security, with special attention to animal welfare, ecological impact, and biodiversity. For companion animals, attention is to animal welfare, and functions, such as recreation, support, and sport. For natural populations, attention is to biodiversity and ecosystem services. These topics are discussed in an international context. The EMABG is truly international, as illustrated by the numerous links of the consortium to global research and to capacity building in developing countries. The topics of EMABG are related to important societal issues: attention is to development of complementary skills needed to work in teams that contribute to solutions.

The summary of study program of the EMABG course is in Table 1. The main characteristics of the course are:

1. The EMABG is a 2 year course (120 ETCS) and builds on existing MSc courses.

2. The EMABG has three joint activities: Introduction Period, Summer Event and graduation event. Furthermore thesis research is often conducted under joint supervision from the two host universities.

3. The EMABG has required and elective subjects at the two host universities for the development of scientific expertise and complementary skills.

4. Students are offered an opportunity to do an internship or placement, this is regarded as an extracurricular activity.

The EMABG offers a tailor-made study plan that meets the needs of the individual student. Each EMABG student plans his/her own study at two host universities. The student will spend one year at each of the selected host universities. Coherence and quality of the study program are discussed and approved by the mentors of both host universities to ensure that the study plans meets the requirements of both universities to award their degree. The study program requires approval from the Examining Committee or comparable body of both host universities.
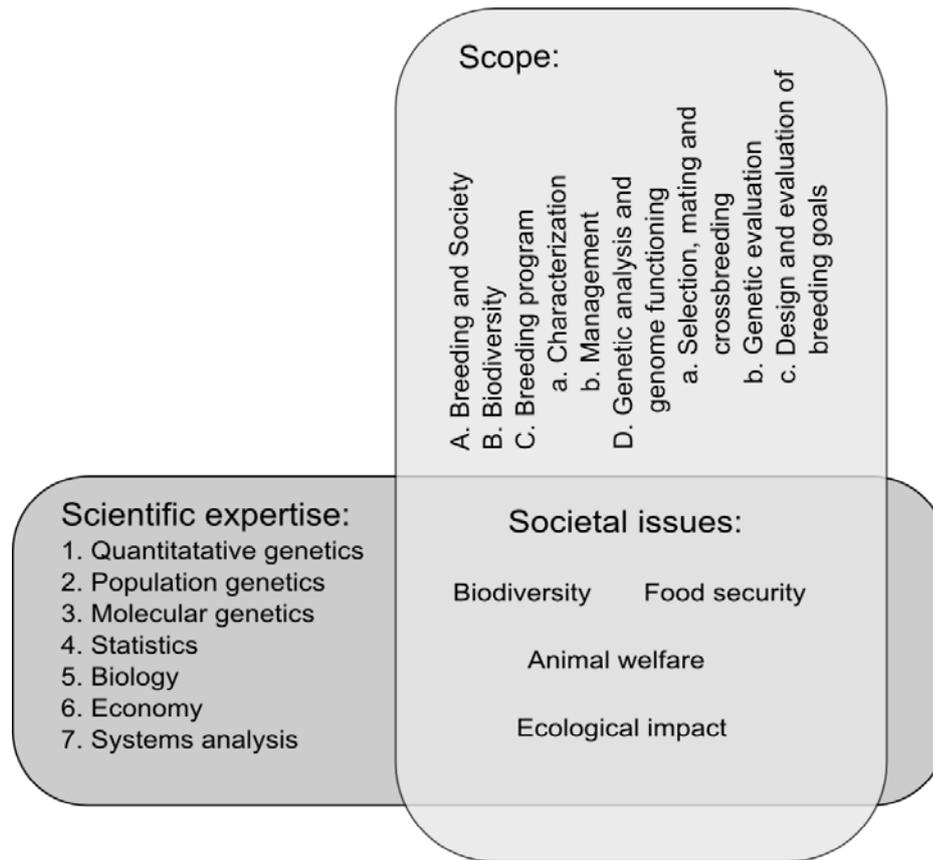
Figure 1: Illustration of the scientific expertise and scopes that are used in the course to develop the appropriate expertise and competences required to address the societal issues.

Introduction Period (in August at WU, The Netherlands)
At the opening of the course, all EMABG students will attend the joint Introduction Period (IP) in Wageningen, this period is recognized as "Welcome to EMABG" subject in study program (6 ECTS). This IP introduces students to a European and Global dimension that will complement their existing knowledge of farm-animal breeding and genetics. Furthermore, the IP pays attention to cultural differences and rights and responsibilities of students and teachers in EMABG. The IP is the cornerstone of the EMABG, because it provides students with an invaluable insight into the multi-faceted nature of European training in animal breeding and genetics. The three-week intensive subject provides the students with an introduction to topics ranging from biodiversity to business management and to questions of social responsibility. The WE also introduces students to each other and to the staff from all partner universities, introduces the opportunities for specialisation within EMABG, and starts discussions between staff and students regarding their choice of optional subjects.

Disciplinary subjects (at all universities)
Each university provides a number of disciplinary subjects related to animal breeding and genetics. A detailed description of the disciplinary subjects is given in sections 4 and 5. That section provides an overview of the learning outcomes and the scientific expertise and scopes covered by each of the subjects. Each university will recognise the disciplinary subjects from the other universities. The overview in section supports students in making a careful selection of subjects, to enable that students can utilize the complementarity between partner universities.

Table 1. Overview of study program of EMABG course

What	Aim	Year (%) 1	Year (%) 2	ECTS
Joint Introduction Period	Introduction + academic skills	100		6 (a)
Disciplinary subjects	Development of scientific expertise	60	40	24-36
Elective subjects	Development of scientific expertise in related areas	60	40	18-30
Complementary skills	Development of skills needed to become an effective scientist	70	30	0-24
Joint Summer Event	Project management and career planning		100	(a)
Internship	Getting to know the industry	50	50	(b)
Thesis research	Conducting research related to Animal Breeding and Genetics		100	30-60
Joint graduation event	Presentation of research results		100	p.m.
Degree from two universities		50	50	120

(a) The total study load of Joint Introduction Period, and Joint Summer Event is 6 ECTS.
(b) Internship is regarded as an extra-curricular activity.

Internship or placement (in a national or international organization or company)
The aim of the Internship is to offer students the opportunity to learn about the needs of national and international organisations and companies in their field and to apply their skills and knowledge. The opportunity for an internship is included in the program in response to the request from current EMABG students who want to gain experience outside universities during the summer period between academic years. Organizations and companies will be offered the opportunity to formulate assignments for internship, and the student can propose an organisation and assignment for internship. The length of the internship will range from 4 to 8 weeks. The exact period depends on the course schedules of the two host universities of the student. The assignment, placement, and reporting are agreed upon in advance by the organisation and one of the host universities. The organisation is required to provide a mentor for the student during the internship. No ECTS credits are awarded for the internship, but the internship can be mentioned by the student as an extra-curricular activity.

Elective subjects (in any of the partner universities)
Students can choose from a large variety of subjects from each partner university to complete their personal study plan. The partner universities offer a broad range of subjects lectured in English in fields such as Animal Health, Product Quality, Natural Resource Management, Business Economics, Plant Science, and Microbiology. Section 6 shows the diversity of subjects followed by EMABG students at the different partner universities in the past years.

Complementary skill training (in any of the partner universities)
Complementary skill training provides the students with tools to respond to a challenging situation in animal breeding programs. This training focuses on problem solving through team work, science communication and ethics. It is important that students learn-by-doing to work together as an international team to realise a goal. The complementary skill training can be

offered as a separate subject (e.g. Academic Master Cluster at WU) or be integrated as a teaching method in other subjects.

Thesis research under joint supervision (in any of the partner universities)
The thesis research is an important component of the EMABG course and consists of research leading to a thesis in the field of animal breeding and genetics. The student is required to follow a number of subjects (disciplinary and/or elective) in order to be able to conduct thesis research. These required subjects are discussed with the student during the Introduction Period at the start of the program. Depending on the study program of the student, the thesis will be conducted under the supervision of teaching staff from one or both (joint supervision) of the host universities. In the case of joint supervision, the research plan must be approved by both universities awarding the degrees, the research must be conducted under dual supervision, and examiners from both universities must be involved in the final examination of the thesis. In the case of joint supervision, a thesis contract with details on the requirements and process is signed by the student and both supervisors (see section 6 for copy of thesis contract). Video conferencing, e-mail, and Skype may be used to facilitate dual supervision and to enhance contacts between partners.

Complementarity
All EMABG partners have a large training and research program in the animal breeding and genetics. Consequently, there is overlap between the subjects offered by the partners. For example, all partners provide the basic skills needed for animal breeding and genetics. Partners also have their own identity resulting from differences between the universities in which they are embedded, their past and current research program, and the differences between the societies in which they operate. The partners complement each other, therefore, on

- Scientific expertise and subjects offered,

- Educational expertise and teaching methods,

- Network and capacity of disseminating the research findings; and

- Geographical and cultural area, and livestock production systems.

