Universitat Autònoma de Barcelona

2021/2022

Agrogenomics

Code: 101939
ECTS Credits: 6

Degree	Type	Year	Semester
2500890 Genetics	OT	4	0

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Teachers

Josep Maria Folch Albareda
Jesús Piedrafita Arilla
Carlota Poschenrieder Wiens
Silvia Busoms Gonzalez
Joaquín Casellas Vidal

External teachers

Amparo Monfort
Jordi Garcia
Maria Jose Aranzana
Marta Pujol
Pere Arús
Werner Howad

Prerequisites

There are no official requirements to enroll in Agrigenomics, but it would be good to meet the following conditions:

- The students should know the basics of Quantitative Genetics and Breeding

- The student should be able to read texts written in English

Objectives and Contextualisation

The agri-food industry is the main activity of the European manufacturing industry, with an approximate value of 954,000 million euros and a total of 310,000 companies that provide service to 500 million customers. The Spanish agri-food industry ranks fifth in the European ranking and the first in the national level, represents 17% of the Spanish industrial GDP (and 7% of the total), exports for a value of 13,000 million euros (only surpassed by automobile sector) and has 32,000 companies.

Genetic improvement, genomics and biotechnology are fundamental pillars of the efficient and sustainable production of animal and plant food. Numerous multinational companies (Monsanto, Evogene, Hypor, ABS Global US, Du Pont etz.) have specialized in the production of high-value genetic resources (eg seeds or seminal doses) that are marketed worldwide with the ultimate purpose to increase the economic performance of agricultural and livestock farms. Likewise, the agri-food sector is characterized by carrying out an intense research activity not only at the level of universities and scientific centers, but also in the business sector. For example, in Spain, in the last three years, the Technology Platform Food for Life Spain has promoted more than 120 scientific projects of R + D + i for a value of 282 million euros.

The goal of the subject of Agrogenomics is to provide a solid training in the field of genomics and genetics applied to the improvement of domestic animal and plant species, the preservation of their biodiversity and the development of tools biotechnology

Teaching goals:

1. Becoming familiar with genetic improvement strategies and understanding their connection with the food industry.
2. Knowing the main structural and functional features of the genomes and transcriptomes of domestic plant and animal species.
3. Understanding how genetic data can be used to elaborate biological hypotheses about the physiology of organisms.
4. Developing methods aimed to genetically evaluate candidates to breeders and understanding the factors that limit the rate of genetic progress asociated with distinct selection strategies.
5. Being aware of the genetic basis of hereditary diseases that afflict domestic species.
6. Acquiring a perspective about the techniques involved in identifying major genes affecting complex traits and their application to genomics and breeding.
7. Acquiring the skills to estimate the amount of genetic diversity based on molecular and genealogic data.
8. Knowing the scientific basis of the techniques dedicated to improve the productivity of crops.
9. Understanding how -omic tools can be employed to the genetic improvement of domestic animals and plants.

Competences

- Apply knowledge of theory to practice.
- Be able to communicate effectively, orally and in writing.
- Design and interpret studies associating genetic polymorphisms and phenotypical characters to identify genetic variants that affect the phenotype, including those associated to pathologies and those that confer susceptibility to human illnesses or those of other species of interest.
- Design experiments and interpret the results.
- Develop self-directed learning.
- Measure and interpret the genetic variation in and between populations from a clinical, conservational and evolutionary perspective, and from that of the genetic improvement of animals and plants.
- Produce, direct, execute and assess projects where knowledge of genetics or genomics is necessary.
- Use and manage bibliographic information or computer or Internet resources in the field of study, in ones own languages and in English.

Learning Outcomes

1. Apply acquired knowledge and skills in genetics and genomics to potential technology-based business projects on genetics and genomics.
2. Apply association studies to the prediction of phenotypes of individuals or specimens.

3. Apply association studies to the selection of livestock characters.
4. Apply knowledge of theory to practice.
5. Be able to communicate effectively, orally and in writing.
6. Design experiments and interpret the results.
7. Develop self-directed learning.
8. Explain the underlying genetic basics of tests to identify individuals or specimens from their DNA fingerprint.
9. Use and manage bibliographic information or computer or Internet resources in the field of study, in ones own languages and in English.

Content

1. GENETIC IMPROVEMENT AND GENOMICS OF DOMESTIC PLANT SPECIES

1.1. Biodiversity of crop plants, environmental problems associated with cultivation and breeding goals

Topic 1: Agriculture: Performance, limiting factors, sustainability

Topic 2: Agricultural biodiversity; Origin and conservation of germplasm

Topic 3: Cereals, diversity, domestication, reproduction, hybrid seed, objectives for improvement

Topic 4: Leguminous, diversity, biological nitrogen fixation, improvement objectives

Topic 5: Vegetables, diversity, intensive crops and environmental problems, objectives of improvement

Topic 6: Brassicaceas, diversity, reproduction, improvement objectives, environmental issues

Topic 7: Fruit trees, diversity, reproduction, environmental problems, improvement objectives

Topic 8: Crops medicinal and aromatic plants; diversity, reproduction, quality control.

1.2. Use of biotechnological tools for the conservation and use of genetic variability and for obtaining new varieties of crops

Topic 9: Introduction to molecular markers, sequencing and re-sequencing of plant genomes, identification of SNPs and high performance genotyping. Examples in plants.

Topic 10: Domestication and applications for future agriculture. Examples in wheat.

Topic 11: Introduction to plant genetic improvement. Methods of genetic analysis of agronomic characters with molecular markers. Major genes and quantitative characters. Mapping and cloning of genes. Use of molecular markers in plant improvement programs.

