VNIVERSITAT DE VALÈNCIA

Course Guide
36841 Plant Physiology

COURSE DATA

DATA SUBJECT

Code: 36841
Name: Plant Physiology
Cycle: Undergraduate Studies
ECTS Credits: 10.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1106 - Degree in Biology	Facultat de Ciències Biològiques	3	Annual

SUBJECT-MATTER

Degree	Subject-matter	Character
1106 - Degree in Biology	Biología Vegetal	COMPULSORY

COORDINATION

RENAU MORATA BEGOÑA

SUMMARY

Plant Physiology is a third-year subject in the Biology Degree and is part of the subject area of Plant Biology, which also includes the subject Botany II, taught in the second year of the Degree.

Plant Physiology aims to provide basic knowledge of how plants function and the processes that take place in them as living beings, also integrating knowledge acquired in other subjects, such as Cell Biology, Botany I and II, Histology, and Biochemistry.

For its understanding, water relations (absorption, transport, and loss of water by the plant), mineral nutrition, and the transport of photoassimilates will be studied. Likewise, photosynthetic metabolism, which allows the reduction and assimilation of the main bioelements, as well as respiratory processes, also involved in the plant's energy metabolism, will be studied. An introduction to secondary metabolism will be made, through which compounds of fundamental importance are produced. In addition to the basic physiological processes of plants, it is important to know the mechanisms involved in their growth and development, as well as their interactions with the environment. Therefore, topics ranging from plant hormones to photoreceptors are addressed, including plant movement, the different processes of their life cycle, and the integration of all these processes in space and time, as well as the mechanisms of adaptation to possible unfavorable conditions in their surrounding environment.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

The subject "Plant Physiology" requires having passed the first-year subjects: "Cell Biology", "Biology" and "The Tree of Life".

COMPETENCES / LEARNING OUTCOMES

1106 - Degree in Biology

(CB3) 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.

(CB4) Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Apply principles of physics, chemistry and geology to the field of biology.

Design and conduct experiments by using scientific techniques and instruments appropriately and complying with laboratory safety regulations.

Interpret, analyse, evaluate, process and synthesise biological data and information by applying mathematical and statistical methods.

Organise, plan and manage information in a manner that allows the individual to analyse, synthesise and develop critical reasoning that can be applied to solve problems, make decisions and carry out work.

Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía

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 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.

That students know how to apply their knowledge to their work or vocation in a professional manner and possess the skills that are usually demonstrated through the development and defense of arguments and the resolution of problems within their area of ¿¿study

Understanding the morphological and functional diversity of living beings. Understanding their functions, the basic underlying mechanisms from an integrative point of view, and their adaptations to the environment throughout their life history.

Understand the morphological and functional diversity of living beings. Understand the functions of the basic underlying mechanisms from an integrative point of view and their adaptations to the environment throughout their history.

Use scientific language, both oral and written, and be able to adapt the register to the target audience and/or readers. Use the most common foreign languages in each discipline as a vehicle for communication in a globalised system.

DESCRIPTION OF CONTENTS

1.- Introduction to Plant Physiology.

Introduction to Plant Physiology.- Concept and scope of study of Plant Physiology. Relationship of Plant Physiology with other sciences. The Plant Physiology Program. Bibliographic Sources. Assessment of the subject.

The plant cell. Characteristic organelles of the plant cell. The cell wall: structure, composition, and function. Transformations of the wall and communication zones.

Practice 1.- Membrane permeability. Factors that affect it.

2.- Water relations

Water in the plant.- Importance of water. Structure and properties of water. Water potential: concept and components. Water relations in cells and tissues.

Absorption and transport of water in the plant.- Circulation of water in the soil-plant-atmosphere system. Absorption of water by the root. The root as an osmometer: root pressure and guttation. The ascent of water in the plant. Composition of xylem sap. Mechanism of water ascent in the plant.

Transpiration.- Concept, importance, and magnitude. Types of transpiration. Transpiration through stomata. Mechanisms of stomatal opening and closing. Factors affecting transpiration.

Practice 2.- Measurement of water and osmotic potentials in plant tissues. Practice 3.- Measurement of transpiration with the potometer

3.- Mineral nutrition

Absorption and transport of nutrients by plants.- The root as an absorption organ. Absorption at the cellular level. Radial transport in the root. Longitudinal transport.

Mineral nutrition.- Mineral composition of the plant. Essential mineral elements. Functions of mineral elements in the plant. Mineral deficiencies: causes and symptoms.

Practice 4.- Mineral nutrition.

4.- Metabolism in plants (1)

Photosynthesis. Photosynthesis: concept, general equation, and included processes. Types of photosynthesis. The photosynthetic apparatus in plants: chloroplast, structure, and chemical composition. Photosynthetic pigments: chlorophylls, carotenoids, and phycobilins.