The mobility between universities offers the opportunity for students to benefit from this complementarity by studying in different environments, which will assist them in becoming internationally experienced.

> *The mobility offers students the opportunity to benefit from the complementarity of partners, to experience studying in different environments which will assist them in becoming internationally experienced.*

The five host universities represent diversity of geographical areas, local languages, and cultures. Complementarities are also found in the diversity of livestock production systems (from high to low input systems), breeds raised (from highly specialized to robust breeds), animal products (from cheap and standard products to products under official signs of quality or origin), and organisation of breeding programs (farmer cooperatives or associations and private companies).

3. Requirements and learning outcomes

The EMABG is implemented as a double-degree program. The minimum contribution of each university that is required for awarding double degrees is in Table 2.

Table 2. Minimum contributions (in ECTS) from each university for awarding a degree.

University	Minimum contribution from university (ECTS)
BOKU	30 for subjects at BOKU and 30 for thesis under (joint) supervision of BOKU
APT	30 for subjects at APT and 30 for thesis under (joint) supervision of APT
SLU	30 for subjects at SLU and 30 for thesis under (joint) supervision of SLU
UMB	• At least 60 ECTS at UMB, • minimum of 30 for thesis under (joint) supervision of UMB
WU	• 30 for subjects at WU and 30 for thesis under (joint) supervision of WU • the full program should contain at least 48 ECTS of individual work (e.g. thesis, internship, individual literature research) • students need to follow two out of four restricted optional subjects at WU (or take equivalent courses at the other host university)

The **learning outcomes** of EMABG have been refined in 2011, in response to changes in the field and feedback from students and employers. After completion of the EMABG course, graduates will be able to:

1. Describe the current world context of animal breeding, and reflect on its social and ethical aspects.
2. Show knowledge of biostatistics, and quantitative and molecular genetics, and use correct scientific vocabulary.
3. Identify and analyse key factors and forces behind animal breeding problems and relate their own discipline to a multidisciplinary framework.
4. Create a solution for a given problem by applying appropriate research methods, instruments and tools, and organise, monitor, and evaluate results within their specialisation, while
   - collecting relevant information and literature,
   - understanding and applying required methods to conduct research,
   - reflecting critically on own and literature research work, and adjusting and suggesting improvement of the analysis.
   - concluding and pointing out practical recommendations based on analysis of results.
5. Present an oral and written report of study and research activities, considering the nature of the audience.
6. Adapt and apply their knowledge to different working and cultural environments.
7. Demonstrate the learning and organisational skills to continue to study in a manner that may be largely self-directed or autonomous.
8. Operate in an international context in both content and social-cultural aspects, both independently and in a team.

.4. Detailed description of ABG subjects within EMABG, including learning outcomes, expertises and scopes

4.1 EMABG Subjects: Norwegian University of Life Sciences (UMB)

Course code	Course name	No. of ECTS	Scientific disciplines						Scopes			
			1	2	3	4	5	6	A	B	C	D
EDS220	Statistical analysis	10				X					X	
AKA251	General Aquaculture-genetics and breeding	5	X			x					X	
AKA260	Aquaculture Breeding and Genetics	10	X		x	x					X	
AKA350	Optimisation of Fish Breeding Programmes	10	X		x	X		x	x		X	
BIO210	Molecular Biology	10			X		X					X
BIO220	Eucaryot Molecular Biology				X							X
BIN300	Statistical Genomics	10	X		x	x					X	
BIN310	Models and Algorithmns in Bioinformatics	10				X					X	
BIN350	Genom Analysis, methodology	5			X		X					X
BIO322	Molecular Genomics	10			X							X
BIO321	Population Genetics and Molecular Evolution	10		X						X	X	
GEN320	Molecular Markers for Genomics	5			X							X
HFA300	Animal Breeding Plans	10	X		X	X		X	X		X	
HFA301	Calculation of Breeding Values	10	X		x	x					X	
HFA303	Biological Aspects of Animal Breeding	5	x				X	x	X	x		
HFA304	Theory and Application of Inbreeding Management	10	X							X	X	
HFX300	Design and Analysis in Animal Science and Aquaculture	5				X					X	
STAT300	Statistical Data Analysis	10				X					X	

Scientific disciplines
1. Quantitative genetics
2. Population genetics
3. Molecular genetics
4. Statistics
5. Biology
6. Economics/system analysis

Scopes
A) "Breeding and society"
B) Biodiversity
o   Management
o   Characterization
C) Breeding program
o   Breeding goals
o   Genetic evaluation ((G)EBV)
o   Selection/mating/cross
D) Genetic analysis and (genome) functioning

4.2 EMABG subjects: University of Natural Resources and Life Sciences (BOKU)

Course code	Course name	No. of ECTS	Scientific disciplines						Scopes			
			1	2	3	4	5	6	A	B	C	D
932.306	Advanced Animal Breeding	6	x							x	x	
932.313	Design of Breeding Programs	4	x								x	
932.310	Excursion Animal Production	1						x	x			
932.047	Animal Breeding and Genetics	6	x	x	x	x					x	x
932.311	Quantitative Animal Genetics	6	x			x					x	
932.048	Paper Discussion Animal Breeding and Genetics	2	x	x	x					x	x	x
932.324	Animal Husbandry in Tropical and Subtropical Regions	3						x	x	x		
169.402	Applied Development research I	3						x	x			
169.403	Applied Development research II	3						x	x			
912.010	Agricultural Sciences in developing countries	3						x	x			
932.401	Applied Statistical Methods in Livestock Sciences	7	x			x					x	
932.312	Genetics of Diversity	3		x						x		
930.300	Master's Thesis Seminar	2	x	x	x			x	x	x	x	x
932.301	Molecular Animal Genetics	4			x	x	x					x
932.308	Animal Production Systems	6						x	x			
951.325	Molecular Plant Breeding (Lecture)	3			x							x
951.326	Molecular Plant Breeding (Practical)	3			x							x

Scientific disciplines
1. Quantitative genetics
2. Population genetics
3. Molecular genetics
4. Statistics
5. Biology
6. Economics/system analysis

Scopes
A) "Breeding and society"
B) Biodiversity
o   Management
o   Characterization
C) Breeding program
o   Breeding goals
o   Genetic evaluation ((G)EBV)
o   Selection/mating/cross
D) Genetic analysis and (genome) functioning

4.3 EMABG subjects: AgroParisTech (APT)

First year:

M1 Students follow the academic schedule of AgroParisTech students.

This annual schedule is organised following 6 fixed (described below) and 5 optional sequences (not listed).

Course code	Course name (First year)	No. of ECTS	Scientific disciplines						Scopes			
			1	2	3	4	5	6	A	B	C	D
BT63	Module Biologie Intégrative – *Integrative biology module*	9			x		x					x
	Module Langues étrangères - *Foreign Language module*	3										
	Module Statistiques - *Statistics module*	3				x						
	Module Epistémologie – *Epistemology module*	3							x			
4TE28	Module Europe de l'Animal – Le bien être en question – *Europe, Animals and Welfare module*	3							x			
AGROPT15	*Farm animals today module (in English)*	3		x	x		x		x	x	x	
Course code	**Course name (Second year)**	**No. of ECTS**	**1**	**2**	**3**	**4**	**5**	**6**	**A**	**B**	**C**	**D**
A.1	Quantitative and statistical genetics, mathematical tools	5	x			x					x	
A.2	Multi-scale investigations of genetic variation	5			x		x					x
A.3	Genetic diversity and populations management	5	x	x				x	(x)	x	x	
B.1	Ethical, juridical and social aspects in animal science	2.5						(x)	x			
B.2	Practice of molecular biology	2.5			x							x

Scientific disciplines

1. Quantitative genetics
2. Population genetics
3. Molecular genetics
4. Statistics
5. Biology
6. Economics/system analysis

Scopes

A) "Breeding and society"
B) Biodiversity
o   Management
o   Characterization
C) Breeding program
o   Breeding goals
o   Genetic evaluation ((G)EBV)
o   Selection/mating/cross
D) Genetic analysis and (genome) functioning

4.4 EMABG subjects: Swedish University of Agricultural Sciences (SLU)

Course code	Course name	No. of ECTS	Scientific disciplines						Scopes			
			1	2	3	4	5	6	A	B	C	D
BIO962	Genome analysis	10			X		X					X
BIO961	Bioinformatics	10			X		X					X
BIO996	Genetically modified organisms	10			X		X					X
BI1036	Gene regulation in eukaryotic cells	15			X		X					X
HV0098	Designing breeding programmes	10	X	X		X	X	X	X	X	X	X
MS0041	Analysis of categorical data	5				X						
HV0092	Disease genetics	5	X	X	X	X	X		X		X	X
HV0091	Behavioural genetics	5	X		X	X	X		X		X	X
HV0036	Behavioural Physiology	5					X					
BI1173	Conservation biology (nature conservation)	10		X			X		X	X		
HV0061	Cattle production	15	X	X			X	X	X	X	X	
HV0060	Pig production	10	X	X			X	X	X	X	X	
HV0084	Tropical livestock production	5					X	X	X	X	X	
HV0079	The biology and use of the horse	15	X	X			X	X	X	X	X	
HV0072	Dogs and cats – genetics, health and reproduction	10	X	X	X		X		X	X	X	
HV0087	Dog and cat nutrition	5					X					
HV00--	Animal welfare and behaviour (4 courses, in total 30 ects)	30					X					

