# COURSE DATA

## DATA SUBJECT

**Code:** 33198
**Name:** Molecular techniques in genetic improvement
**Cycle:** Undergraduate Studies
**ECTS Credits:** 4.5
**Academic year:** 2025-26

## STUDY (S)

| Degree | Center | Acad. year | Period |
|---|---|---|---|
| 1111 - Grado en Biotecnología | Facultat de Ciències Biològiques | 4 | Second quarter |

## SUBJECT-MATTER

| Degree | Subject-matter | Character |
|---|---|---|
| 1111 - Grado en Biotecnología | Optability | ELECTIVES |

## COORDINATION

ESCRICHE SOLER BALTASAR

# SUMMARY

The subject "Molecular techniques in genetic breeding" is taught in the elective module within the fourth year of the Biotechnology Degree program, and it deepens the basic knowledge about molecular markers and their inheritance, as well as notions of population genetics that will have been acquired in the core subject of the second year called "Genetics." Subjects like "Principles in genetically modified organisms" (core) and "Food Biotechnology" (elective) have descriptors with content that overlaps with the present subject, although specifically applied to animals or microorganisms. Thus, taking this into account, the subject has been primarily designed with a focused, non-exclusive but prioritized approach centered on plant genetic improvement. From this perspective, the subject has been coordinated with the subject "Plant Biotechnology" (elective), which has certain similar descriptors, so that, despite some repetition (both are elective subjects), each subject provides different intensifications.

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Students should start with a general knowledge of molecular biology and genetics. The objective of this subject is for the student to delve into basic aspects of genetic improvement techniques, primarily using molecular markers.

## PREVIOUS KNOWLEDGE

### RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

### OTHER REQUIREMENTS

## COMPETENCES / LEARNING OUTCOMES

### -

Actuar con autonomía en el aprendizaje, tomando decisiones fundamentadas en diferentes contextos, emitiendo juicios en base a la experimentación y el análisis y transfiriendo el conocimiento a nuevas situaciones

Analizar a nivel molecular el resultado de la manipulación de un organismo.

Colaborar eficazmente en equipos de trabajo, asumiendo responsabilidades y funciones de liderazgo y contribuyendo a la mejora y desarrollo colectivo

Contribuir en el diseño, desarrollo y ejecución de soluciones que den respuesta a demandas sociales, teniendo en cuenta como referente los Objetivos de Desarrollo Sostenible

Demostrar razonamiento crítico y autocrítico en el ámbito de la titulación, considerando aspectos tales como la ética profesional, los valores morales y las implicaciones sociales de las diferentes actividades realizadas

Determinar los marcadores moleculares apropiados en procesos de mejora con fines biotecnológicos.

Diseñar procesos de manipulación y obtención de productos biotecnológicos.

Diseñar y aplicar aproximaciones biotecnológicas en el campo de la Agroalimentación.

Propose creative and innovative solutions to complex situations or problems, typical of the area of ¿¿¿¿connection, to donate responses to the various professional and social needs

Saber comunicarse de manera efectiva, tanto de forma oral como escrita, adaptándose a las características de la situación y de la audiencia

## DESCRIPTION OF CONTENTS

1 Introduction. Genetic breeding. The variation. Genotype and Phenotype. The selection.
2 DNA markers. Introduction to the markers. First generation DNA markers (RFLPs and minisatellites).

## 1. Topics

1 Introduction. Genetic breeding. The variation. Genotype and Phenotype. The selection.Second generation DNA markers (microsatellites, RAPDs, AFLPs, and SNPs). Third generation DNA markers and mass genotyping (microarrays, detection by allele-specific ligation, mass NGS sequencing). Choice of a marker.
3 Linkage analysis with molecular markers. Concept and analysis of linkage. Estimation of the recombination fraction. Logarithm of the odds.
4 Marker mapping. Genetic map. Assignment to linkage groups. Practical cases.
5 Genetic structure of populations. Hardy-Weinberg equilibrium. Deviations from H-W equilibrium. Estimation of genetic variability. Plant reproduction systems.
6 Genes and quantitative characters. Quantitative character modeling and model interpretation. Mapping populations. Demographic factors and selection.
7 Selection assisted by molecular markers. Detection of QTLs. Marker-assisted selection (MAS). Case studies.
8 Genomic techniques and genetic breeding. Introduction. New challenges for plant breeding. The Genomic Revolution. Genomic variability. GWAS. Genomic selection. Transcriptomic. Genome Editing.

## WORKLOAD

### PRESENCIAL ACTIVITIES

| Activity | Hours |
|---|---|
| Tutorials | 9,00 |
| Theory | 21,00 |
| Laboratory | 15,00 |
| **Total hours** | **45,00** |

### NON PRESENCIAL ACTIVITIES

| Activity | Hours |
|---|---|
| Attendance at other activities | 0,00 |
| Individual or group project | 22,50 |
| Independent study and work | 0,00 |
| Preparation of lessons | 25,00 |
| Preparation for assessment activities | 20,00 |
| Resolution of case studies | 0,00 |
| **Total hours** | **67,50** |

## TEACHING METHODOLOGY

The teaching of this subject will be carried out through the following methodological approaches: lectures, organized discussion sessions on the topics of the syllabus, tutorials, and laboratory activities.