Topic 12: Analysis and use of genetic variability in plant improvement. Conservation of germplasm in nuclear collections. GWAS and genomic selection. Examples in small fruits.

Topic 13: Transgenics and genome editing in plants. Situation of the current legislation.

Topic 14: The genomics applied to the improvement of rosaceae.

Topic 15: Genomicsapplied to the improvement of cucurbitaceae.

2. BREEDING AND GENOMICS OF DOMESTIC ANIMALS

Topic 1: Domestication. Introduction. The Neolithic Revolution. Morphological and behavioral changes associated with animal domestication. The domestication of pigs and ruminants.

Topic 2: Conservation of breeds: The general conservation problem. Causes of racial regression. Valid reasons for the conservation of breeds. Strategies and conservation methodology. Genetic aspects of conservation.

Topic 3: Structure of breeding and conservation programs; foundation and management of pure breeds.

Topic 4. Introduction to the genetic improvement of domestic species. Breeding companies and associations.

Topic 5. Genomics of domestic species. GWAS and QTL identification related to economic interest and pathologies. Sequencing of genomes.

Topic 6. Genetic improvement in domestic species. Genetic parameters, evaluation and selection of breeders by BLUP. Genomic selection. Structure of populations and spread of genetic progress.

Topic 7. Immunogenetics. The genes of the major histocompatibility complex and its association with the genetic resistance to infectious diseases. Genetic causes of hereditary diseases in domestic species. Prion diseases.

Topic 8. Transgenesis, cloning and editing of genomes: examples and current legislation.

Methodology

The teaching methodology that will be used during the whole learning process is based essentially on the student's work combined with the assistance of the teacher, both in terms of the acquisition and interpretation of the information related to the subject, as in the proper direction of the learning process. In accordance with the teaching objectives of the subject, the training activities that will be carried out are:

Master classes: With these classes, the student acquires the fundamental knowledge of the subject, with practical examples that will be solved in class, which will, in addition, be worked out and complemented with seminars and tutorials. The dialogue with students will be encouraged and classes will be based on audiovisual materials, mainly Power Point presentations, which will be posted in advance to the Virtual Campus.

Seminars: They will deal with very specific and highly relevant topics in the world of domestic species genetics such as, for example, the genomic selection or the creation of companies of genomic analysis. Whenever possible, an expert will be invited to make a brief dissertation on the subject to be discussed. Afterwards, the students and teaching staff will proceed to discuss the subject in depth.

Programmed tutorials: Sessions previously arranged (email) to solve doubts and maintain discussions about specific contents of the subject and their practical application.

Autonomous study and self-learning: The student will reflect on the knowledge acquired through face-to-face teaching, doing an elaboration and synthesis of such knowledge. Queries and issues that arise during the course of this learning process will be solved in the programmed tutorials.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Master class	32	1.28	6

Seminars	8	0.32	4, 5
Type: Supervised			
Programmed mentorships	6	0.24	5, 9
Type: Autonomous			
Autonomous study and self-learning	98	3.92	4, 9

Assessment

The assessment will be individual and will be carried out continuously in the context of the different training activities that have been programmed. There will be two theoretical-practical partial examinations. There will be 2 assignments, one of Plant Genetics and another of Animal Genetics. In these assignments, practical questions will be raised to students, in order to stimulate their capacity for critical reasoning (in the specific context of agro-genomics). The presentation of the Animal Genetic Work will last 15 minutes + 5 minutes of questions, while in the case of Plants the presentation of the work will last 20-25 minutes + discussion. It is also possible to program, at the discretion of the teacher, the completion of short-term exercises in class, eg. solve a question raised during a master class or a seminar. In total, the assignments will account for 20% of the final grade, while the short exercises will allow to bonus the final grade with 1 point. The partial exam of Plant Genetics will be done in writing, combining topic-type questions to be developed with shorter questions of conceptual type and with multi-test questions. The partial exam of Animal Genetics will be a test with answers of double option (truth / false). The minimum mark to pass the partial will be 5 points with a maximum of 10 points. The participation in class and, very particularly in the seminars, will also be valued. Students who do not pass one or both exams will be entitled to a final exam. The minimum mark for averaging both parts (Plants and Animals) will be 4.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial Exam 1 - Plant Genetics	40% Final grade	2	0.08	1, 4, 6, 8, 5, 9
Partial Exam 2 - Animal Genetics	40% Final grade	2	0.08	4, 2, 3, 6, 5, 9
Plant and Animal genetics Assignments	20% Final Grade	2	0.08	4, 7, 5

Bibliography

Brown, J. & Caligari, P. 2008, An Introduction to Plant Breeding, Blackwell Ed.

Chrispeels, M.J., Sadova, D.E. 2003. Plant Genes and Crop Biotechnology. Jones & Bartlett Publ., Sudbury, (2nd Edition)

Falconer DS, Mackay TFC. 2001. Introducción a la Genética Cuantitativa. Ed. Acribia.

Folta, K.M. & Gardiner 2009. Genetics and Genomics of Rosaceae. Springer (1st Edition)

Fries R & Ruvinsky A. 1999. The Genetics of Cattle. CABI Publishing (1st Edition).

Hartmann HT et al. 2001. Plant Propagation. Principles and Practice. Prentice Hall, (7th edition).

Jenks, M.A. & Bebeli, P. 2011. Breeding for fruit quality. Wiley-Blackwell (1st Edition)

Nicholas FW. 2003. Introduction to Veterinary Genetics. Blackwell. Publishing (2nd Edition).

Ostrander EA & Ruvinsky A. 2012. The Genetics of the Dog. CABI Publishing (2nd Edition)

Rothschild MF. 2011. The Genetics of the Pig. CABI Publishing (2nd Edition).

Software

No software will be used.