Scientific disciplines

1. Quantitative genetics
2. Population genetics
3. Molecular genetics
4. Statistics
5. Biology
6. Economics/system analysis

Scopes

A) "Breeding and society"
B) Biodiversity
o   Management
o   Characterization
C) Breeding program
o   Breeding goals
o   Genetic evaluation ((G)EBV)
o   Selection/mating/cross
D) Genetic analysis and (genome) functioning

4.5 EMABG subjects: Wageningen University (WU)

Course code	Course name	No. of ECTS	Scientific disciplines						Scopes			
			1	2	3	4	5	6	A	B	C	D
ABG-51306	Welcome to EM-ABG	6	x						x	x	x	
ABG-…04	Summer School Animal Breeding and Genetics	4	x	x				x	x		x	
ABG-30806	Modern Statistics for the Life Sciences	6	x			x					x	
ABG-30306	Genomics	6		x	x		x					x
ABG-50806	Ecology of Animal Life Histories	6		x			x			x		
ABG-31306	Genetic Improvement of Livestock	6	x			x		x		x	x	
ABG-20306	Animal Breeding and Genetics	6	x			x			x	x	x	
ABG-58106	Wildlife Conservation Genetics	6	x	x			x		x	x		
YAS-60312	Research master cluster	12							x	x	x	x
GEN-30306	Genetic Analysis, Tools and Concepts (GATC)	6			x		x					x
GEN-30806	Population and Quantitative Genetics	6	x	x			x			x	x	
MAT-20306	Advanced Statistics	6				x						x
MOB-20306	Gene Technology	6			x		x					x

Scientific disciplines
1. Quantitative genetics
2. Population genetics
3. Molecular genetics
4. Statistics
5. Biology
6. Economics/system analysis

Scopes
A) "Breeding and society"
B) Biodiversity
o   Management
o   Characterization
C) Breeding program
o   Breeding goals
o   Genetic evaluation ((G)EBV)
o   Selection/mating/cross

D) Genetic analysis and (genome) functioning

5. EMABG subjects: Overview of subjects with learning outcomes

5.1 Norwegian University of Life Sciences

Course code	Course name	No. of ECTS	Level (BSc/MSc)	Period	Lecturers	Learning outcomes
EDS220	Statistical Analysis	10	BSc/MSc	Autumn	Ellen Sandberg	-Students will acquire knowledge of basic statistical models and methods that are used in applied research
AKA251	General Aquaculture – Genetics and breeding	5	BSc/MSc	Autumn	Hans Magnus Gjøen	-Students will learn the basic aquaculture genetics and breeding, in addition to some major aquaculture breeding programmes.
AKA260	Aquaculture Breeding and Genetics	10	MSc	Spring	Hans Magnus Gjøen	-Students are to acquire sound knowledge in the use of traditional and modern fish breeding methods. The students are to gain skills in the evaluation of various strategies and methods and be able to understand the principles of estimating various breeding parameters. As a conclusion of the course, the students will be able to suggest a breeding program for a fish breeding company with given breeding goals and restrictions.
AKA350	Optimisation of Fish Breeding Programmes	10	MSc	Autumn	Hans Magnus Gjøen	-The student will be able to understand and make sensible use of various simulation software for optimisation of breeding schemes for aquaculture species.
BIO210	Molecular Biology	10	BSc/MSc	Autumn	Bao Dzung Diep	-An elementary understanding of DNA synthesis (replication, recombination and reparation), RNA synthesis and protein synthesis. A basic molecular biological understanding of gene regulation. It is important that the students understand model systems for gene regulation: The lactose operone, regulation of the tryptophan operone and the lambda bacteriophage. A basic understanding of protein-DNA interaction in gene regulation is important. Both bacterial and eukaryote systems will be elucidated, but the main emphasis will be on bacteria.
BIO211	Laboratory Course in Molecular	5	BSc/MSc	Spring	Bao Dzung Diep	-The laboratory course gives practical experience in basic molecular genetic and molecular biological techniques. By writing the laboratory journal, the students are trained in critical evaluation of experimental data.

	Biology					

BIO220	Eucaryot Molecular Biology	5	BSc/MSc	Spring	Hilde-Gunn Opsahl Sorteberg	-Here, we will guide the students from a genetic understanding to application of their genetic knowledge (theory and practical experience from laboratory experiments) and analysis. The knowledge they are to gain is on eucaryote genetics and on the understanding of genes and genomes. This course provides a basis for further studies in biotechnology, livestock breeding, food, plant breeding, bioinformatics and medicine. Students should also learn how to use literature for solving problems, with elements of problem-based learning in colloquia. This is to repeat the basis of molecular biology as well as opening up for increased current learning.
BIN300	Statistical Genomics	10	MSc	Spring	Theodorus Meuwissen	-Students should be able to judge the pros and cons of: - alternative mapping methods for genes and QTL, - alternative designs and methods of analysis for the fine scale mapping of genes, - alternative methods for the analysis of sequence data and gene detection. The students should acquire sufficient knowledge to follow more advanced courses in these fields.
BIN310	Models and Algorithmns in Bioinformatics	10	MSc	Autumn	Lars-Gustav Snipen	-Students must be able to explain the theory behind central scoring models for sequence alignments, and thereby understand the basis of statistically based conclusions. The students will understand the optimal algorithms for sequence alignments, and implement variants of them in a high-level language. Students will know the principles behind commonly used heuristic algorithms for pairwise and multiple sequence alignments. Markov models, and other probabilistic models, and how these are used for sequence analysis, are central to the course. Students will process large data sets in a modern scripting language, and retrieve relevant information from searches in international databases. The student should also be able to present subject-relevant material both orally and in writing.
BIN350	Genom Analysis, methodology	5	MSc	Autumn	Øivind Andersen	-Students shall be able to give an overview of important genome resources, explain how these are organised in information databases, and on an individual basis be able to evaluate which of these resources are most relevant in real-life cases.
BIO322	Molecular Genomics	10	MSc	Autumn	Dag Inge Våge	-After completing the course, students are to have established a good understanding of how higher-level eucaryote genomes are built up and regulated. The students are to be able to describe and explain the most important methods used to study genomes, transcriptomes and proteomes, including the evaluation of the strengths and weaknesses of the methods.The students will learn and obtain experience with how to prepare and deliver effective oral and written presentations of technical information and scientific

						results. They will learn to think critically and solve complex and multidisciplinary problems, as well as learn to accurately interpret current research literature.
BIO321	Population Genetics and Molecular Evolution	10	MSc	Autumn	Odd Arne Rognli	-The students should be able to understand the dynamics of the evolutionary changes that happen at the molecular level, the evolutionary forces behind such changes and the evolutionary effects of different molecular mechanisms on genomes, genes and gene products. --The students should also gain theoretical insight and practical skills in methods used in comparative and phylogenetic analyses based on molecular data. The students should develop a critical approach towards the interpretation of this type of data, and a level of knowledge sufficient to understand cutting edge research articles on the subject. The students should be able to plan their own research on the subject and apply relevant methods in order to analyse and present the results
GEN320	Molecular Markers for Genomics	5	MSc	Spring	Manfred Joachim Heum	-The students will learn DNA marker-based approaches for understanding genome organisation and evolution. The lab part will provide the students with hands-on experience to do DNA-based work for their MSc/ PhD work.
HFA300	Animal Breeding Plans	10	MSc	Spring	Tormod Ådnøy	-Students will learn about the importance of biological, technical and economic conditions within animal species, and evaluate this in alternative breeding plans.
HFA301	Calculation of Breeding Values	10	MSc	Autumn	Tormod Ådnøy	-Students will learn what breeding values calculated as blup-values are, and will be able to calculate these values for example data sets. They will also be acquainted with the estimation of variance components that are required to find blup-values.
HFA303	Biological Aspects of Animal Breeding	5	MSc	Autumn	Odd Vangen	-Students will be able to describe domestic animals as a biological system with development strategies developed through evolution and adaptation to the environment. Students will learn examples where domestic animal breeding has resulted in the partial disruption of this biological system. Students will be able to analyse these examples and reflect on how different domestic animal breeds and species can be compared. -The following concepts will be explained; fitness, resource allocation, maternal effects, development strategies etc. -The most important traits in domestic breeding will be explained, in addition to experiments examining the consequences of selection. -The student should also be able to consider different ways of comparing domestic animals, and exhibit a balanced view of ethical and biological aspects of breeding through discussions

HFA304	Theory and Application of Inbreeding Management	10	MSc	Spring	John Arthur Wooliams	-To present a unified approach to the management of inbreeding, providing supporting concepts with practical tools.
HFX300	Experimental Design and Analysis in Animal Science and Aquaculture	5	MSc	Autumn	Theodorus Meuwissen	-The course shall increase the practical understanding and application of statistical techniques, that were taught in earlier statistics courses, to the practical situations in animal science and aquaculture. -The students shall be able to use, understand, and know the pros and cons of various statistical methods and designs that are used as part of their main master thesis. Also, the students should be able to critically judge the statistical methods used in research reports.
STAT300	Statistical Data Analysis	10	MSc	Spring	Trygve Almøy	-The students learn about the assumptions, applications, and theoretical background for the most common methods within multivariate statistical analysis. It will be emphasised that the students, to a given problem in their study or later in their work, will be able to formulate the problem in such a way that it can be analysed by means of suitable multivariate statistical method(s). Furthermore, the students learn to decide which method(s) that can be used to model and analyse the problem, and to do the analysis, (if necessary) by means of suitable software. The students also learn the practical interpretation and to assess the validity of models, methods, and results.

