Universitat de Lleida

DEGREE CURRICULUM

# GENETICS

Coordination: FIBLA PALAZON, JUAN

Academic year 2021-22

# GENETICS 2021-22

## Subject's general information

<table>
<tr><td>Subject name</td><td>GENETICS</td></tr>
<tr><td>Code</td><td>101610</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>Bachelor's Degree in Biotechnology</td><td>2</td><td>COMPULSORY</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><td>PRALAB</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>2.2</td><td>3.8</td></tr>
<tr><th>Number of groups</th><td>2</td><td>1</td></tr>
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</td></tr>
<tr><td>Coordination</td><td>FIBLA PALAZON, JUAN</td></tr>
<tr><td>Department</td><td>BASIC MEDICAL SCIENCES</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
</table>

# GENETICS 2021-22

| Teaching staff | E-mail addresses | Credits taught by teacher | Office and hour of attention |
|---|---|---|---|
| FIBLA PALAZON, JUAN | joan.fibla@udl.cat | 2 | |
| LAPLANA LAFAJA, MARINA | marina.laplana@udl.cat | 2,8 | |
| LOPEZ ORTEGA, RICARDO ENRIQUE | ricard.lopez@udl.cat | 2 | |
| SANUY CASTELLS, DELFI | delfi.sanuy@udl.cat | 1,4 | |

## Subject's extra information

Genetics has a central role in the teaching of Biotechnology. The improvement of plants and animals has been an activity developed by man empirically since the birth of agriculture and livestock. Throughout the 20th century, the application in the field of Biotechnology of scientific knowledge in Genetics has allowed a clear development of improvement strategies. In a first stage, the application of the laws of inheritance and knowledge about the transmission of quantitative traits, laid the foundations for the genetic improvement applied in the agri-food field throughout much of the last century. Subsequently, the development of genetic modification techniques at the end of the 20th century has led to a methodological change in genetic improvement strategies, not without certain controversies. With the birth of the "Genomic Era" at the beginning of the 21st century, both methodological approaches have found common paths of action in marker-assisted genetic improvement and in the identification and characterization of loci involved in quantitative traits.

Knowledge about Genetics will be taught in different subjects of the degree. Aspects related to the nature, function, maintenance and organization of genetic material will be the subject of the first year Molecular Biology course. Aspects related to the genetic modification of DNA molecules will be the subject of the second Genetic Engineering subject. Finally, the aspects related to the study of biodiversity, the mechanisms of hereditary transmission, the study of genetic variability and the aspects related to the Genetics of populations, will be studied in the subject of Genetics presented here.

The course will begin with a brief introduction to the methodology used in the study of the biodiversity of living beings with a brief introduction to the large groups of organisms. They then introduced us to the methodology of genetic analysis and aspects related to the transmission and inheritance of the characters. We will approach the study and characterization of genetic variability and its application in the design of characterization strategies and genetic diagnosis. Finally, the last topics will deal with aspects related to population genetics and evolution.

Throughout the course, the student must carry out practical activities where their participation will be essential for the achievement of the objectives set.

## Learning objectives

The student who passes the course must: (Knowledge objectives)

Know the classification and organization of large groups of metazoans
Know the terminology and basic vocabulary of genetics
Understand the universality of the laws of inheritance
Know the basic concepts of the genetics of transmission, chromosomal theory of inheritance and its study through controlled crosses.
Know the singularities of genetic analysis and its application in Biotechnology
Understand the origin of genetic variability, its implication in the process of evolutionary change and its practical application in the genetic identification of organisms, genetic mapping and in the improvement of animals and plants
Understand the basic concepts of population genetics and its application in the study of populations of animals and plants.
Know the concepts of biodiversity and conservation of genetic resources and their relevance.
The student who passes the course must be able to: (Ability objectives)

Correctly interpret the results of a controlled crossing.
Propose hypotheses about the inheritance patterns of a character based on the results or available experimental data.
Obtain information from bibliographic resources and databases on the Internet.
Correctly interpret the information in databases in reference to the genomic structure and organization.
Calculate the genotypic and allelic phenotypic frequencies from the available population data
To form a critical judgment regarding the application of genetic techniques in animal and plant improvement.
Approach problem solving with critical judgment incorporating available scientific information on the subject.
Develop skills in laboratory work, applying quality criteria and good practice.
Develop oral and written communication skills of scientific results.

## Competences

**General skills**
CG1 Being able to search for and selectively use sources of information necessary to achieve the training objectives.
CG3 Work as a team, with a multidisciplinary vision and with the ability to make a rational and effective distribution of tasks among team members.
CT3 Use information and communication tools and techniques for data analysis and the preparation of oral and written reports and other training and professional activities.
CT4 Respect the fundamental rights of equality between men and women, the promotion of Human Rights and the values of a culture of peace and democratic values.
CG4 Know and properly use the scientific and technical vocabulary of the different areas of Biotechnology.
CG5 Work in the laboratory applying quality criteria and good practice.
CG6 Know and know how to use the software and the specific databases in the different fields of Biotechnology.
CG7 Use the scientific method to analyze data and design experimental strategies with biotechnological applications.
CG8 Being able to form a critical opinion about the implications of biotechnology at an ethical, legal and environmental level.
CG11 Acquire criteria for choosing the most appropriate analytical techniques for each specific practical case

**Specific competences (according to document Pla d'Estudis)**
CE19 Know the singularities of genetic analysis and its biotechnological functions.
CE20 Understand the function of genes and their regulation in response to external changes in the cell.
CE45 Know the diversity of living beings, the importance of their maintenance and management strategies from the biotechnological field.

