Universitat de Lleida

DEGREE CURRICULUM

PHYSIOLOGY AND PLANT CELL CULTURES

Coordination: PELACHO AJA, ANA MARIA

Academic year 2020-21

Subject's general information

Subject name	PHYSIOLOGY AND PLANT CELL CULTURES
Code	101615
Semester	1st Q(SEMESTER) CONTINUED EVALUATION
Typology	Degree: Bachelor's Degree in Biotechnology; Course: 2; Character: COMPULSORY; Modality: Attendance-based
Course number of credits (ECTS)	7.5
Type of activity, credits, and groups	Activity type: PRALAB / TEORIA Number of credits: 1.5 / 1 / 5 Number of groups: 9 / 5 / 1
Coordination	PELACHO AJA, ANA MARIA
Department	HORTICULTURE, BOTANY AND LANDSCAPING
Teaching load distribution between lectures and independent student work	In-situ and online lectures and student work 75h Independent student work 140 h
Important information on data processing	Consult this link for more information.
Language	Catalan: 10% Spanish: 80% English: 10%
Distribution of credits	Theory. Large Group 5.0 Laboratory practices. Small group 2.5

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
BERMAN QUINTANA, JUDIT	judit.berman@udl.cat	7	
PELACHO AJA, ANA MARIA	anamaria.pelacho@udl.cat	3,2	
SERRANO RUIZ, HADALY	hadaly.serrano@udl.cat	7	
SORIA VILLALONGA, YOLANDA JACINTA	yolanda.soria@udl.cat	6,3	

Subject's extra information

Plant physiology and plant cell culture is a 2nd year compulsory subject. Students will take this course after having had a first contact with the basics of Cellular and Molecular Biology, Biochemistry and Genetics. In this subject, the basic theoretical concepts related to the biology and functioning of plants are presented, and a first approach to the techniques of in vitro culture of plant cells, tissues and organs is made.

The knowledge acquired in this subject will allow the subsequent study of other subjects, such as Plant Biotechnology (3rd year) and other of plant biotechnology related subjects, such as Biotechnological Applications of In Vitro Cultivation of Plant Cells and Tissues or Secondary Plant Metabolism (4th year). The Plant Physiology basis will be essential for all those who want to dedicate themselves to the biotechnology aspects mostly dealing with agri-food and plants; it will also be useful for those who will dedicate themselves to biomedical, environmental or animal aspects.

After completing this subject, Biotechnology students must be able to develop biotechnological projects related to plants or to their metabolites. Particularly, they must be able to work in a plant cell and tissue culture laboratory.

Learning objectives

At the end of the course, the student is to be able to:

- Establish relationships between Plant Physiology and other scientific fields.
- Describe the basic functioning of plants, to associate plant structure to plant functions and to conveniently use the specific terms of Plant Physiology.
- Describe the plant developmental processes during the plant vital cycle.
- Describe the modulating effect the environmental factors have on plant growth and development, and the involved mechanisms.
- Associate the basic principles of Plant Physiology with its practical applications.

- Apply the acquired knowledge to solving problems related with the biotechnological applications of Plant Physiology.
- To know the main plant cell and tissue culture applications.
- To read, understand and communicate results from a plant cell culture scientific paper.
- To start a plant tissue culture.
- To design a plant cell and tissue culture medium.
- Produce experimental designs to solve problems related with the plant functioning. To obtain, analyze and interpret experimental results produced.
- Elaborate reports, summaries and presentations.
- Search for information assisted by searching tools, databases and bibliographic collections.

Significant competences

General competences

- To be able to selectively search and use the required information resources to reach the educational objectives.
- To interpret the scientific and technical information under a critical perspective and to be able to produce presentations based on this information.
- To be able to produce easy to understand oral and written reports on the fulfilled work, with a justification based on the theoretic and practical knowledge attained (UdL strategic competence).
- Team working, with a multidisciplinary approach and with capacity to rationally distribute tasks among the team members.
- To be able to communicate in the international environment of the professional development (UdL strategic competence).
- To use information and communication tools and technologies for data analysis and for producing oral and written reports and other educational and professional outputs (UdL strategic competence).
- To know and to conveniently use the scientific and technical terms specific of the different Biotechnology areas.
- To work in the laboratory applying good practices and quality standards.
- To know and to be able to use software and databases specific for the different areas in Biotechnology.
- To use the scientific method to analyze data and to design experimental strategies for applications in biotechnology.
- To acquire decision criteria for the analytical techniques more convenient for every specific practical case.

