Universitat de Lleida

DEGREE CURRICULUM

GENETICS

Coordination: PENA SUBIRÀ, RAMONA NATACHA

Academic year 2023-24

GENETICS 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>GENETICS</td></tr>
<tr><td>Code</td><td>100309</td></tr>
<tr><td>Semester</td><td>1st Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Double bachelor's degree: Bachelor's Degree in Veterinary Medicine and Bachelor's Degree in Science and Production</td><td>2</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th colspan="3">PRALAB</th><th colspan="2">PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>0.8</td><td>0.4</td><td>0.4</td><td>0.4</td><td>0.4</td><td>3.6</td></tr>
<tr><td>Number of groups</td><td>4</td><td>2</td><td>2</td><td>2</td><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>PENA SUBIRÀ, RAMONA NATACHA</td></tr>
<tr><td>Department</td><td>ANIMAL SCIENCE</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>On-site or tutor-directed hours: 60h
Off-site hours (self-paced): 90h</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Catalan: 50%
Spanish: 30%
English: 20%</td></tr>
</table>

GENETICS 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CASALI TABERNET, ANDREU	andreu.casali@udl.cat	2	
ESTANY ILLA, JUAN	joan.estany@udl.cat	1,2	
LAGHOUAOUTA , HOUDA	houda.laghouaouta@udl.cat	3,2	
PENA SUBIRÀ, RAMONA NATACHA	romi.pena@udl.cat	1,2	
SIN CASAS, ESTER SATURNINA	ester.sin@udl.cat	2	

Learning objectives

The course aims to initiate students to the basics of gene inheritance in animals, so that he/she is in possession of the scientific basis necessary for proper management of animal resources, especially those aspects related to animal breeding programs.

Objectives of Knowledge

The course intends that the student knows the structure of the genetic material, as well as the mechanisms of gene expression, control and regulation; the principles of inheritance of traits affecting animal reproduction, growth and health; and, finally, genetic properties of animal populations, as well as the causes of evolution and change. To know the rules of inheritance that explain animal traits and behavior. To know how to calculate and use basic genetic parameters used in selection schemes.

Objective of capacity

Block 1

1. To be able to interpret the table of the genetic code and to transcribe sequence of DNA to RNA and to protein.
2. To be able to gather information on genetic mutations and variants of a given gene through the use of databases available on the Internet.
3. To be able to use on line restriction enzyme databasis to determine the targets existing in a DNA sequence, as well as making the choice of primers to amplify a specific sequence by PCR.
4. To retrieve data available on the internet about genome projects, and the organization and structure of a particular genomic locus in different species.

Block 2

1. To apply the laws of inheritance to predict expected descendants in directed crosses.
2. To Interpret and write technical reports in relation to the genetic basis of domestic animals
3. To know how to perform genetic diagnosis of hereditary diseases in animals

Block 3

1. To be able to estimate genotype and allelic frequencies in an animal population and predict the effects caused by mutation, migration, selection and genetic drift.
2. To know how to calculate the inbreeding coefficient of an animal and the relationship between two animals.
3. To be able to calculate the effective population number and predict the evolution of inbreeding in the course of generations.
4. To be able to interpret the concepts of breeding value and heritability.

Competences

BASIC SKILLS

- (GVET-GCPA) CB1. To acquire and understand knowledge in an area of study that starts from the basis of general secondary education, and is usually found at a level that, while supported by advanced textbooks, also includes some aspects that involve knowledge beyond the state-of-the-art of this field of study
- (GVET-GCPA) CB2. To apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.
- (GVET-GCPA) CB3. The ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant issues of a social, scientific or ethical nature
- (GVET-GCPA) CB4. To be able to communicate information, ideas, problems and solutions to both specialized and non-specialized audiences)
- (GVET-GCPA) CB5. To know how to develop the learning skills necessary to undertake further studies with a high degree of autonomy
- (GCPA) CB6. To recognize the biological, chemical, physical, mathematical and economic foundations necessary for the development of professional activity

GENERAL SKILLS

- (GVET) CG2. The prevention, diagnosis and treatment of individuals or groups, as well as the fight against animal diseases, be considered individually or in groups, particularly zoonoses.
- (GVET) CG3. The control of the breeding, handling, welfare, reproduction, protection, and feeding of the animals, as well as the improvement of their productions.
- (GCPA) CG2. Use the knowledge of basic sciences (biology, physics, biochemistry, physiology, mathematics, statistics, economics, ...) to understand animal processes and their involvement in the agrucultural system