5.2 University of Natural Resources and Life Sciences, Vienna

Course code	Course name	No. of ECTS	Level (BSc/MSc)	Period	Lecturers	Learning outcomes
932.306	Advanced Animal Breeding	6	MSc	March - June	Dr. Alfons Willam	Upon completion of the course the student should be able to: -Deepened understanding of the theoretical knowledge in animal breeding and linking up with practical animal breeding. -Understanding the basic concept of a breeding program and the organization of running a breeding program.
932.313	Design of Breeding Programs	4.5	MSc	October - January	Dr.Alfons Willam	Upon completion of the course the student should be able to: -Deepened methodical understanding of the basic process of designing and optimizing breeding programs. -Simple designing and optimizing breeding programs through modeling. -Evaluation of alternative breeding programs in pig and cattle based on theoretical and practical examples.
932.310	Excursion Animal Production	1	MSc	Field trip - Summer	Prof. Dr. Knaus Wilhelm Friedrich Dr. Willam Alfons Prof. Dr. Winckler Christoph Prof. Dr. Zollitsch Werner	-Within a 3-day-field trip to farms students get a practical view and understanding of the various forms of animal production here in Austria (cattle, pigs, laying hens, poultry, sheep, goats, and in some years niches like turkeys, geese, etc.). Animal food processing is mostly part of the program.
932.047	Animal Breeding and Genetics	6	MSc	September -October	Prof. Dr. Johann Sölkner, Dr. Gábor Mészáros	This course is given as a distant-learning variant of the Animal Breeding and Genetics course at WU (ABG-20306).

932.311	Quantitative Animal Genetics	6	MSc	October - January	Prof. Dr. Johann Sölkner	Student is able to: -Understand in depth the concepts of models depicting the genetics of traits (from infinitesimal to major gene effects) -Apply procedures of estimation of heritabilities and breeding values in animal populations -Grasp and evaluate new concepts of genomic selection
932.048	Paper Discussion Animal Breeding and Genetics	2	MSc	October - January	Prof. Dr. Johann Sölkner, Dr. Gábor Mészáros	Upon completion of the course the student should be able to: -recognise the specific structure of a scientific paper -extract the most important information from the paper and present these for an audience involved in animal breeding and genetics -critically review and formulate questions about the published work -engage in scientific discussions -deal with the rights and tasks of a chairperson, as a part of a different role during the lecture
932.324	Animal Husbandry in Tropical and Subtropical Regions	3	MSc	March - June	Dr. Maria Wurzinger	Students are able to: -characterize a livestock production system and to describe linkages between different components -analyze different interventions (feeding strategies, animal interventions, breeding) -understand limitations of livestock production
169.402	Applied Development research I	3	MSc	October – January	Maria Wurzinger, Michel Hauser, Georg Gratzer, e.o	Students are able to: -discuss different theories on development research -prepare a research proposal -apply interdisciplinary and transdisciplinary research
169.403	Applied Development research II	3	MSc	March – June	Maria Wurzinger, Michel Hauser, Georg Gratzer e.o	Students are able to: -communicate research results in different forms -present research findings to a scientific and non-scientific audience
912.010	Agricultural Sciences in	3	MSc	October – January	Georg Gratzer, Maria Wurzinger,	Students are able to: -analyze different components of a production system

	developing countries				Axel Mentler, Michel Hauser	-understand current conflicts in land management and use of natural resources -discuss principles of development cooperation and interact with different stakeholders
912.011	Agricultural Sciences in developing countries (Seminar)	6	MSc	March - June	Dr. Maria Wurzinger, Prof. Dr. Georg Gratzer, Prof. Dr. Axel Mentler	Students are able to: -search relevant literature for preparation of a scientific publication -present and discuss different research results orally and in a paper -engage in scientific discussions
932.401	Applied Statistical Methods in Livestock Sciences	7	MSc	March - June	Dr. Birgit Fürst-Waltl	At the end of the course students should -have and extended knowledge about statistical methods (linear models and nonparametric statistics) as used in the area of animal science -be able to choose the right statistical method for their problem and to interpret the results correctly. -be able to edit and analyze data by means of the software package SAS
932.312	Genetics of Diversity	3	MSc	October - January	Dr. Birgit Fürst-Waltl	At the end of the course students should -be familiar with basic terms and principles of population genetics essential for the understanding of the mechanisms of evolution and the methods used in animal and plant breeding -be able to calculate and interpret various measures of genetic variability -be able to put lessons learnt into practice (regarding genetic variability and conservation genetics of domesticated but also wildlife and zoo populations)

930.300	Master`s Thesis Seminar	2	MSc	October - January	all	Upon completion of the course the student should be able to: -review the published literature in the field of their thesis -summarize these findings and give an overview about the methodology in a form of a short presentation -summarize, formulate and present their own research findings, after conducting the thesis research -clarify the less clearly stated points to the audience (if needed) -defend their research findings in a scientific discussion
932.301	Molecular Animal Genetics	4	MSc	October - January	Dr. Marlies Dolezal Dr. Hermann Schwarzenbacher	Upon completion of the course the students have a basic understanding -of how to search and retrieve information from the big public biological databases EMBL and NCBI. -of how to use some of the most important bioinformatics tools provided at the EBI and NCBI -of how to navigate in Ensembl and the UCSC genome browser -of the steps involved in genome projects -of high throughput technologies such as microarrays for studying sequence variation and expression, tiling arrays and next generation sequencing -of the principles of QTL mapping in livestock populations -of the principles of whole genome association studies and of genomic selection -of statistical methods applied to state-of-the-art molecular animal breeding and genetics

932.308	Animal Production Systems	6	MSc	October - January	Prof. Dr. Wilhelm Friedrich Knaus, Prof. Dr. Christoph Winckler, Prof. Dr. Werner Zollitsch, Mag. Marlene Kirchner	Upon completion of the course the student should be able to: -to conceive and analyse the most relevant factors that are embraced by an animal production system. -to get a broader picture of the consequences of changing factors within the system regarding animal performance but also ecological and social aspects. -to be able to present and discuss the interrelationships between various factors of a selected animal production system (sometimes by means of a case study depending on the general topic of the year).
951.325	Molecular Plant Breeding (Lecture)	3	MSc	October - January	Prof. Hermann Bürstmayr, Prof. Eva Stöger	Upon completion of the course the student should be able to: -understand the principles of molecular genetics and especially their relevance for plant and animal breeding -gain a thorough knowledge about molecular genetic tools for plant and animal improvement -learn about examples and applications of molecular genetics methods in plant and animal improvement -learn about recombinant DNA techniques (plant transformation, genetically modified organisms) and their application potential for crop improvement
951.326	Molecular Plant Breeding (Practical)	3	MSc	February	Prof. Hermann Bürstmayr, Dr. Barbara Steiner	Upon completion of the course the student should be able to: -plan and perform practical molecular marker work in a molecular marker laboratory. -this includes DNA extraction, DNA quality control, performance of microsatellite marker analysis, polymerase chain reaction, agarose- and polyacrlyamide gel electrophoresis -data collection from DNA fingerprinting experiments, including gel-scoring. -understand the principles of genetic mapping and genetic diversity analsyis based on molecular genetic data

5.3 AgroParisTech

First year

M1 Students follow the academic schedule of AgroParisTech students.

This annual schedule is organised following 6 fixed (described below) and 5 optional sequences (not listed).

