

Academic Year/course: 2022/23

## 28418 - Quantitative and molecular genetics in animal breeding

### Syllabus Information

**Academic Year:** 2022/23

**Subject:** 28418 - Quantitative and molecular genetics in animal breeding

**Faculty / School:** 105 - Facultad de Veterinaria

**Degree:** 451 - Degree in Veterinary Science

**ECTS:** 6.0

**Year:** 2

**Semester:** Second semester

**Subject Type:** Compulsory

**Module:**

## 1. General information

### 1.1. Aims of the course

The aims of this course are to:

- Know the scientific bases of the disciplines that integrate animal genetic improvement.
- Know how to apply the methods and techniques of evaluation of reproducers in theoretical contexts.
- Know the formulation of improvement strategies in species of zootechnical interest.
- Integrate into programmes for animal genetic improvement, molecular genetics and conservation of genetic resources, being able to provide alternatives that improve the effectiveness of these programmes.
- Give genetic advice in pathologies of hereditary origin.
- Know the possibilities of application of transgenesis and gene therapy in veterinary medicine.

The above approaches and objectives are in line with several of the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (<https://www.un.org/sustainabledevelopment/>). Specifically, knowledge of animal breeding allows increasing the competitiveness of livestock populations and available income in rural areas. In this way, it becomes a tool that allows the population to settle and generate good quality jobs in a rural environment (SDG1: No Poverty, SDG8: Decent Work and Economic Growth, and SDG10: Reduced Inequalities). In addition, the increase in profitability of extensive farming augments the viability of these livestock populations, contributing to the maintenance of the environment and farming ecosystems (SDG12: Responsible Consumption and Production, and SDG15: Life on land). Finally, animal breeding aims at increasing food and protein production (SDG2: Zero Hunger), the development of healthier animal products (SDG3: Good Health and Well-being) and the reduction of the livestock-associated carbon footprint (SDG13: Climate Action). The knowledge acquired in this subject provides capacities and competences to achieve the aforementioned goals.

### 1.2. Context and importance of this course in the degree

Animal breeding is one of the fundamental pillars of animal production. It configures the genetic structure of livestock populations to achieve production objectives. In this context, animal breeding is the basis for the cost-effectiveness and sustainability of the production of food of animal origin.

This course aims to provide training in the disciplines on which animal breeding is based. The general objective is to train professionals who have the operational capacity to establish and evaluate animal breeding programmes.

From the methodological point of view, animal breeding is a broad and complex discipline in which several subjects come together. Its foundation lies in population and quantitative genetics, based on applied statistical techniques.

Until now, this information was constituted by the phenotypic manifestation of the genes involved and by the genealogical relationships between the animals in the population. This approach forms the basis of the current animal breeding programmes of companies and breeders' associations. On the other hand, molecular genetics, based on molecular biology techniques, are increasingly involved in animal breeding programmes both from the point of view of genome observation and modification.

### 1.3. Recommendations to take this course

It is desirable that the student has acquired the skills relating to the basic training subjects of the first year and first four months of the second year. Those corresponding to Genetics and Statistics are considered very relevant.

Safety recommendations must be followed and adhered to during the training activities. All the information is available to the students in the following links, as well as in the Docent Digital Ring (ADD) of each subject:

<https://veterinaria.unizar.es/estudiantes/formacion-prevencion-riesgos-y-seguridad#normas>  
<https://veterinaria.unizar.es/prevencion/protocolosespecificosveteriaria>

<http://patologiaanimal.unizar.es/medidas-de-seguridad>

## 2. Learning goals

### 2.1. Competences

Student's competencies after completing the course:

#### **Generic transversal competences:**

1. Ability to analyze and synthesize
2. Robustness in the basic knowledge of the profession
3. Oral and written communication.
4. Skills to retrieve and analyze information from different sources
5. Ability to pose and solve problems
6. Critical capacity and generation of new ideas
7. Propose and evaluate hypotheses
8. Relate and integrate concepts and ideas
9. Development of the sense of logic.
10. Capacity for reasoning and interpreting facts
11. Ability to work in a team, in diverse and intercultural environments
12. Ability to manage the time spent on studying, plan their learning tasks, and adapt them to personal needs.
13. Autonomy and initiative in the progress of their studies and in learning
14. Development of self-confidence and self-motivation
15. Acquisition of technological skills in the management of videoconferencing software.
16. Development of skills for the telematic presentation of results.
17. Learning graphical and statistical analysis software ([www.r-project.org](http://www.r-project.org))

#### **Specific competences:**

1. Analyze traits that take part in an objective or selection criteria, with their factors, properties and limitations.
2. Make initial proposals for genetic improvement plans that are consistent with the proposed formulations.
3. Develop the genetic analysis of a character.
4. Understand, justify and propose new guidelines for genetic improvement and conservation.
5. Give genetic counseling.
6. To make proposals for the use of gene transfer in the veterinary profession.

7. Know the appropriate measures to estimate and control inbreeding levels for conservation purposes.

## 2.2. Learning goals

If students complete the course successfully, they should be able to

1. Include the fundamentals of animal genetic improvement developed from productive, genealogical and molecular information.
2. Know the genetic analysis of the characters involved in the objectives and selection criteria.
3. Develop and interpretate results of genetic evaluation models of selection candidates using genealogical, phenotypic and molecular information.
4. Discern between basic alternatives oriented to the design of improvement plans in livestock breeds and selection schemes for specialized genetic lines.
5. Know the appropriate measures to estimate and control inbreeding levels.
6. Give genetic advice in pathologies of hereditary origin.
7. Learn the methodological bases and applications of gene transfer in Veterinary Medicine.