SPECIFIC SKILLS

- (GVET) CE3. To identify and apply the principles and bases in morphology, bionomy and systematics of animals and plants of veterinary interest
- (GVET) CE7. To know the molecular and genetic principles and bases of biological processes as well as identify the basic principles of genetic biotechnology and population genetics
- (GVET) CE9. To know the microorganisms and parasites that affect animals and those that have an industrial, biotechnological or ecological application as well as know the techniques of the immune response
- (GCPA) CE1. To identify the biological, chemical, physical, mathematical and economic foundations necessary for the development of professional activity. To identify the characteristics and processes of biomolecules essential for life. To be able to use basic laboratory analytical techniques to determine chemical and biochemical parameters

- (GCPA) CE4. To acquire an integrated view of cellular structures, relating them to their specific functions and the biochemical processes involved. To identify the characteristics of the main taxonomic groups of animals and plants. To be able to argue the basics of inheritance that explain the characteristics and behavior of animals.
- (GCPA) CE16. To apply advances in biotechnology to be able to assess its usefulness and interest in the practice of animal production and health

SOFT SKILLS

- (GVET-GCPA) CT1. To acquire an appropriate understanding and oral and written Catalan and Spanish
- (GVET-GCPA) CT2. To acquire a significant command of a foreign language, especially English
- (GVET-GCPA) CT3. To train in the use of new technologies and information and communication technologies
- (GVET-GCPA) CT4. To acquire basic knowledge of entrepreneurship and professional environments
- (GVET-GCPA) CT5. To acquire essential notions of scientific thought
- (GCPA) CT6. To analyze specific situations, define problems, make decisions and implement action plans in the search for solutions.
- (GCPA) CT7. To apply acquired knowledge to real situations, properly managing available resources.
- (GCPA) CT8. To interpret studies, reports, data and analyze numerically.
- (GCPA) CT9. To select and manage written and computerized sources of information related to professional activity.
- (GCPA) CT11. To manage individual and team work
- (GCPA) CT12. To acquire a hollistic training.
- (GCPA) CT14. To know and apply the scientific method to professional practice

Subject contents

TABLE OF CONTENTS - TOPICS

Introduction. Animal genetics and breeding

SECTION 1. THE HEREDITARY MATERIAL

Topic 1. Nucleic acids: structure and chemical components. Structure and organization of genes in prokaryotes and eukaryotes. Nuclear DNA and mitochondrial DNA. Maintenance and replication of genetic information

Topic 2. Mechanisms of gene expression. Transcription in prokaryotes. Eukaryotic transcription. Processing and maturation of mRNA in eukaryotes. Translation. The genetic code.

Topic 3. Regulation and control of gene expression. Regulation in prokaryotes: the Operon model. Regulation in eukaryotes: chromatin structure and gene regulation. Control levels: transcriptional, translational and post-translational. Gene regulation and cell differentiation.

Topic 4. Mechanisms of genetic change. Gene mutation and repair. Recombination. Mobile genetic elements. Chromosomal mutations. Variability and genetic polymorphism.

Topic 5. Genetic engineering and modification. Molecular analysis techniques. Polymerase chain reaction (PCR). Cloning: cloning vectors. DNA sequencing. Mechanisms of gene transfer. Transgenic animals.

SECTION 2. PRINCIPLES OF INHERITANCE

Topic 6. Mendelian Inheritance. The chromosomes. Kariotypes. Laws of inheritance. Monohybridism and polyhybridism. Family trees. Probability and statistical verification.

Topic 7. Complex Inheretance. Relationship between alleles: dominance, codominance and overdominance. Allelic series. Lethal alleles. Interaction between genes: epistasis, gene modifiers and suppressors. Phenotypic expression: pleiotropy, penetrance and expressivity.

Topic 8. Inheritance of sex. Sex determination. Gender-related traits, influenced by sex and limited to one sex. Extranuclear inheritance.

Topic 9. Recombination and linkage. Recombination frequency. Distance genetics. Linkage groups. Linkage maps. genetic maps

Tema 10. Genetic diagnosis. Genetic abnormalities in domestic species. Inheritance patterns and analysis of family trees. Using markers. Interpretation of genetic tests.

SECTION 3. Quantitative and Population Genetics

Topic 11. The genetic constitution of a population. Gene frequencies and genotype. The ideal population. The Hardy-Weinberg equilibrium.

Topic 12. Changes in gene frequencies in an infinite population. Systematic events of mutation, migration and selection. Reproductive fitness. Particular cases of selection in one locus.