Course code	Course name	No. of ECTS	Level (BSc/ MSc)	Period	Lecturers	Learning outcomes
BT63	Module Biologie Intégrative – Integrative biology module	9	MSc	Sep-Oct	D. Azzout, C. Gallardin, T. Heams, C. Neema, B. Ney, M.D. Bancal, M.Saint-Dizier	-To relate the different levels of organisation within a living being. -To establish a basic model or analysis on a file including biological information. -To interpret a model regards to its biological implications.
	Module Langues étrangères - Foreign Language module	3	MSc	Sep-Jan	D. Serrano, G. Tamisier, A. Reule	-To acquire an improved level of comprehension and expression in one foreign language.
	Module Statistiques - Statistics module	3	MSc	Sep-Oct	E. Lebarbier, E. Pommies, C. Vuillet, M. Zetlaoui	-To apply linear model and Principal Component Analysis on a given data file
	Module Epistémologie – Epistemology module	3	MSc	Oct	T. Heams	-To analyse scientific information with a critical mind.
4TE28	Module Europe de l'Animal – Le bien être en question – Europe, Animals and Welfare module	3	MSc	Nov-Dec	C. Duvaux Ponter, C. Wisner Bourgeois	-To identify the basis of animal welfare, regards to behavioural physiological and sanitary aspects -To identify the parameters that led to the current European legislation toward animal welfare. -To list the actors interacting about animal welfare.
AGROPT 15	Farm animals today module (in English)	3	MSc	Nov	A. Serment, G. Tamisier	To list the numerous roles of animals using selected examples. -To tell basic information on the different aspects of animal production. -To memorise a basic animal science vocabulary.

Second year

Course code	Course name	No. of ECTS	Level (BSc/MSc)	Period	Lecturers	Learning outcomes
A.1	Quantitative and statistical genetics, mathematical tools	5	MSc	Oct-Dec	E. Verrier, V. Ducrocq	-To identify the statistics basis of the main concepts used in quantitative genetics -To memorize the properties of the up-to-date methods for genetic evaluation and the conditions of validity of their application. -To construct the right model in a concrete situation of data analysis and to perform a genetic evaluation on small data sets.
A.2	Multi-scale investigations of genetic variation	5	MSc	Oct-Dec	H. Gilbert, F. Hospital, P. Croiseau, T. Heams	-To record the statistical methods used in association genetics. -Be able to apply methods of QTL detection on small datasets. -To identify biological processes involved in genome expression. -To relate the different forms of variation in genome structure and expression.
A.3	Genetic diversity and populations management	5	MSc	Oct-Dec	E. Verrier, G. Leroy, F. Phocas, F. Hospital	-To state the concepts of population genetics and to infer an analysis of genetic variability within and between populations. -To recall the approaches and methods to define breeding goals. -To memorise the principles, methods and organisation of a breeding program and to know how to assess its efficiency.
B.1	Ethical, juridical and social aspects in animal science	2.5	MSc	Sep	M. Mambrini, H. Combrisson	-To identify the ethical issues subtending their research and experimental practices -To practice an ethical evaluation of their research project and finally -To associate ethics among the vectors and arguments considered for the future development of their topics.
B.2	Practice of molecular biology	2.5	MSc	Sep	S. Bellier	-To practice of basis processes in molecular biology. -Identify the conditions to obtain reliable results in molecular analysis.

5.4 University name: Swedish University of Agricultural Sciences (SLU)

Course code	Course name	ECTS	Level	Period	Lecturers	Learning outcomes
BIO962	Genome analysis	10	MSc	29 Aug - 6 Nov 2011, 65%	Prof G. Andersson Prof L. Andersson	After completion of the course, the student should be able to: - comprehensively describe organization and evolution of different procaryotic and eucaryotic genomes - describe projects concerning complex genomes - understand the principles for genome mapping and how different mapping techniques are used to identify genes underlying diseases, plant defense or control of phenotypic traits in both animals and plants - use laboratory methods to define genetic variation at the molecular level - integrate knowledge in genetics and biotechnology to solve complex problems of relevance for genome analysis - independently search for, summarize, interprete and critically assess scientific articles in genetics, molecular genetics and genomics - discuss ethical issues related to the genetics of complex traits and formulate his/her own point of view and argue for it in writing and orally - summarize the importance of and how bioinformatics can be used in genome analysis.
BIO961	Bioinformatics	10	MSc	7 Nov 2011 - 15 Jan 2012, 65%	Assoc prof E. Bongcam	After completion of the course, the student should be able to: -understand and describe the basic principles of bioinformatics - independently carry out comparisons of protein and DNA sequences, and to interpret the results - work within Unix/Linux operating systems - build a bioinformatics "workbench" with publicly-available programs that are suited to his/her own needs - use biological databases - know the statistical methods on which bioinformatics is based

BIO996	Genetically modified organisms	10	MSc	29 Aug 2011 – 15 Jan 2012, 35%	Researcher Dr N. Gyllenstrand Prof J. Meijer Prof G. Andersson Assoc prof A. Lundén	After the course the students should be able to: - describe how genetic modification of microorganisms, animals and plants are carried out and applied - detect genetically modified organisms - describe principles of risk-benefit analysis of genetically modified organisms - describe legislation, regulations and ethical values relevant to genetic modification and laboratory animals - handle mouse and rat and describe appropriate sample and injection procedures - outline the design of a unit for experimental animals and its activities - describe different parameters used to assess pain, stress and wellbeing of animals - write an application to carry out animal experiments considering ethical aspects
BI1036	Gene regulation in eukaryotic cells	15	MSc	16 Jan - 25 Mar 2012	Prof L-G. Larsson Prof H. Ronne Assoc prof C. Sun	After completion of the course the student is expected to be able to: - describe important molecular mechanisms, which are the basis for expression of the genetic material in eukaryotic cells - discuss important modern techniques in molecular genetics, biochemistry and cell biology that are used to study gene expression and gene regulation in eukaryotic cells - demonstrate the ability to apply practically a number of advanced techniques developed within this subject - independently interpret and critically analyse obtained results as well as to give written and oral presentations of the results in English
HV0098	Designing breeding programmes	10	MSc	16 Jan - 25 Mar 2012, 65%	Prof L. Rydhmer Prof E. Strandberg Prof D-J de Koning Assoc prof F. Fikse	On completion of the course, the student should be able to: - critically review scientific literature in animal breeding - describe how breeding organisations work and explain why the breeding programmes of today are designed the way they are - estimate genetic parameters, breeding values and genetic progress - design breeding programmes for domestic animals of different species, in various environments and production systems - assess animal breeding programmes regarding different sustainability aspects and suggest concrete measures to improve these programmes.

MS0041	Analysis of categorical data	5	MSc	16 Jan - 25 Mar 2012, 35%	Assoc prof C. von Brömssen	After completion of the course, the student should be able to - account for basic statistical principles for analysis of categorical data. - analyse and obtain concrete results by means of the computer package SAS. - discuss and to critically judge the statistical contents in scientific articles from different fields of applications.
HV0092	Disease genetics	5	MSc	16 Jan - 25 Mar 2012, 35%	Prof E. Strandberg	After completion of the course, the student should be able to: - describe various types of inheritance for health traits (diseases and disorders) - summarize and discuss methodologies used to analyse such traits (both molecular genetic and statistical methods) - describe and discuss consequences of relations between health traits and other important traits, both in farm and companion animals - suggest and analyze breeding programs aimed at improving health traits, and to discuss measures needed to implement such programs - read and critically assess scientific papers on disease genetics - discuss ethical issues related to disease genetics and formulate his/her own point of view in such topics.
HV0091	Behavioural genetics	5	MSc	26 Mar - 1 Jun 2012, 35%	Prof L. Rydhmer	After completion of this course the student should be able to: - comprehensively describe how different behaviours are inherited and how behavioural traits can be changed through selection, and also to predict consequences of such selection - integrate knowledge in genetics and ethology in order to solve complex problems of relevance for animal husbandry - independently search, summarize, interpret and critically assess scientific articles on behavioural genetics - discuss ethical issues in relation to behavioural genetics and formulate a point of view in such issues, both in written form and orally.
HV0036	Behavioural physiology	5	MSc	26 Mar - 1 Jun 2012, 35%	Assist prof E. Sandberg Prof K. Dahlborn	After completion of the course the student should be able to: - explain how animal behaviour is related to the anatomy, histology and physiology of the brain and nervous system - evaluate and discuss the action of hormones of importance for behaviour - describe the sensory organs of different domestic animals and discuss their importance for animal behaviour

