ETS Ingeniería Agronómica, Alimentaria y de Biosistemas	
Program	20BT– Degree in Biotechnology

Course number and name	
Number	20504314
Name	Plant Molecular Biology
Semester	S2 [(February-June)], 3rd Year

Credits and contact hours	
ECTS Credits	6
Contact hours	72

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Specific course information

Description of course content

The subject's main objective is that students get to know the main aspects of molecular biology processes of plants, the relevance of these molecular processes in plant production (food, biomass, biomolecules, etc.) and its impact on the bioeconomy. The knowledge of the molecular biology of plants will allow understanding its plasticity and its ability to respond and adapt to changing environmental conditions, which is essential for plants to be able to complete its life cycle. To achieve these objectives in the subject, different aspects of Plant Molecular Biology are addressed such as:

- The characteristics of plant genomes and the molecular mechanisms involved in the regulation of plant gene expression and the cell cycle.
- The main molecular characteristics of plant cells and their cell walls, as well as their function in the regulation of developmental processes and the response of plants to environmental stress.
- The main characteristics of plant metabolism and main plant metabolic pathways, including the its secondary metabolism, and the impact of modifying the plant metabolism in the improvement of food production and in human and animal health.
- Molecular mechanisms of plant perception and signal transduction that control plant development and the response of plants to environmental signals and stresses, and their role in the regulation of plant physiological processes. The main similarities and differences between the mechanisms of perception and transduction of the signals of plants and animals will be studied.

List of topics to be covered

1. **Introduction to the molecular biology of plants: origin and diversification of plants**
    1.1. The Planet Earth, Photosynthesis and the Origin of Cells
    1.2. Origin of the Eukaryotic Cell
    1.3. Origin of Land Plants
    1.4. Seed Plants
    1.5. Angiosperms
2. **Plant genomes and their regulation**
    2.1. Nuclear Genome: Chromosomal DNA
    2.2. Regulation of Nuclear Genes
    2.3. Genomic Sequences
    2.4. Genomes and Biotechnology
    2.5. Cytoplasmic Genomes
3. **Molecular biology of the plant cell**
    3.1. Cell Cycle and Cell Division
    3.2. Plant Organelles
    3.3. Plant Cell Wall
        3.3.1. Primary Wall: Polysaccharides and Proteins
        3.3.2. Secondary Wall: Polysaccharides and Lignin
        3.3.3. Cell Wall and Cell Communication: Plasmodemata
        3.3.4. Cuticle
        3.3.5. Cell Wall and Cell Expansion
4. **Plant metabolism and its regulation (I)**
    4.1. Photosynthetic Pigments. Antenna Complexes and Reaction Centers.
    4.2. Photosystems.
    4.3. Photophosphorylation and cF0cF1 ATPase.
    4.4. Reduction and Carbon Fixation Reactions
    4.5. Photorespiration
    4.6. C4 plants. CAM plants. Regulation of the C4 Cycle and CAM.
    4.7. Molecular Regulation of Photosynthesis
    4.8. Starch: Synthesis, Degradation and Biotechnological Interest.
    4.9. Sucrose: Synthesis and Degradation: Integrated Control of the Synthesis of Starch and Sucrose
    4.10. Fructans and Raffinose
5. **Plant metabolism and its regulation (II)**
    5.1. Triacylglycerides and Amphipathic Lipids
    5.2. Fatty Acid Synthesis
    5.3. Synthesis of Membrane Glycerolipids
    5.4. Synthesis of Triacylglycerides
    5.5. Degradation of Triacylglycerides and Fatty acids
    5.6. Glyoxylate Cycle
    5.7. Terpene Synthesis
    5.8. Porphyrin Synthesis
6. **Plant metabolism and its regulation (III)**
    6.1. Nitrogen sources and Assimilation Mechanisms: Nitrate Reductase and Nitrite Reductase
    6.2. Ammonium Assimilation. Amino Acid Metabolism

6.3. Synthesis and Intracellular Trafficking of Proteins in Plants
6.4. Chaperones
6.5. Reserve Proteins
6.6. Assimilation of other Micronutrients (P, S, Cu and Mo)

7. **Plant secondary metabolism**
7.1. Alkaloids
7.2. Cyanogenic Glycosides and Glucosinolates
7.3. Mimetic amino acids
7.4. Terpenoids
7.5. Phenylpropanoids, Flavonoids and Tannins

8. **Molecular signals and signal transduction pathways in plants**
8.1. Generalities
8.2. G-proteins
8.3. Receptors
8.4. Protein Kinases and Phosphatases
8.5. Second Messengers: Inositol Triphosphate, Cyclic Nucleotides and Calcium
8.6. Ubiquitination and Protein Degradation
8.7. Phytohormones
8.8. Signal iIntegration and Transcriptional Regulation

