Universitat de Lleida

DEGREE CURRICULUM

PHYSIOLOGY AND PLANT CELL CULTURES

Coordination: PELACHO AJA, ANA MARIA

Academic year 2021-22

PHYSIOLOGY AND PLANT CELL CULTURES 2021-22

Subject's general information

Subject name	PHYSIOLOGY AND PLANT CELL CULTURES
Code	101615
Semester	1st Q(SEMESTER) CONTINUED EVALUATION
Typology	

Degree	Course	Typology	Modality
Bachelor's Degree in Biotechnology	2	COMPULSORY	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	4	4	1

Coordination	PELACHO AJA, ANA MARIA
Department	HORTOFRUCTICULTURA, BOTANICA I JARDINERIA
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

PHYSIOLOGY AND PLANT CELL CULTURES 2021-22

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
BERMAN QUINTANA, JUDIT	judit.berman@udl.cat	3,5	
PELACHO AJA, ANA MARIA	anamaria.pelacho@udl.cat	3,2	
SERRANO RUIZ, HADALY	hadaly.serrano@udl.cat	3,5	
SORIA VILLALONGA, YOLANDA JACINTA	yolanda.soria@udl.cat	4,8	

Subject's extra information

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

The knowledge acquired in this subject will allow the subsequent study of other subjects, such as Biotechnological Applications of In Vitro Cultivation of Plant Cells and Tissues, Secondary Plant Metabolism, or Plant Biotechnology. The knowledge in Plant Physiology will be essential for all those who want to dedicate themselves to the plant and agri-food biotechnology; it will also be of interest for those who will dedicate themselves to biomedical, environmental or animal biotrechnology aspects.

Learning objectives

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

- Establish the relationship 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 effects the environmental factors have on plant growth and development, and the involved mechanisms within the plants.
- Associate the basic principles of Plant Physiology with its practical applications.
- Apply the acquired knowledge to solving problems and to the biotechnological applications of Plant Physiology.
- To know the main plant cell and tissue culture applications.
- To design and produce a plant cell and tissue culture medium.
- To start and carry out a plant tissue culture.

- 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.

Competences

General skills

- GC1 Being able to selectively search for and use sources of information necessary to achieve the training objectives.
- GC2 Interpret scientific-technical information with a critical sense, and be able to make presentations based on this information.
- GC3 Working in a team, with a multidisciplinary vision and with the ability to make a rational and efficient distribution of tasks among team members.
- GC4 Knowing and adequately using the scientific and technical vocabulary of the different areas of Biotechnology.
- GC5 Working in the laboratory applying criteria of quality and good practice.
- GC7 Using the scientific method to analyze data and design experimental strategies with biotechnological applications.

Specific skills

- CE17 To know the essential metabolic processes of living beings and their regulation.
- CE18 Acquire an integrated vision of cellular structures, relating them to their specific functions and the biochemical processes involved.
- CE22 Acquire a precise knowledge of the basic principles and physiological mechanisms of animal and plant organisms.
- CE25 To know the practice of microbial, animal and plant cell culture.

Transversal skills

- CT1 Being able to produce comprehensible written and oral reports on the work carried out, with a justification based on the theoretical-practical knowledge obtained.
- CT3 To use information and communication tools and techniques for data analysis and the preparation of oral and written reports and other training and professional activities.

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 plant development. Quantifying growth. Plant hormones and regulators. Detection and quantification of plant hormones.

Unit 9. Auxins. Discovery. Auxins in plants: chemical nature and distribution. Auxin-like regulators. Effects and applications. Auxin metabolism: synthesis, degradation, inactivation and formation of conjugates. Auxin transport. Auxin signaling and regulation. Tools in auxin research.

Unit 10. Gibberellins and Brassinosteroids. *Gibberellins*: Discovery. Chemical structure and distribution. Metabolism and homeostasis. Gibberellin deficient plant mutants. Gibberellin synthesis inhibitors. Physiological effects of gibberellins. Practical and commercial applications of gibberellins and of growth retardants. Gibberellin mode of action. *Brassinosteroids*: Steroid plant hormones. Identification. 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. Effects and interaction with other plant hormones.

Unit 12. Ethylene. Characteristics. Effects. Conbtrol of ethylene synthesis and applications. Metabolism. Ethylene related compounds.

Unit 13. Abscisic acid. Discovery of abscisic acid. Stress responses and other effects mediated by abscisic acid. Abscisic acid metabolism.

Unit 14. Photomorphogenesis. Light and plant development. Pigments and photoreceptors. Phytochrome and plant development: effects mediated by phytochrome. Effect of photoperiod in flowering and plant types according to the response to photoperiod. Morphogenic effects of blue and UV radiation. Circadian clocks.

Unit 15. Plant developmental processes I. Plant movements. Vegetative growth and plant productivity. Juvenility and maturity in plants. Flowering and vernalization. Flower development.

Unit 16. Plant developmental processes II. Formation and development of fruits and seeds. Types of fruit. Embryogenesis. Seed development and dessication. Dormancy in buds and seeds. Types of seeds. Seed stratification. Germination. Dormancy and sprouting in other plant organs.

Unit 17. Secondary plant metabolism. Secondary metabolites, types and metabolic pathways. Roles for secondary metabolites. Selected cases of 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. Plant tissue culture as a research system and in 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**

Failure to attend the practical activities without the due justification means not passing the subject.
The evaluation of the subject follows the UdL regulations.

Bibliography

Bibliography: Essentials

- Azcón-Bieto J., Talón M. 2008. Fundamentos de Fisiología Vegetal. Interamericana Mc Graw Hill, Madrid.
- Guardiola Bárcena J. L., García Luis A. 1990. Fisiología Vegetal. 1. Nutrición y Transporte. Síntesis.Madrid.
- Hopkins W. G., Hüner P.A. 2009. Introduction to Plant Physiology. Wiley International Edition. New York.
- Razdan M.K 2003. Introduction to plant tissue culture. Intercept. UK.
- Salisbury F. B., Ross C.W. 2000. Fisiología de las Plantas. Paraninfo, Madrid.
- Taiz L., Zeiger E. 2010. Plant Physiology. Sinauer Associates Inc. Publishers, Sunderland.

Bibliography. Supplementary

- Beck Ch. B.2005. An Introduction to plant structure and development. Cambridge University Press.
- Buchanan B. B., Gruissem W., Jones R. L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologist. Rockville.
- Christou P., Klee H. 2005. Handbook of Plant Biotechnology. J Wiley & Sons. Chichester.
- Davies P. J. 2004. Plant Hormones: Biosynthesis, signal transduction, action. Kluwer. Dordrecht.
- Gamborg OL, Phillips GC. 1995. Plant cell tissue and organ culture. Fundamental methods. Springer Verlag.
- George EF. Plant propagation by tissue culture. Part 1 (1993): The technology. 574p. Part 2 (1996): In practice. 799p. Exegetics Ltd., England.
- Graham L.E., Graham J.M., Wilcox L.W. 2006. Plant Biology. Pearson Education Inc., New Jersey.
- Lea P., Leegood R.C. 1999. Plant Biochemistry and Molecular Biology. J. Wiley & Sons. Chichester.
- Sinha R.V. 2004. Modern Plant Physiology. Alpha Science International. Pangbourne, India
- Srivastava L.M. 2001. Plant growth and development. Hormones and environment. Academic Press, San Diego.
- Endress R. 1994. Plants cell biotechnology. Springer Verlag.
- Trigiano RN, Gray DJ (Eds) 2000. Plant tissue culture concepts and laboratory exercises- CRC Press.