						- analyse important differences in behavioural physiology of domestic animals - describe and suggest different methods to measure parameters in behavioural physiology
BI1173	Conservation biology	10	MSc	7 Nov 2011 - 15 Jan 2012, 65%	Prof Lena Gustafsson Assoc prof T. Ranius PhD stud Katja Fedrowitz	After completing the course, the students shall be able to: - identify the extent and causes of the most important threats to biodiversity globally and nationally. - summarise the main effects on biodiversity by forestry, agriculture and other types of land use, including habitat restoration. - assess threats to species and populations, for instance as done when redlists are constructed. - synthesise relevant information by searching and reading scientific articles. - work out a case study in which modern ecological theories are applied in nature conservation - identify different reasons to conserve nature, and explain how these affect research and priorities given in conservation work - explain some conflicts between nature conservation and other goals of the society. - explain how governmental and non-governmental organisations (global, national, and local) work with nature conservation. - communicate scientific information related with nature conservation to different types of audience. - explain different approaches to solve conservation problems.
HV0061	Cattle production	15	MSc	16 Jan - 25 Mar 2012, 100%	Prof B. Berglund Assoc prof J. Bertilsson Dr K-J Petersson	After passing this course the student should be able to: - describe the importance of cattle for the agriculture as well for the society as a whole and account for trends and development in cattle production - identify the most important strengths, weaknesses, opportunities and threats to Swedish cattle production in relation to the EU and to the rest of the world - in written and oral form, analyze production systems for milk and meat from cattle regarding efficiency, economy, reproduction, natural animal behavior, animal health and welfare, as well as for working conditions and for the surrounding environment - formulate feeding as well as management recommendations for cattle based on the animal needs, available feedstuffs and economic prerequisites - describe important quality traits in milk and beef and how these are influenced

						by breeding, feeding and management - explain the importance of genetic variation for genetic improvement of animal production, reproduction and health - describe and compare the design of breeding programs for milk and beef production in different countries - describe recording systems for cattle and their importance for management control and for breeding activities
HV0060	Pig production	10	MSc	26 Mar - 1 Jun 2012, 65%	Assoc prof N. Lundeheim Assoc prof M. Neil Prof J-E Lindberg	After completing the course the student should be able to: - describe the structure of pig production, including the conditions and structure in Sweden and other parts of the world, and be able to discuss their ethical aspects - describe the pig´s nutritional requirements in the different stages of its life, the connection between nutrient supply and production, the usage of different feedstuffs, and the variation in, and heritability of, the various traits that are important for production, reproduction and health - describe the most common diseases of the pig - analyze and evaluate different breeding programs, management systems and production models (including ecological production), with regard to production efficiency, economy, animal health and protection, product quality and influence on the environment - summarize the scientific literature in popular science news-items, critically review the contents and discuss potential applications in pig production - plan, with a focus on the production economics, animal health and welfare, the production of pig-meat needed for a society of a given size, from raw materials to pre-slaughter.
HV0084	Tropical livestock production	5	MSc	16 Jan - 25 Mar 2012, 35%	Assoc prof E. Wredle Prof J. Philipsson Assoc prof B. Malmfors	After passing this course, the student should be able to: - explain the role of livestock in agriculture, food supply, poverty alleviation and interactions with the environment in developing countries - describe and critically evaluate different forms of animal production systems under tropical conditions, with a focus on small-scale integrated systems - describe the usage of commonly occurring tropical feedstuffs - broadly describe the most important diseases of livestock and their significance for both humans and animals in the tropics, and also describe the most important means of disease control - describe and analyse breeding strategies and the suitability of different animal

						genetic resources and their use for sustainable animal production under tropical conditions
HV0079	The biology and use of the horse	15	MSc	29 Aug - 6 Nov 2011, 65%	Prof J. Philipsson Dr Å. Viklund Assoc prof A. Jansson	After completion of the course, the student should be able to: - describe and compare traits and areas of utilization of different horse breeds, as well as analyze the development of the horse industry - describe domestication and natural behavior of the horse and exemplify how feeding and management can influence the behavior. - describe the physiology of the horse with main focus on reproduction-, digestion-, exercise physiology and locomotor apparatus as well as conformation - describe and compare different reproduction techniques - describe and compare methods for training and testing of young horses of the most common breeds for sport, work and breeding - describe and compare different methods for genetic evaluation and selection among horses of the most common breeds - characterize the most common diseases, defects and disorders and discuss choices of healthcare methods as well as animal welfare issues - plan and critically assess horse management systems considering feeding, management and effects on animal behavior and environment, as well as adaptation to current legislations - with a biological holistic perspective indentify and analyze needs and conditions for a sustainable use of horses.
HV0072	Dogs and cats – genetics, health and reproduction	10	MSc	7 Nov 2011 - 15 Jan 2012, 65%	Prof E. Strandberg Dr K. Grandinson Prof G. Andersson PhD stud P. Arvelius	After completion of the course, the student should be able to: - describe factors influencing the development of breeding programs for dogs and cats - use knowledge about health traits and genetics to evaluate possibilities for breeding programs for health traits in various populations - describe and compare reproductive physiology of dogs and cats - search for and evaluate species-specific information about breeding and diseases - describe and compare various information sources that can be used as a basis for breeding and studies of health traits - discuss ethical issues concerning dog and cat breeding and health - independently describe and scientifically analyze problems of relevance for breeding and health of dogs and cats, suggest solutions and present these orally and in written form.

HV0087	Dog and cat nutrition	5	MSc	7 Nov 2011 - 15 Jan 2012, 35%	Assoc prof M. Neil	After completing the course, the student should be able to: - describe and discuss conditions for of keeping dogs and cats in Sweden and in other parts of the world - describe the nutritional requirements for dogs and cats, and relations between feeding and health, including similarities and differences between these species -compose diets for dogs and cats in different phases of life and varying conditions - search for and evaluate information regarding nutrition of dogs and cats - independently survey and scientifically analyze nutritional problems of relevance for dogs and/or cats, and suggest solutions, and present and discuss these orally and in writing.
HV00--	Animal welfare and behaviour (4 courses, in total 30 ects)	30	MSc	29 Aug 2011 – 15 Jan 2012	Assoc prof L. Berg Prof B. Algers Prof H. Blokhuis Assoc prof L. Lidfors Prof L. Keeling Assistant prof J. Jung	In summary, after completion of the 4 courses students should be able to: - describe and analyse the importance of performing different animal behaviours in diverse animal environments. - formulate problems arising in animal husbandry connected to animal behaviour. - explain how humans can be affected by animals and vice versa - discuss animal protection and animal welfare from different perspectives - explain and comment upon EU, Swedish legislation and international aspects to protect animals as well as -identify the most commonly occurring views in animal ethics. - work scientifically, to be able to design studies on the behaviour and welfare of animals, as well as critically evaluate the studies of others. - prepare and lead seminars based upon research papers within applied animal behaviour

5.5 Wageningen University (WU)

Course code	Course name	ECTS	Level	Period	Lecturers	Learning outcomes
ABG-51306	Welcome to EM-ABG	6	MSc	September-October	prof. dr ir JAM van Arendonk persons from European partners EM-ABG	- Describe the role and organisation of Animal Breeding in various species in general terms; - Identify and explain the set-up of EM-ABG and its (scientific) environment; - Discuss a scientific concept; - Critically read and comment on a scientific paper; - Write an abstract and make a scientific poster for a chosen paper.
ABG-52304 (new in 2013)	Summer School Animal Breeding and Genetics	4	MSc	August	prof. dr ir JAM van Arendonk persons from European partners EM-ABG, collaboration with ILRI	After this course the student will be able to: -respond, in writing, on issues related to characterization and use of animal genetic resources, -understand the basic ideas of participatory approaches to understand needs of farmers, -design a breeding program which meets the local environemental and market conditions -evaluate of alternative breeding programs in farm animals based on theoretical and practical examples -present a case study on the implementation of breeding program
ABG-30806	Modern Statistics for the Life Sciences	6	MSc	January - February	dr. H. Bovenhuis	-Explain the general differences between a linear model (LM), linear mixed model (ABG-30306LMM) and generalized linear model (GLM) in terms of model assumptions -Present simple examples of data structures that should either be analyzed by a LM, LMM or GLM -Execute an analysis with a standard LM (ANOVA or regression), LMM (split-plot) or GLM (logistic regression or log linear model) for a given data set and interpret the results of such an analysis. -Explain the principle of maximum likelihood estimation. -Describe the differences between Bayesian and frequentistic statistics

						-Explain how the heritability of a trait can be estimated in pedigreed populations and in a cross between inbred lines -Explain how Quantitative Trait Loci (QTL) can be detected in an outcross population and in a cross between inbred lines and design QTL mapping experiments. -Design an experiment for estimating heritabilities or for QTL mapping. -explain the difference between a linkage study and an association study.
ABG-30306	Genomics	6	MSc	January - February	prof. dr MAM Groenen dr JAL van Kan prof. dr ir FPM Govers ir HJWC Megens	-Find and retrieve genomic information using web based genome browsers and databases; -Recall and use the tools used for the development of genetic, physical and sequence maps of prokaryotic and eukaryotic genomes -Recall the relations between these different maps and the specific application of the different maps in genome mapping; -Use comparative mapping tools, and in particular be able to explain the concept of genome synteny and orthologous and parologous relationships between genes; -Use methods to identify genes and ascribe potential functions to their products and apply the concept of gene ontology. -Recognize the incompleteness of the available genomic data in databases and that the data is being generated and updated almost on a daily basis; -Use genomic information to deduce information on the organization, functioning and evolution of microbes, plants and animals; -To assess the methods and the results for mapping monogenic and complex genetic traits in the fields of medicine, nutrition, animal breeding and plant breeding.
ABG-50806	Ecology of Animal Life Histories	6	MSc	February	K Lessells (NIOO-KNAW) M Visser (NIOO-KNAW) M Naguib (NIOO-KNAW) dr ir P Bijma A van Noordwijk	-Recall key concepts related to the evolution of life-histories (including: the existence of different kinds of explanation for biological characteristics ('Tinbergen's 4 whys'); trade-offs; phenotypic plasticity). -Apply these key concepts to the evolution of life-history phenomena. -Critically appraise evolutionary explanations for life-history phenomena. -Formulate clear questions related to life-history phenomena. -Think up alternative hypotheses for life-history phenomena. -Understand the need for experiments in measuring or testing causal