Specific competences (according to the Study Plan document)

- To acquire precise knowledge of the plants basic principles and physiological mechanisms.
- To know plant cell and tissue culture.
- To transfer information, ideas, problems and solutions to the public, both specialized and non-specialized.

Subject contents

Introduction. Course presentation and organization. Definitions: plant physiology, plant cell and tissue culture, related concepts. Basic concepts in plant physiology. Relationship with biotechnology. General data of the course. Literature.

Unit 1. Water transport in the plant. Water in plants. Hydric potential. Water movement in the plant. Water movement in the soil. Water movement in roots. Water movement in leaves. Rise of water in the xylem. Theory of tension-cohesion. Cavitation and embolism. Regulation of water transport in the plant.

Unit 2. Transpiration and stomata movements. Transpiration. Stomata and cuticular transpiration. Environmental and endogenous factors affecting transpiration. Resistance to transpiration. Stomata characteristics. Stomatal movements. Regulation of stomatal movements. Daily variation of water absorption and transpiration. Water deficit in the plant.

Unit 3. Inorganic composition of plants. Introduction. Essential mineral elements. Metabolism and function of

essential mineral elements. Macronutrients. Micronutrients. Beneficial mineral elements. Transport of mineral elements.

Unit 4. Transport in the phloem. The phloem as a transport system. Phloem structure. Substances transported in the phloem. Movement of photoassimilates. Sources and sinks. Transport mechanisms. Inactivation and longevity of sieve elements.

Unit 5. Photochemical reactions of photosynthesis. Photosynthesis as endergonic process. Nature of light. Capture of light energy. Chloroplast structure and composition. Photosystems and reaction centers. Electronic transport chains. NADH and ATP synthesis.

Unit 6. CO_2 fixation and reduction: C3 plants. Introduction. CO_2 fixation and reduction. Calvin cycle. Sucrose and starch synthesis. Photorespiration.

Unit 7. CO_2 fixation and reduction: C4 and CAM plants. Photosynthesic mechanism of C4 plants. Efficiency of C3 and C4 plants. Factors affecting phosothynthesis. Acid metabolism of crassulacean plants (CAM).

Unit 8. General aspects of plant development. Concepts. Genetic, environmental and hormonal control. Second messengers. Cell division, growth and differentiation. Totipotency. Polarity. Plant development and plant cycle. Plant types in relation to development. Quantifying growth. Plant hormones and synthetic regulators. Detection and quantification of plant hormones.

Unit 9. Auxins. Auxins in plants. Effects and applications. Auxin-like regulators. Auxin metabolism. Synthesis, degradation, inactivation, conjugates. Auxin transport. Auxin mode of action.

Unit 10. Gibberellins and Brassinosteroids. Gibberellins: Discovery. Gibberellin deficient mutants. Effects and uses. Synthesis. Degradation and inactivation. Conjugates. Inhibitors of gibberellin synthesis. Effects and applications. Mode of action. Brassinosteroids: identification, types and effects on plant development.

Unit 11. Cytokinins and strigolactones. Cytokinins: Discovery. Effects. Cytokinins and cytokinin-like regulators. Synthesis. Degradation and inactivation. Conjugates. Mode of action. Strigolactones: identification, types and effects on plant development.

Unit 12. Ethylene. Ethylene. Characteristics. Effects and applications. Metabolism. Ethylene related compounds.

Unit 13. Abscisic acid. Discovery of abscisic acid. Effects of abscisic acid. Abscisic acid metabolism.

Unit 14. Photomorphogenesis. Concepts. Light and plant development. Pigments and photoreceptors. Phtoreceptors. Phytochrome: discovery, physico-chemical characterization, types and distribution. Phytochrome conversions. Photostationary state. Phytochrome and plant development. Morphogenic effects of blue and UV radiation.