9. **Molecular biology of developmental processes in plants**
9.1. Plant Development Overview
9.2. Embryo and Seed Development
9.3. Root and Shoot Development, and Floral Transition
9.4. Senescence, Cell Death and Abscission
9.5. Seed Development and Germination
9.6. Fructification
9.7. From sporophyte to gametophyte

10. **Molecular biology of the response to environmental cues**
10.1. Light and Photoperception
10.2. Floral Transition
10.3. Flower Development

11. **Molecular biology of the response to environmental stress**
11.1. Light Stress
11.2. High temperatures
11.3. Salinity
11.4. Drought
11.5. Freezing
11.6. Anaerobiosis and Oxidative Stress
11.7. Heavy Metals and other Environmental Contaminants
11.8. Responses to Biotic Stress

12. **Molecular Biology and Biotechnology in Domestication and Agriculture,**
12.1. Crop Domestication Origins
12.2. Examples of Domestication: corn, wheat and tomato.

13. **Comparative molecular biology of plants and animals**
13.1. Signal Transduction Mechanisms and Regulation

Prerequisites or co-requisites
- Genetics - Molecular genetics and regulation of gene expression - Plant Physiology
Course category in the program
Mandatory

Specific for course objectives

Specific learning outcomes

RA170 - Know the functioning of plant genomes and their regulation
RA175 - Know the molecular bases of plant development processes and the response of plants to environmental cues and stresses
RA178 - Know the main molecular similarities/differences between the processes of development and response to plant and animal environmental signals/stresses
RA171 - Know the main pathways of plant metabolism and their regulation
RA173 - Demonstrate mastery of the fundamentals of plant molecular biology and its potential applications biotechnological
RA174 - Know the impact of the molecular biology of plants in the processes of improving productivity agri-food and in the design of biotechnological applications
RA172 - Know the main mechanisms of perception and signal transduction in plants
RA177 - Acquire laboratory experience to handle the basic molecular biology techniques to be used in the development of their professional work.

Further reading and supplementary materials

-PLANT BIOLOGY. Alison M. Smith, George Coupland, Liam Dolan, Nicholas Harberd, Jonathan Jones, Cathie Martin, Robert Sablowski, Abigail Amey. Garland Science . 2010. ·

-BIOCHEMISTRY AND MOLECULAR BIOLOGY OF PLANTS (2nd edition). B.B. Buchanan, W. Gruissem, R. Jones. American Society of Plant Physiologists. Wiley. 2015

-PLANT PHYSIOLOGY AND DEVELOPMENT (sixth edition) L. Taiz, E. Zeiger, I.M. Moller, A. Murphy. Sinauer Associates, Inc. 2018.

-Review articles: Trends in Plant Science, Current Opinion in Plant Biology, Current Opinion in Plant Biotechnology, Science, Nature, Cell, Plant Cell, …

-Presentations, images and videos.

Teaching methodology

_13_ **lectures**	2 **problem solving sessions**	_1_ **collaborative action**	_3_ **laboratory sessions**
Other:			

Evaluation Criteria

Students will be assessed through progressive assessment, according to the criteria

specified below.

PROGRESSIVE/CONTINUOUS ASSESSMENT: it will consist of 4 face-to-face activities in the classroom, that will include tests questions, theory and problems:
1- Multiple choice questionnaires on the main fundamentals of the different thematic units, performed every 3-4 topics during class time (10% of the final grade).
2-Partial exams, the first one including topics 1-7 and the second with topics 8-13 (70% of the final grade). It will be possible to eliminate the partial with 4.5, but it is necessary to approve this section of theory (5) to pass the subject.
3-Laboratory practices (20% of the final grade). The activity will include the presentation of a scheme of the practices (10% of the practices note) and the presentation of a report of the results of the practices (90% of the practice grade). It is necessary to pass the practices (>4.5) to pass the subject.
4-In the rest of the progressive evaluation, the elaboration and presentation of cooperative works will be valued, as well as attendance/contribution/participation in class (can go up to 1 point).

The evaluation activities will be face-to-face Although evaluation elements through Moodle can be used in some cases. Only those present in the exam rooms will be evaluated in the computer tests. If connections outside the classroom are detected, measures equivalent to when copying a test will be taken.

GLOBAL EVAUATION THROUGH FINAL EXAM. If student renounces to it, his progressive assessment can be replaced by a final exam (80% of the final grade) to evaluate the general contents of the subject. The rest (20% of the final note) will consist of the laboratory practices that will be evaluated as stated above.

The evaluation of the subject in the EXTRAORDINARY CALL will be carried out through a single global exam, regardless of the option chosen in the ordinary call. To pass the subject, both the theory and practical exams must be passed.

Attendance at practices is mandatory to pass the course.