					(NIOO-KNAW) K van Oers (NIOO-KNAW)	hypotheses concerning life-history phenomena. -Design experiments to test between alternative hypotheses for life-history phenomena. -Develop and explain, both in writing and verbally, a research project on a life-history phenomenon.
ABG-31306	Genetic Improvement of Livestock	6	MSc	November - December	Prof. Dr. Ir. JAM van Arendonk Dr. Ir. H Bovenhuis	-Derive multiple trait selection indices and the corresponding accuracy of selection for simple situations. -Derive breeding goals based on information on economic and societal properties of the production system. -Estimate breeding values from small data sets using the mixed model equations. -Explain the underlying principles of genomic selection and its consequences for the structure of breeding programs. -Predict the rate of genetic improvement of alternative breeding programs. -Understand and discuss the consequences of different structures of breeding programs on the response to selection and the rate of inbreeding. -Explain and quantify the effect of selection on the genetic variance (Bulmer effect). -Explain the reduced selection intensity due to small groups of candidates and correlated index values of candidates
ABG-20306	Animal Breeding and Genetics	6	BSc-MSc	September-October	H.A. Mulder dr. ir. P. Bijma	- Explain with the single locus model that populations can be changed genetically by means of artificial selection. -Explain how family relationship between individuals can be used to estimate breeding values. -Estimate the genetic merit of animals based on phenotypic observations using selection index theory (in simple cases). -Describe the steps that need to be taken when setting up a breeding program. -Describe the consequences of different selection and mating strategies for the response to selection. -Explain how artificial selection can have undesirable long-term effects and indicate how these undesirable side effects can be prevented. -Predict the rate of inbreeding for simple situations

						-Explain the principle of linkage analysis
ABG-51806	Wildlife Conservation Genetics	6	MSc	March/April	Dr. ir. J. Komen Prof. dr. B.J. Zwaan Dr. D.K. Aanen Dr. Ing. R.P.M.A. Crooijmans	After successful completion of this course students are expected to be able to: - identify the major evolutionary forces that shape genetic variation; - explain how evolution and genetics are linked; - calculate inbreeding coefficients in small populations; - explain the dynamics of genetic variation due to population size and structure; - evaluate and construct management and conservation breeding plans and programmes.

6 Diversity of subjects followed by EMABG students at different partner universities

WU Course category	Course code	Course name	Number of students
Disciplinary subjects	ABG-31306	Genetic improvement of livestock	26
	ABG-30806	Modern statistics for life sciences	15
	ABG-20306	Animal Breeding and Genetics	22
	ABG-51306	Welcome to EM-ABG	24
	ABG-30306	Genomics	10
	ABG-50806	Ecology of Animal Life Histories	1
	GEN-30306	Genetic Analysis, Tools and Concepts (GATC)	4
	GEN-30806	Population and Quantitative Genetics	1
Elective subjects	MAT-20306	Advanced Statistics	19
	MOB-20306	Gene Technology	5
	CBI-30306	Human and Veterinary Immunology	1
	VIR-30306	Molecular Virology	1
	BIF-30806	Advanced Bioinformatics	2
	ADP 30806	Adaptation Physiology II	1
	APS-20806	System Approach in Animal Sciences	2
	COM 32806	Communication Strategies in Everyday Life	1
	BIC 20306	Cell Physiology and Genetics	1
	MIB 21306	Bioinformation Technology	1
	QVE-30306	Quantitative Veterinary Epidemiology	1
	SCH 20306	Gender, Culture, Consumers and Markets: Critical Historical and Sociocultural Feminist Perspectives	1
	BIC-80812	Systems@work: A toolbox of systems biology	1
Complementary skills	YAS-60312	Research Master Cluster	5

SLU Course category	Course code	Course name	Number of students
Disciplinary subjects	BI 0962	Genome Analysis	21
	BI 0961	Bioinformatics	23
	HV 0098	Designing breeding programs	2
	HV 0076	Disease genetics	16
	HV 0020	Behavioural Genetics	12
	HV 0021	Animal Breeding and genetics	10
	IN 0709	Tropical Livestock breeding	5
	HV 0072	Dog and Cat genetics	7
	IN0795	Principles of Animal Breeding	3
	IN0794	Livestock Breeding Program Project	3
Elective subjects	HV 0051	Cattle Production	2
	BI 0996	GMOs and Lab animal Science	17
	HV 0074	The biology and use of the horse	6
	HV 0040	Protection and welfare of animals	2
	HV 0095	Anthrozoology	1
	HV 0068	Tropical Livestock production	4
	BI 1011	Bees, Apiculture and Pollination	1
	HV 0058	Dog and cat nutrition	1
		Project Work- bioinformatics	1
	MS0041	Analysis of Categorical Data	1
	HV0018	Biology of lactation	2
	IN0632	Individual course	4
	BI0969	Methods in protein chemistry	1
	IN0751	Individual course in horse breeding	1
	HV0060	Pig production	2
	HV0097	Applied animal behaviour	1

APT Course category	Course code	Course name	Number of students
Disciplinary subjects	A1	Quantitative genetics and mathematical tools	12
	A2	Multi scale investigation of genetic variation	12
	A3	Genetics diversity and population management	12
	B1	Ethical, juridical and social aspects in Animal Science	12
	B2	Practice of molecular biology	12
Complementary skills	C1	Literature review	12

BOKU Course category	Course code	Course name	Number of students
Disciplinary subjects	932-312	Genetics of diversity	12
	932-313	Designing breeding programs	12
	932-309	Biostatistics in livestock science	10
	932-306	Advanced animal breeding	10
	932-048	Paper discussion in animal breeding	14
	954-301	Genome structure and Genome analysis	6
	932-311	Quantitative Animal Genetics	12
	932-047	Animal Breeding and Genetics	8
	932-301	Molecular animal genetics	4
Elective subjects	932-310	Excursion animal production	10
	751-310	Metabolism Physiology	1
	932-317	Animal welfare assessment	2
	932-324	Animal husbandry in Tropical and subtropical regions	10
	932-047	Excursion animal breeding and genetics	1
	832-311	More recent conflict species in Wildlife Management	2
	923-308	Animal Production Systems	8
	932-401	Applied statistical methods in livestock research	5
	954-316	Computer-assisted Data analysis in Molecular biology	4
	832-321	BOKU international Wildlife lectures	1
	951-325/6	Molecular Plant breeding (theory/practical)	12
	793-306	Bioinformatics	6
	772-308	Biotechnology	1
	933-320	Facilitating Organic farming in Tropical and sub-tropical regions	2
	732-317	Participatory Methods and Tools for Mountain forestry Applications	1
	954-310	Phylogenetic evaluation of DNA sequences	2
	932-322	Small Ruminant Science	2
	945-316	Cell biology	3
	954-305	Molecular biology for plant pathogen-interaction	1

	793-402	Bayesian Data Analysis in the Life Sciences	2
	851-001	Statistics with R - the Open Source Way	2
	851063	Statistical data analysis using SAS	1
	933-110	Organic farming in tropical and subtropical regions	2
	954-313	Genetically modified organisms in the environment	2
	772308	Genetic Model Organisms in Biotechnology	1
	832-321	International wildlife lectures	1
	791-309	Animal cell culture technology	1
	954-314	Exercises in molecular biology	1
	791-325	Flow cytometry and cell sorting	1
	751312	Food safety in livestock feeding	1
	970301	Analysis of Bio-Hazards in Foods	1
	954313	Biotechnology meets Population Genetics	1
	954315	Practical course in cell biology	1
	954-316	Molecular biology	1
	951-321	Classical and molecular cytogenetics for plant breeding	1
Complementary skills	735-329	Decision making in management with special emphasis on cultural differences	1
		Journal club biotechnology in animal breeding and genetics	1
	915-327	Project management	3
	120-090	German for Beginners	4
	120-091	German for beginners II	1
	891-325	Research design	1
	120-001	Intensive German course	3
	930-300	Master thesis seminar	2

UMB Course category	Course code	Course name	Number of students
Disciplinary subjects	AKA 251	General aquaculture breeding and genetics	7
	AKA 350	Optimization of fish breeding programs	3
	AKA 260	Aquaculture breeding and genetics	4
	BIO 322	Molecular Genomics	4
	HFA 304	Theory and Application of inbreeding management	8
	HFA 300	Animal breeding plans	11
	BIN 300	Statistical genomics	16
	GEN 220	Genetics Basis of Biodiversity	7
	BIO 321	Population Genetics and Molecular Evolution	7
	BIN 350	Genome Analysis, Methodology	7
	BIN 322	Molecular genomics	3
	HFA 301	Calculation of Breeding Values	3
	GEN 320	Molecular markers for genomics	3
Elective subjects	BIO 340	Bioethics	1
	EDS-220	Statistical analysis	5
	BIN 210	Molecular biology	1
	BIN 310	Models and algorithms in bioinformatics	3
	BIO 210	Molecular Biology	4
	EDS 220	Statistical analysis	2
	BIO 350	In situ RNA hybridisation techniques	1
	BIN321	Evolution	1
	TAT 250	Laboratory Course in International Aquaculture	2
	HFX207	Introduction to Animal Production and Fish Farming in Developing Countries	2
	HFX306	Feeding and Production Diseases in Cattle	1
	BIO 220	Eukaryotic Molecular Biology	2
	BIO 211	Laboratory course in Molecular Biology	3
Complementary skills	STAT 330	Analysis of Categorical data	1
	STAT 200	Statistical Data Analysis	2