## 2.3. Importance of learning goals

It allows to know the principles of the genetic improvement, as an element of the veterinary profession. In addition, it must provide skills for the approach of genetic evaluation models and information organization/treatment, promoting attitudes favorable to livestock associationism, performance control and technical innovation.

## 3. Assessment (1st and 2nd call)

### 3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

#### Evaluation activities

The student must demonstrate that has achieved the intended learning outcomes through the following assessment activities...

1. Theory exam: Development of multiple choice, short and essay-type questions during 1.5 hours (50 % of the grade) on the dates scheduled by the center at the end of the semester. Weights of every question in the global mark will be indicated. Wrong answers in the multiple-choice test will be penalized with 1 divided the number of wrong options times the weight of the question in the global mark.
2. Problems: Development of multiple-choice test and resolution of problems, posed in theoretical scenarios (35% of the grade) on the same date as the theory test. Weights of every question in the global mark will be indicated. Wrong answers in the multiple-choice test will be penalized with 1 divided the number of wrong options times the weight of the question in the global mark.
3. Practices: We will deal with approaches that the students will have to solve individually (8% of the grade). The assessment will be carried out throughout the semester, once the corresponding practical sessions have been completed.
4. Seminars: To be held in groups, publicly presenting the specific results proposed to each (7% of the rating). The assessment will be carried out throughout the semester, once the corresponding seminars have been held.

Sections 1 and 2 must be passed separately with at least a rating of 4 of 10.

### **Marking system:**

According to the national regulation Law 1025/2003, 5th of September which lays down the European system of credits and marking system for the university degree.

0-4,9: FAIL.

5,0-6,9: PASS

7,0-8,9: GOOD (NT).

9,0-10: EXCELLENT (SB).

As the article 158 of the Statutes of the University of Zaragoza lays down, provisional grades will be displayed at least for 7 days and students will be able to review them on the date, time and place provided for that purpose.

## **4. Methodology, learning tasks, syllabus and resources**

### **4.1. Methodological overview**

The program includes the following activities (each unit involves two theoretical teaching sessions)

1. Theoretical lectures. 30 sessions of 1 hour each, to develop key concepts.

2. Problems. 14 sessions of 1 hour each, to solve problem propositions.

3. Practices. 8 online or face-to-face sessions of two hours each, supported by freely available computer simulation programmes. (<https://sites.google.com/a/unizar.es/pqgen/>), by free software for statistical analysis ([www.r-project.org](http://www.r-project.org)) or by the access to on-line databases. The online sessions will be held synchronically and, among their objectives will be the acquisition of competences 15 (Acquisition of technological skills in the management of videoconferencing software) and 16 (Development of skills for the telematic presentation of results).

4. Seminars. One session of 4 hours with the teacher to analyze and discuss different case-studies proposed.

Individual study and the resolution of proposed cases is a non-presential activity for the student.

### **4.2. Learning tasks**

The learning activities will consist of attending theoretical, practical and problem lectures and to develop and present two seminars on topics proposed by the teaching staff. In addition, the student will attend the presentations of their classmates and must carry out individual study.

### **4.3. Syllabus**

#### **Theoretical lectures and problems:**

#### **BLOCK 1. INTRODUCTION**

Unit 1. An approach to animal breeding. Objectives and selection criteria.

#### **BLOCK 2. GENETIC STRUCTURE OF A QUANTITATIVE TRAIT**

Unit 2. Values, means and variances.

Unit 3. Genetic relationship and inbreeding.

Unit 4. Resemblance between relatives, heritability and repeatability.

#### **BLOCK 3. SELECTION**

Unit 5. Response to selection and correlated response.

Unit 6. Selection indexes.

Unit 7. Best Linear Unbiased Predictor (BLUP)

#### **BLOCK 4. MOLECULAR GENETICS AND SELECTION.**

Unit 8. Linkage disequilibrium and detection of Quantitative Trait Loci (QTL)

Unit 9. Gene and marker assisted selection.

Unit 10. Genomic selection.

### **BLOCK 5. CROSSBREEDING**

Unit 11. Heterosis and complementarity.

Unit 12. Crossbreeding designs.

### **BLOCK 6. CONSERVATION**

Unit 13. Inbreeding depression and effective population size.

Unit 14. Conservation genetics.

### **BLOCK 7, BREEDING PROGRAMS**

Unit 15. Introduction to breeding programs in non-prolific species: ruminant and horses.

Unit 16. Introduction to breeding programs in prolific species: pigs, poultry, rabbits and fish.

### **BLOCK 8. INHERITANCE OF DISEASES IN DOMESTIC ANIMALS**

Unit 17. Hereditary diseases associated with single copy genes and a multigenic inheritance.

Unit 18. Control and eradication of hereditary diseases.

### **BLOCK 9. GENOME MODIFICATION IN ANIMAL BREEDING**

Unit 19. Transgenesis as a tool in Veterinary sciences.

Unit 20. Therapies based on the genetic modification and its applications in animal breeding.

#### **Practical Lectures:**

1. Effect of selection of the genetic structure of the populations.
2. Genetic relatedness and inbreeding.
3. Resemblance between relatives.
4. Heritability.
5. Selection indexes.
6. Best Linear Unbiased Prediction (BLUP)
7. Marker assisted selection and genomic selection.
8. Genetic basis of hereditary diseases.

#### **4.4. Course planning and calendar**

The dates and key milestones of the subject are described in detail, along with those of other subjects of the degree of Veterinary, on the website of the Faculty of Veterinary (link <http://veterinaria.unizar.es/gradoveterinaria/>). This link will be updated at the beginning of each academic year.

#### **4.5. Bibliography and recommended resources**

<http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=28418>