Unit 15. Plant developmental processes I. Photoperiodism and flowering. Plant types according to the flowering response to photoperiod. Flowering and vernalization. Flower development. Other photoperiod-related responses. Biological internal clock and plant rhythms. The flowering inducing stimulus. Juvenility and flowering.

Unit 16. Plant developmental processes II. Formation and development of fruits and seeds. Types of fruit. Pollination and fertilization. Fruit growth and ripening. Types of seeds. Embryogenesis. Seed development and desiccation. Dormancy in buds and seeds. Seasonal dormancy and sprouting. Seed types. Seed stratification. Germination. Dormancy and sprouting in other plant organs.

Unit 17. Secondary plant metabolism. Concepts. Metabolic pathways and types of secondary metabolites. Roles for secondary metabolites. Types, examples, effects and functions of terpenes, phenolic compounds, and nitrogen-containing metabolites. Uses and applications of secondary metabolites. Biochemistry of plant defense.

Unit 18. Plant tissue culture essentials. Concepts. Basis. General characteristics. The culture medium. Growth regulators in plant tissue culture. Initiation of plant tissue cultures. Basic requirements.

Unit 19. Plant tissue culture in agriculture and biotechnology. In vitro cultures for propagation and sanitation. In vitro cultures in plant breeding. In vitro cultures in genetic transformation. Plant tissue culture and germplasm conservation. In vitro cultures for the production of secondary plant metabolites. In vitro culture research systems.

Plant tissue culture for other fields of study .

Unit 20. Micropropagation. Objectives. Micropropagation phases. Initiation and establishment. Multiplication procedures. Rooting and acclimatization. Practical cases.

Practical Activities

1. **Laboratory Practice**.

2. **Problems**. Water relationships, nutrient solutions, analysis of experimental data. Exercises.

3. **Guided activities in groups**. Course assignments. Search for information in specialized databases. Organization and presentation of results.

4. **Online activities**. Through the Virtual Campus

Methodology

Due to the special circumstances derived from the health crisis caused by COVID-19, this subject will have both face-to-face and virtual teaching. In principle, exams, practices and a portion of theory teaching will take place face-to-face in the clasrrom with the professor; as specified in the schedule of the course. In the event the circumstances evolve towards a change in attendance, it will be reported in due course.

Activity Type	Description	Face-to-face activity/online, in the clasrroom with a professor		Non face-to-face student activity		Assessment	Total Time/ECTS
		Objectives	**Hours**	**Student work**	**Hours**	**Hours**	**Hours**
Master / online lesson	Master/online lesson	Learning main concepts	48	Study: to know, understand and synthesize knowledge	98		146
Problems and cases	Interactive lesson	Problems and case solving. Discussions or application activities	2	Learn to solve problems and cases, to present results, and to discuss.	6		**8**
Laboratory	Laboratori practices	Carrying out the laboratory practices. To underspand phenomenoms, measuring,...	25	Studiy and produce the report	30		55
Others	Online activities	Problems solving, search for information, discuss scientific papers			6		6
Exams						4	4
Totals			75		140	4	219 / 7.5 ECTS

Practical activities

Attendance to practices is mandatory and unjustified absence lead to failure of the subject.

It is MANDATORY that students have the following individual protection items (EPIs) during the laboratory practices.

- White laboratory coat
- Safety glasses
- Gloves for chemical / biological protection
- Mask

The EPIs can be purchased at UdL's ÚDELS store

Center for Cultures and Cross-Border Cooperation - Cappont Campus

Carrer de Jaume II, 67 low. 25001 Lleida

Evaluation

Type of activity	Assessment Activity		Marks percentage
	Procedure	**Number**	
Master/online lessons	Written exams on the course programme theory, problems	2	**70**
Laboratories, problems, cases, seminars	Delivery of reports. Written or oral assignments: elaboration of cases, presentation of seminars	3	**30**
Total			**100**

Bibliography

Bibliography: Essentials

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