7 Topics of MSc thesis

University	Thesis title
WU	• Community fingerprinting of benthic invertebrates Denaturing Gradient Gel Electrophoresis and 454 sequences • Detecting Signatures of Selection in chicken genome using next-generation sequencing technology • Genetic analysis of milk fatty acid compositions based on Infrared Data • Detection of copy number variation (CNV) in whole genome SNP data in dairy cattle • Analysis of Pooled Data for Early Egg Production in Laying Hens • Relationships of milk Se content with udder health and fertility traits in dairy cow • Comparing different approaches to pedigree reconstruction in commercial brood stocks of Common sole, Solea solea (L., 1756) • Social Effects and Heritable Variation in Finishing Traits of Pigs • Effects of selection based on survival of full sib groups in cannibalistic laying hens • Genetic diversity in Dutch Draught Horses
SLU	• Fine mapping of QTL for autoimmune vitiligo in a cross between the Smyth and Brown line chickens • Molecular analysis of candidate genes for immune-mediated rheumatic disease in the canine breed Novia Scotia Duck Tolling Retriever • Inherited disorders and their management in some European warmblood sport horse breeds • Fine mapping of QTL for autoimmune Diseases in Chickens • Production Objectives and Selection Criterions for Three Endemic Ruminant Breeds in The Gambia and Senegal • Characterisation of Global Brown Swiss Cattle Population Structure • Bioinformatics and molecular genetic studies of the IGF2-TF gene family • MHC class II genes as risk factors for immune diseases in German Shepherd dogs • Genetic analyses of eventing data of Swedish Warmblood hoses • Evaluation of a novel statistical test for determining specific scenarios of epistasis
APT	• The genetic factors of the immune responses in domestic fowl: polygenic parameters, detected QTL's and identified genes • Fine mapping of QTL involved un viral resistance in rainbow trout and search for candidate genes • Adaptation of fish to their environment: link between phenotypic plasticity and classical welfare measurements • Ability of mammary glands tissue to respond to pathogen: inflammatory response, expression study • Analysis of the genetic diversity in divergent sheep populations • Correlative responses on female reproduction in a selection experiment for feed efficiency in a Large White population • Genetic variability and correlations for growth and carcass traits in Creole cattle raised under two contrasted environments

	• Molecular genetics of cortisol production • Detecting genome wide associations for production traits in commercial pig populations • QTL mapping for pig meat quality traits
BOKU	• Concept measuring inbreeding depression and purging of finesse traits on a finer scale • Estimates of economic values for important traits of two indigenous sheep breeds of Ethiopia • Measuring inbreeding depression and purging of fitness traits on finer scale
UMB	• Screening of blood and mucus parameters towards breeding for resistance to Salmon louse in Atlantic Salmon • Effects of feeding behaviour on growth and feed efficiency of pigs • Casein haplotype variability among the Norwegian dairy goats • Comparison of genomic selection methods using Austrian Simmental cattle Genomic data • Casein loci SNPs and haplotypes association with milk production traits of Norwegian goats and their French Alpine crosses • Prediction of Copy number variation from their LD with SNPs • Effects of polymorphisms in DGAT1 and SCD1 on milk fat composition of summer milk samples. • Troubleshooting in parentage assignment of Common sole (Solea solea) • Genetic diversity in the Gelder horse • Molecular characterization of Bantam Phenotype in Chicken • and correlations for egg production for different periods in crossbred lines using pooled observations • the effect of Beta-lactoglobulin protein variants on production, reproduction and conformation traits • Genetic Diversity of Shetland Ponies with an Emphasis of Withers Height Category and Coat Colour • Genome assembly of Culicoides obsoletus causing agent of IBH in horses

8 – EMABG joint thesis contract

THESIS CONTRACT FOR ALL EMABG STUDENTS
The thesis contract needs to be completed for each thesis project conducted by
EMABG students (i.e. with and without joint supervision).

STATUS OF THE THESIS CONTRACT
The thesis contract formalizes the agreements made between the student and
the departments. It is a supplementation and elaboration of the rights and
obligations that student and supervisors have. In case of joint supervision, the
contract specifies the roles and obligations of staff from both universities involved
in the supervision.

FILL IN AND SIGN THE CONTRACT

-   Before any thesis activities begin, this form must be filled in for all thesis
    courses by the student and the representatives of the departments from
    the universities involved.
-   The student and the two department representatives must each sign
    three completed forms. Each will receive an original, and a copy will also
    be sent to the study coordinators and the EMABG secretariat.
-   In case of joint supervision: representatives of both universities need to
    sign this form.
-   After adding to and/or changing the contract, the student will be given a
    new copy.

PROBLEMS AND COMPLAINTS

-   If there are any problems or complaints having to do with supervision or
    evaluation please contact the study coordinator or look at the host
    university website for procedures.

PLEASE USE THESE INSTRUCTIONS WHEN COMPLETING THIS FORM!!!

1. GENERAL INFORMATION

Student :…………………….. EMABG year : 1 / 2

Current host university: ………………. Registration no. :………………………

Department : ……………………… Study coordinator:…………………….

1st supervisor of thesis: ……………… Course code: ………………………..

2nd supervisor of thesis: ……………… Amount of ects: ……………………….

Examiner   :……………………….

Is joint supervision required for fulfilling requirements for obtaining double degree? Yes/No

In case of a joint thesis also fill in the details for your first host university:

University:…………………………………..   Registration no.: ……………………………..

Department:…………………………………..   Study coordinator:…………………………….

Supervisor :……………………………………   Course code:………………………………….

Examiner:……………………………………………

2. GENERAL DESCRIPTION AND PLANNING FOR THE THESIS (see also section 3)

Subject : . . . .

Planned starting date   : . . . - . . . - ..   Special circumstances concerning planning:

Planned completion date   : . . . - . . . - ..

Intensity: . . . hours / week   . . . .

Other comments: : ……………………………………………………………………………..

3. MAGNITUDE OF ACTIVITIES, PLANNED AND ACTUAL*

Nature of the activities	Planned weeks
Total number of weeks	

*Can be updated in project plan

4. PREREQUISITE SUBJECTS (those which must still be completed)

Code   Name   Credits   Planned completion

. . . . . - . . . . before starting | completing thesis

. . . . . - . . . . .before starting | completing thesis

. . . . . - . . . . before starting | completing thesis

5. AGREEMENTS REGARDING JOINT SUPERVISION, REPORTING AND EVALUATION

5.1 Supervision

Action	Planned date(s)
Approval of project plan* by supervisor(s) of both universities (within 4 weeks after the start of the thesis work)	
Student writes a monthly written update ("joint supervision logbook") to supervisors of both universities	No dates needed
Three formal discussion moments between student and supervisor(s) of both universities – (via video-conferencing, Skype, phone, etc.)	1. 2. 3.
Discussion (over e-mail) with supervisor(s) of both universities about the draft of the thesis report	

* background and detailed description of the topic (min. 2 pages), written by the student

5.2 Reporting

1. Student writes a report of the performed thesis research.

2. Student keeps logbook on all the above mentioned activities (feedback, written updates, etc). Logbook, signed by supervisors and student, is handed in before the exam.

5.3 Evaluation

At the exam, at least the examiners and the student are present. Form of the exam is dictated by the rules of the host university. In case of a joint thesis, an exam will be held via video-conferencing or Skype when the local situation permits this. The examiners will jointly agree on the mark. The following aspects are subject of evaluation

A Research competence

1 Commitment and perseverance
2 Initiative and creativity
3 Independence
4 Efficiency in working with data
5 Handling supervisor's comments and development of research skills
6 Keeping to the time schedule

B Thesis report

1 Relevance research, clearness goals, delineation research
2 Theoretical underpinning, use of literature
3 Use of methods and data
4 Critical reflection on the research performed (discussion)
5 Clarity of conclusions and recommendations
6 Writing skills

C Oral presentation

1 Graphical presentation
2 Verbal presentation and defence

D Examination

1 Defence of the thesis
2 Knowledge of study domain

6. AGREEMENTS REGARDING FACILITIES AT THE HOST UNIVERSITY *[workplace, availability of apparatus + materials,, building access, printing costs]*

7. Specific arrangements regarding research or publication of thesis *[confidentiality etc]*

8. SIGNING THE AGREEMENT

....   Student
[place]

. . . ‾ . . . ‾ . . . .
[date]

Study coordinator   Thesis supervisor   Examiner
current host university   current host university   current host university

. . . .

Only In case of joint supervision