Topic 13. Inbreeding and kinship. Non-random mating. Inbreeding coefficient. Effect of inbreeding on genotypic frequencies. Coefficient of kinship. Calculation of the coefficients of inbreeding and kinship in family trees.

Topic 14. Finite Populations. The concept of genetic drift. Change in allelic frequencies by genetic drift. Inbreeding in finite populations. Effective number of a population. Inbreeding and genetic drift.

Topic 15. Modeling quantitative traits. The continuos variables. Genotypic value and environmental value. The genotypic model: additive, dominant and epistatic values. The concept of breeding value. Decomposition of genotypic variance. Heritability of a trait.

PRACTICAL CONTENTS

Seminar 1 (2h). The Genome. Animal models. Visit to a lab at IRB-Lleida

Seminar 2 (2h). Hereditary diseases in animals. Omia Database

Practical cross-curricular project :

- **Practice 1** (4h). Handling animal genomic databases
- **Practice 2.2** (2h) Simulation of matings in Drosophila and determination of the genetic basis of four mutant phenotypes ..
- **Practice 3.2** (2h) Case study: estimating the breeding value of a gene marker

Case-based studies:

- **Practice 2.1** (2h). Mendelian genetics problems.
- **Practice 3.1** (2h). Problems of population genetics.
- **Practice 4** (8h): Polymorphisms and molecular markers: DNA isolation from blood samples and laboratory determination of allelic variants of two genotype mutations following two different protocols (each student will process a different animal sample).

Methodology

The teaching activity is structured in theory and practical sessions, according to the **schedule of**

activities included in the course activity plan that will be available in the teaching space of the subject's Virtual Campus in **PDF** format.

1. Lectures. The lectures are based on theory sessions and aim to present the subject on each Topic. Each 2-hour session corresponds to a topic.

2. Practical lessons. The practical sessions consist of problem classes, computer lab sessions, problem-solving, laboratory sessions and seminars. Ocassionally there might be some invited conference. It is **MANDATORY** that students have the following personal protective equipment (PPE) in the course of teaching practices: It is **MANDATORY** that students wear the following personal protective equipment (PPE) during the teaching practices: lab coat (laboratory sessions). Students failing to bring the PPE described or not complying with the general security rules will be denied access to the lab. The practice sessions will help the students gain experience in the methologies needed to fullfil the Practical Cross-curricular Project of the course (see ***Evaluation***). .

- Problem-solving sessions aim to discuss problems and exercises that students must must have work beforehand.
- Sessions in computer labs are used to introduce students in the use of databases of interest in genetics, as well as to analyze simulated cases of animal population genetics.
- Finally, the laboratory sessions will be used to solve a case study of two genes, which will be used to introduce students to protocols specific to molecular genetics.

3. During the course there will be two seminars that address issues of specific interest or state-of-the-art topics related to animal genetics.

Students will have the teaching resources of the course in the Course electronic dossier. Each practical activity will be complemented with a detailed protocol of the objectives and procedures to be used.

Development plan

The subject is structured in three blocks of knowledge and a laboratory activity that is transversal to the **three blocks**. Each block will have 12 hours of theory and 4 hours of practice. There will be two seminars (4 h) and a laboratory practice (8 h).

- Assigned timetable: Wednesday (15-17h), Friday (17-19h). Some Practices will take place in the morning. See "Schedule of activities" file in RESOURCES (PDF) to check for specific days.
- Students can access the timetable of the course activities in the "Schedule of Activities" in the RESOURCES section (PDF) of the virtual campus of the course..
- Practice 4 - morning timetable for 4 consecutive days, highlighted in red in the "Schedule of Activities"

- **Classroom: ETSEA - Building 3, room 3.0.02.**
- **Lab: Building 1. 1st floor, Genetics lab 1.1.04**
- **Computer Labs: Building 4**

Evaluation

Continuous assessment will be carried out in accordance with the following assessment blocks:

- BLOCK 1 - Exam Section 1 (25%).

  At the end of Section 1 (Topics T01 to T05) there will be an exam, which will account towards 25% of the final grade. The exam may consist of a test of multiple choice questions (different statements, one correct answer, mistakes substract points), theoretical questions of short answer, reasoning questions or numerical problems. Other evaluation blocks will only be considered if the grade for this block is equal to or higher than 4.5.

- BLOCK 2 - Exam Section 2 (25%).

  At the end of Section 2 (Topics T06 to T10) there will be an exam, which will account towards 25% of the final grade. The exam may consist of a test of multiple choice questions (different statements, one correct answer, mistakes substract points), theoretical questions of short answer, reasoning questions or numerical problems. Other evaluation blocks will only be considered if the grade for this block is equal to or higher than 4.5.