The student is required to attend the theory classes, where they will be provided with an overview of the topic being covered, with special emphasis on key concepts. In the same session, the most appropriate resources for further exploration of the topic will be indicated, allowing the student to enhance their

understanding. Regarding the practical classes, experiments will be designed to reinforce the concepts presented in the theory classes.

The subject is designed to include both on-site and non-presential work.

## EVALUATION

The assessment of students' learning will be conducted through the evaluation of the following sections:

1. After the end of classes, an examination will be scheduled, which will account for 60% of the final grade for the course. This will be an examination consisting of two parts of theory and one part of problems (exercises) in a single session held in the classroom. A minimum score of 4 out of 10 must be obtained in each part to pass. For the final examination grade, the scores of theory and problems (exercises) will be averaged, provided that a minimum score of 4 out of 10 is achieved in each part and the overall exam score is equal to or greater than 5 out of 10. In the final examination grade, theory counts for 60% and problems for 40%.
2. Attendance assessment (20%), laboratory notebook submission (30%), and experimental data analysis assessment (50%). A score of 4 out of 10 or higher must be obtained. This section will account 30% of the final grade for the course.
3. An optional project on markers based on an article. This section will account for 10% of the final grade for the course.

The final grade for the course will be the sum of the scores obtained in the evaluation of the three sections described above (theory+problems, laboratory practicals, and optional project), which will contribute to the final grade in the proportions of 60%, 30%, and 10% respectively. The course will be passed with a score higher than 5 out of 10. Attendance at practicals is mandatory and absence from them, according to the regulations of the University of Valencia, results in failure in both exam sessions of the course.

To pass the course in the second exam session, a single theory and problems exam similar to that described in section 1 must be passed. If the student has obtained a score of 4 out of 10 or higher in the practical part (see section 2) and some points in section 3, these points will be added to those of the exam, according to the formula of the first session. If the score of the exercises in section 2 is lower than 4 out of 10, the theory and problems exam will include questions about the laboratory practicals. In this latter case, the value of the exam will be up to 9 points, to which the points from section 3 will be added. In case of failing the course, if the laboratory grade is higher than 5, it may be considered to retain the laboratory grade from the 2024/2025 academic year for the 2025/2026 academic year. The student must request this in writing before the end of October 2025.

## REFERENCES

Acquaah, G. (2007). Principles of Plant Genetics and Breeding. Blackwell. Allard, R. W. (1960). Principles of plant breeding. Editorial: Wiley.

Arun Kumar, Baudh Bharti, R. B. Dubey (2018). Principles of Crop Improvement. LAP LAMBERT Academic Publishing. ISBN 978-613-9-83212-5.

Benito Jiménez, C. i Espino Nuño, F. J. (2013). Genética: conceptos esenciales,

Editorial Médica Panamericana.

Broman, K. i Sen, S. (2009). A Guide to QTL Mapping with R/qtl. (Recurs electronic). Springer Nova York. Disponible en trobes,

Fita Fernández, A. M.; Rodríguez Berruezo, J.; Prohens Tómas, J. (2008). Genética y mejora vegetal. Universitat Politècnica de València.

Griffiths, A. J. F.; Wesier, S. R., D. T.; Lewontin, R. C. i Carroll, S. B. (2013). Genética.Interamericana-McGraw-Hill. Novena edició.

Klug, W.; Cummings, M. R., i Spencer C. A. (2013). Conceptos de genética. Pearson Prentice Hall, Desena edició.

Koh, H. J.; Kwon, S. Y.; Thomson, M. (2015). Current Technologies in Plant Molecular Breeding. Editorial: Springer,

Pierce, B. A. (2016). Genética: un enfoque conceptual. Editorial: Panamericana.

Priyadarshan, P. M. (2019). Plant Breeding: Classical to Modern. Springer ISBN 978-981-13-7094-6.

Rifkin, S. A. (2012). Quantitative Trait Loci (QTL): Methods and Protocols. (Recurs electronic).Humana Press. Disponible en trobes.

Crossa J, Pérez-Rodríguez P, Cuevas J, et al. Genomic Selection in Plant Breeding: Methods, Models, and Perspectives. Trends Plant Sci. 2017;22(11): 961-975. doi:10.1016/j.tplants.2017.08.011

Huang X, Han B. Natural variations and genome-wide association studies in crop plants. Annu Rev Plant Biol. 2014;65:531-551. doi:10.1146/annurev-arplant-050213-03571.

Elshire RJ, Glaubitz JC, Sun Q, et al. A robust, simple genotyping-by-sequencing (GBS) approach for high diversity species. PLoS One. 2011;6(5):e19379. Published 2011 May 4. doi:10.1371/journal.pone.0019379

Lenaerts B, Collard BCY, Demont M. Review: Improving global food security through accelerated plant breeding. Plant Sci. 2019;287:110207. doi:10.1016/j.plantsci.2019.110207

Liu HJ, Yan J. Crop genome-wide association study: a harvest of biological relevance. Plant J. 2019;97(1):8-18. doi:10.1111/tpj.14139

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