COURSE DATA

DATA SUBJECT

Code: 36700
Name: Plant Molecular Biology
Cycle: Undergraduate Studies
ECTS Credits: 4.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1109 - Degree in Biochemistry and Biomedical Sciences	Facultat de Ciències Biològiques	3	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1109 - Degree in Biochemistry and Biomedical Sciences	Biología vegetal	COMPULSORY

COORDINATION

MUÑOZ BERTOMEU JESUS

SUMMARY

Photosynthetic organisms are at the base of the food chains and are probably the living beings that have contributed most in the past to create the environmental conditions for the development of the rest of aerobic living beings. Hence, a challenge for future generations of molecular biologists is the global understanding of them, in order to develop the biotechnological potential of plants to improve the environmental quality of life on Earth.

Plant Molecular Biology will be studied from the molecular point of view, as this group of organisms, and in particular the higher plants have common characteristics that differentiated form a separate knowledge field and is the subject of this course.

First, the differential characteristics of the plants will be studied. Furthermore, the comparison of sequenced genomes of several higher plants enables functional analysis of plant genomes with respect to other groups of organisms. The plant nuclear genome and its intercommunication with organellar genomes will be also studied, in addition to the genetic and molecular tools that allow progress in the current study of plants and their application in biotechnology with biomedical purposes.

The basic mechanisms that distinguish plants from other organisms, such as water acquisition and mineral

elements uptake, photosynthetic CO_2 fixation and its distribution throughout the plant. Finally, the molecular mechanisms and gene expression changes that regulate the processes of development. Furthermore, the knowledge of the molecular bases of plants and their genetic transformation methods, allows the design of biotechnological strategies aimed at different purposes of interest, due to the economic and environmental importance of plants.

Plant Molecular Biology is a subject with an important experimental content, so four laboratory sessions, mainly aimed to familiarize students with the recombinant DNA technology applied to plants and their genetic transformation, mediated by *Agrobacterium tumefaciens*, will be studied.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

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

COMPETENCES / LEARNING OUTCOMES

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Capacidad para la asimilación de textos científicos en inglés.

Have an integrated view of normal and altered cell function, including metabolism and gene expression.

Have capacity for analysis, synthesis and critical reasoning in the application of the scientific method.

Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.

Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

DESCRIPTION OF CONTENTS

1. Introduction

Why study molecular biology of plants in the Biochemistry and Biomedicine degree?. Differential molecular characteristics of plants.

2. The nuclear genome

Characteristics of the plant nuclear genome: ploidies and mobile genetic elements. Plant genome sequencing: functional annotation. Regulation of plant nuclear genomes: RNA polymerases and their regulation; epigenetic mechanisms of gene regulation. Small RNAs regulators

3. Cytoplasmic genomes

Features, organization and functionality of the plastome and chondriome. RNA polymerases and promoters of plastid genes. Anterograde and retrograde communication between genomes.

4. Tools in molecular biology and genetics of plants

Model photosynthetic organisms. Genetic and electronic resources. Nuclear and chloroplast transgenesis. Collection, and analysis of mutant types. Omics technologies in plants. Biotechnological applications related to biomedicine.

5. Movement of water and solutes in plants

Transpiration and regulation. Absorption of water and nutrients through the roots and xylem transport. Assimilate transport.

6. Plants as source of energy

Energy absorption by plants: photosystems. Calvin cycle and photorespiration. C4 and CAM metabolism. Sulfur and nitrogen assimilation.

7. Molecular basis of plant hormone action

Main hormonal groups: Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid, Brasinosteroids, Estrigolactones, Jasmonates, Salicylates, Polyamines, oligopeptides and Nitric oxide. Signaling by: ubiquitination, kinase type receptors and hybrid kinase systems. Interactions and integration of hormonal signaling pathways.

8. Molecular bases of plant growth and development

Establishment of the apical-basal axis. Structure and maintenance of stem and root apical meristems.

9. Light and temperature as signals of the development of plants

Scotomorphogenesis and Photomorphogenesis. Signaling pathways from the main photoreceptors (Phytochromes, Cryptochromes, Phototropines, Family ZEITLUPE and UVR8). Thermomorphogenesis. The circadian clock.