- BLOCK 3 - Exam Section 3 (25%).

  At the end of section 3 (Topics T11 to T15) there will be an exam, which will account towards 25% of the final grade. The exam may consist of a test of multiple choice questions (different statements, one correct answer, mistakes substract points), theoretical questions of short answer, reasoning questions or numerical problems. Other evaluation blocks will only be considered if the grade for this block is equal to or higher than 4.5.

- BLOCK 4 - Practical work (25%)
- Practical Cross-curricular Project (25% of the final grade). At the beginning of the course, groups of 3 students will be formed who will work together to solve a specific project. This project will integrate challenges that must be resolved through the concepts and methodologies presented in each block of the subject. The practical sessions of each block will develop examples on how to apply theory concepts to the resolution of the questions raised in the Project. Once resolved, each group must present a report with the resolution of the issues raised. The report will be delivered on the date indicated in the SCHEDULE OF ACTIVITIES..
- Laboratory work (5% of the final grade) - submission and evaluation of the lab handbook.

Students can have a tutoring session to review the notes for each assessment activity, which they will agree with the person responsible for each activity. Under no circumstances will issues related to assessments be resolved outside of assigned sessions or by email.

In the event that, following these criteria, a student does not reach the minimum grade of 4.5 in one or more of the first three assessment blocks, they may take an extraordinary remedial test for that block, which will take place on the assigned day in the general calendar of the Degree. The extraordinary test will consist of solving test-type questions and short-answer theoretical questions, reasoning questions or numerical problems from the corresponding section of the subject.

The final mark of the course will be the one obtained following the previous scales, with the following particularities: a) The presentation to the extraordinary test may be an additional requirement to opt for the honors registration qualification; b) the sections approved in the extraordinary call will have a maximum final mark of 5; c) the qualification of "not presented" is reserved for students who have presented at most one activity of the course.

Alternative assessment:

Students who request the alternative assessment of the subject in the established periods can participate in classroom and laboratory activities. Each of them will be assigned an individual transversañ project to develop during the course at their own pace. The evaluation will be carried out based on two activities:

- Activity 1. Evaluation of the individual project (30%) - A final report will be delivered following the course instructions.
- Activity 2. Exam (70%) – An exam will be held on the date assigned in the Degree calendar. This exam will contribute 70% to the final grade of the subject. The grade for this activity must be equal to or higher than 4.5 in order to be able to take Activity 1 into account.

Students who do not pass the alternative assessment can take an extraordinary exam on the same date as the rest of ordinary students. The extraordinary test will consist of solving test-type questions and short-answer theoretical questions, reasoning questions or numerical problems from the three sections of the subject. The final grade will take into account the result of the project report presented during the course (30%) as long as the grade of this extraordinary exam is higher than 4.5

Bibliography

RECOMMENDED READING

- BENJAMIN, FALCONER , D S, MACKAY, TFC, 2001. Introducción a la genética cuantitativa. Editorial Acribia.
- BLASCO, A. 2021. Mejora genética animal. Madrid: Editorial Síntesis. Bib ETSEA. Sala 575.636 Bla
- CABALLERO RÚA, A. 2017. Genética cuantitativa. Madrid: Editorial Síntesis
- GRIFFITHS, AJ F, MILLER, JH, SUZUKI, DT, LEWONTIN, RC, GELBART WM. 2008. Genética. McGraw-Hill/Interamericana de España
- PIERCE, BA. 2015. Genética.Médica Panamericana. Madrid
- LEWIS, B. 2010. Genes VII. Oxford University Press
- Nicholas, F. W. 2009. Introduction to Veterinary Genetics. Blackwell Publishing

SUPPORTING INFORMATION

- BUXADÉ, C. (Ed). 1995. Zootecnia: bases de la producción animal. Tomo IV: Genética, patología, higiene y residuos animales. Editorial Mundi-prensa
- DORIAN, G, RUVINSKY, A. (Eds.). 2015. The Genetics of Cattle. CABI Publishing.
- OSTRANDER, E, RUVISNKY, A 2012. The genetics of the Dog. CABI Publishing.
- PIPER, L, RUVINSKY, A. (Eds.). 1997. The Genetics of Sheep. CABI Publishing.
- ROTHSCHILD, M F, RUVINSKY, A (Eds). 2011. The genetics of the pig. Wallingford: CAB Internacional
- VLECK, L D. van, POLLACK, EJ. OLTENACU, EAB.,1987. Genetics for the animal sciences. W. H. Freeman and Co.