## Subject contents

Module I: Genetic analysis of the phenotype

UNIT 1. Introduction to Genetics and Heredity- Objectives and scope of Genetics. Structure of hereditary material,

inheritance and variation. Genotype, Phenotype and Environment. Basic nomenclature in genetics. Genetic analysis of the phenotype. Chromosomal basis of inheritance: Mitosis and meiosis. Chromosomes and the cell cycle. Behavior of chromosomes during Mitosis and Meiosis. Genetic consequences of Meiosis.

UNIT 2. Introduction to the genetic analysis of the phenotype. Type of phenotypes. Genotype-environment interaction. Monogenic, polygenic and multifactorial characters. Concept of heritability. Empirical determination of the heritability of a character. Determination of the genetic basis of a character. Genetic analysis of complex characters. Twin studies: concordance and correlation of character in related individuals. Multifactorial characters. Quantitative traits. Phenotypic distribution of a quantitative character. Analysis of variance. "Threshold" model. Directed selection experiments. Response to selection.

UNIT 3. Genetic analysis of monogenic characters. Mendelian inheritance models. Segregation models: monohybridism / dihybridism. Allelic relationships: dominance and recessivity.

UNIT 4. Inheritance of genes linked to sex chromosomes. Genetic determination of sex. Environmental factors and sex determination. Models of sexual determination: chromosomal balance and homo-heterogametic sex. Dose compensation. Comparative structure of the sex chromosomes. Inactivation of the X chromosome. Heredity influenced by sex. Inheritance limited to one sex.

UNIT 5. Extrachromosomal inheritance patterns. Genome of cytoplasmic organelles and symbionts. Organization of the mitochondria genome. Organization of the chloroplast genome. Characters with maternal effect.

UNIT 6. Extensions of the Mendelian analysis. Genetic analysis of linked genes. Ligation and recombination. Alteration of phenotypic proportions in linked genes. Recombination frequency and genetic distance Genotypic interactions. Epistasia. Allelic incompatibility and lethality. Penetration and expressiveness. Pleiotropia. Epigenetic factors: Genetic footprint.

Module II. Genetic variability
UNIT 1. Mechanisms of genetic change - Mutation: origin and types. Spontaneous mutation and induced mutation. Chromosomal mutations. Karyotype. Numerical and structural changes of chromosomes. Aneuploids in humans. Ploidy in Plants. Gene mutations. Types of gene mutations. Recombination not homologous. Phenotypic effects of mutations.

UNIT 2. Study and characterization of genetic variability - Concept of genetic polymorphism. Study of polymorphism at the DNA level. Type of polymorphic DNA variations: SNPs, insertions / deletions and repeats of variable number. Genotyping methods and techniques. Applications of genetic polymorphisms.

UNIT 3. Genome mapping - Physical maps. Sequence positioning using probes. Somatic hybridization. Other physical mapping techniques. Genetic maps. Recombination frequency and linkage maps. Use of genetic polymorphisms in mapping. Genetic maps in the human species. Lod score method.

Module III. Population Genetics and Evolution
UNIT 1. Population genetics - Mendelian population concept. Phenotypic, genotypic and allelic frequencies. Hardy-Weinberg equilibrium. Hardy-Weinberg equilibrium distortions. Consanguinity and heterosis. Change of allele frequencies. Mutational equilibrium, Migration, Selection: biological efficacy. Stochastic changes: Genetic drift. Population size: founder effect and bottlenecks. (4 hours).
UNIT 2. Evolutionary theories. Darwinian evolution. Mechanisms of speciation. Gradualism vs. Punctualism. Maintenance of genetic variability. Neutralist hypothesis of the maintenance of genetic variability. Biodiversity and conservation of genetic resources.

Module IV. Introduction to the study of biodiversity
UNIT 1. Characteristics and general classification, architecture and embryology of metazoans. Ontogeny and phylogeny.
UNIT 2. Diablàstics, non-celomized triblastics. Characteristics and general classification of: Sponges, Radiates, Flatworms, Nemertins, rotifers and Nematodes.
ITEM 3. Coelomados not fastened. Characteristics and general classification Mollusks, Annelids and Arthropods: Insects (with special emphasis), Crustaceans, Myriapods and Arachnids.
UNIT 4. Chordates: Characteristics and evolutionary classification. Non-amniotes vertebrates: Agnatos, and non-tetrapod gnatostoms (Chondrichthyans and osteichthians) and amphibians. Amniote vertebrates: Reptiles, Birds and Mammals.

Problem sessions
Meiosis and biological cycles. Mendelian proportions and inheritance patterns
Applications of genetic polymorphisms: genetic identification and study of paternity. Study of