10. Molecular bases of flowering

Flower development: from Model ABC to model ABC (D) E. Photoperiodic control of flowering. Vernalization. Other flowering pathways.

11. Molecular bases of seed development

Pollination and double fertilization. Embryogenesis and development of the endosperm. Maturation of seeds. Dormition.

12. Molecular basis of Senescence.

Monocarpic and Polycarpic Senescence. Abscision of organs

13. Laboratory classes

Session 1. Extraction of genomic DNA from control and mutant plants.
Session 2. Identification of T-DNA insertion and TILLING mutants by PCR genotyping and restriction analysis.
Session 3. Analysis of gene expression in plants with constitutive and inducible promoters using the ß-glucuronidase histochemical assay.
Session 4. Identification of transgenic Arabidopsis plants with single-copy insertion and homozygous transgenes through the study of marker gene segregation.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	2,00
Theory	31,00
Laboratory	12,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	15,00
Independent study and work	0,00
Preparation of lessons	10,00
Preparation for assessment activities	42,50
Resolution of case studies	0,00
Total hours	**67,50**

TEACHING METHODOLOGY

The development of the course is divided into:
Theory class: 27 hour sessions where the master class will be mainly used for teaching. The teaching material (pdf powerpoint presentations) used by the teacher as well as the specific bibliography used in each issue, will be accessible in advance in the Virtual Classroom (platform support teaching). The Virtual Classroom is considered the official bulletin of the subject for examination sessions, qualifications and reporting schedules of exam review. The student must be aware of such communications.

Practical laboratory sessions: they are taught during a week in 4 sessions of 3 hours each. Students will have a booklet or script of practices, facilitated by the teacher in advance through the Virtual Classroom. Students must have read the script before performing practical laboratory sessions. Attendance at practical sessions is mandatory. During the session, the teacher will guide the conducting experiments and assist in the discussion of the results obtained.

Seminars, conferences and other activities: activities that allow students to expand their knowledge on the subject and relate with other disciplines and promote the acquisition other than those acquired in the theoretical and practical skills classes will be developed. One of these activities will be critical analysis of scientific papers, selected by the teachers of the course. This activity aims to student training in reading scientific papers (which necessarily involves reading technical English), bringing him/her closer to the original literature from which new knowledge that enable the development and advancement of biomedical sciences are obtained. This activity, mandatory, will be organized jointly with the other courses in the third year. The preparation, presentation and discussion of articles will take place in groups of 2 students and will be supervised by the teacher through tutorials.

EVALUATION

- Theoretical contents will be evaluated with a written exam consisting of questions related to the program content. The result of this evaluation represent 85% of the final grade for the course. There will be the possibility of taking a midterm exam. For those students that pass the midterm exam, the final exam will only include contents from the second half of the subject (those not included in the midterm exam).
- The contents of the laboratory practices will be assessed through a written exam questions that will score 10% of the final grade. The issues may be related to both the experimental part developed, as with the techniques and methodology discussed during the laboratory sessions. Attendance is mandatory and, if approved, the exam is saved for the second call within the same academic year.
- To evaluate the activity of critical analysis of scientific papers the following evaluation criteria will be taken into account. You can also valued integration with other theoretical and practical contents of this or other subjects of the degree. We could get a maximum score of 10 points, 5 points still needed to overcome this activity. The mark obtained will represent 5% of the final grade for each course subjects third participants in this activity. If the student does not reach the minimum score required, suspend the course in which performs this activity. Likewise, the participation of other students in the presentation and discussion sessions, may be considered by the teacher to modulate the final grade for the course.
- In order to pass the course, students must achieve a minimum overall score of 5 points and obtain at least 40% of the maximum marks in each of the following components: laboratory

sessions and theory examination(s). Furthermore, as previously indicated, a minimum of 50% must be attained in the seminar component.
- When a score of 5 points has been obtained, the student's active participation in the theoretical and practical classes will be assessed, adding up to 0,5 points to the final grade.
- Repeaters students who have completed practical classses, but have not passed the course may not attend laboratory classes, although they must retake the exam practices and other assessment activities of the subject.

REFERENCES

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Blackwell. New Delhi, India.
- Reviews published in journals such as Trends in Plant Science, Current Opinion in Plant Biology, and similar sources will be consulted for selected course topics.