Absorption of light energy.- Light absorption and forms of energy dissipation. The photosynthetic unit: reaction centers and light-harvesting antennae. Ultrastructure of thylakoids: composition and distribution of photosynthetic complexes.

Photosynthetic electron transport and photophosphorylation.- Electron transport: cyclic, non-cyclic, and pseudocyclic. The water-splitting complex. Photophosphorylation. Coupling mechanism between electron transport and photophosphorylation.

Photosynthetic carbon dioxide fixation.- Carbon dioxide assimilation in plants: the Calvin-Benson cycle. Regulation of the cycle. Sucrose and starch synthesis. Photorespiration. Biochemistry of the pathway and physiological significance.

Adaptive pathways of prior carbon dioxide accumulation.- Pathways and adaptive significance. C4 photosynthetic metabolism. CAM photosynthetic metabolism. Accumulation in algae. Photorespiration in C4 and CAM plants. Water Use Efficiency (WUE). Transport of photoassimilates.- The phloem, structure, and function. Substances transported by the phloem. Source and sink concepts. Loading and unloading mechanisms. Mechanism of transport through the phloem.

Practice 5.- Photosynthesis in isolated thylakoid vesicles: Hill reaction

5.- Metabolism in plants (2)

Respiration in plants.- General aspects of the respiratory process. Peculiarities of the respiratory chain in plants: alternative oxidase.

Nitrogen and sulfur metabolism.- Forms of nitrogen absorbable by the plant. Nitrogen fixation in symbiotic associations. Assimilatory reduction of nitrate and ammonium. Sulfur assimilation.

Secondary metabolism. Main groups, synthesis pathways, and importance. Alkaloids. Terpenoids. Phenolic compounds.

Practice 6.- Measurement of gas exchange in different species. Practice 7.- Experimental results in Plant Physiology. Problems and questions.

6.- Plant development (1)

Growth in plants. Growth and development in plants: terminology and cellular bases. Organization and activity of apical meristems of the stem and root. Quantification and kinetics of growth.

Plant growth regulators. Concept of phytohormone. Perception and transduction of the hormonal signal. Main groups of hormones: auxins, gibberellins, cytokinins, ethylene, abscisic acid. Other phytohormones: polyamines, brassinosteroids, jasmonates, salicylates, oligopeptides, oligosaccharins.

Practice 8.- Plant hormones: auxins.

Practice 9.- Plant hormones: gibberellins.

Practice 10.- Plant hormones: cytokinins.

7.- Plant development (2)

Photomorphogenesis. Concept. Photoreceptors in photomorphogenesis. The phytochrome system: chemical characteristics, types of phytochrome, metabolism, and photostationary state. Mechanism of action. Phototropins and cryptochromes.

Rhythms and movements in plants. The biological clock. Types of movements in plants. Nutations. Nasties: nyctinasty and thigmonasty. Tropisms: phototropism and gravitropism.

Physiology of flowering. Definition and control of flowering. Endogenous control. Environmental control: photoperiod and low temperatures (vernalization). The floral transition: transduction pathways. Flower development.

Physiology of the fruit. Fruit formation. Parthenocarpy. Fruit growth. Fruit ripening: associated physical and biochemical changes. Climacteric and non-climacteric fruits: characteristics.

Physiology of the seed. Seed development and structure. Germination: factors affecting it. Metabolism of germination. Dormancy: concept. Seed dormancy: causes. Environmental factors that trigger the breaking of dormancy. Hormonal control of seed dormancy. Bud dormancy.

Senescence and abscission. Senescence in plants: types. Abscission: control and hormonal regulation.

Plant physiology under adverse conditions. Stress in plants: definition and types. Plant responses to adverse conditions. Abiotic stress. Biotic stress.

Practice 11.- Germination. Effect of various factors

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	10,00
Theory	65,00
Laboratory	30,00
Total hours	**105,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	20,00
Independent study and work	67,50
Preparation of lessons	70,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**157,50**

TEACHING METHODOLOGY

The course, designed to ensure that students are the main protagonists of their own learning, is structured around four axes:

- Theory classes. The lecture model will be primarily used, as it offers the instructor the opportunity to emphasize key concepts for understanding the topic and will indicate the most recommended resources for further preparation of the topic in depth. In some topics, a participatory model will be used, prioritizing communication among students and between them and the instructor.

- **Practical classes**. In these classes, students will learn about plant physiology in a practical and hands-on manner. Furthermore, students will acquire the skills and abilities necessary for effective laboratory work.

- **Tutorials**. Tutorials will be conducted in small groups. In these, the instructor will guide students through all the elements that make up the learning process, both regarding general approaches and specific issues

related to the topics already covered, including project supervision.

- **Seminars**. In the seminars, students, organized into groups of 2-5, will give a presentation on one of the following possibilities: a) experimental work developed by themselves, b) high-quality scientific articles or other proposals indicated by the subject's faculty, and c) theoretical seminars previously proposed by the professors. The seminars will practice the ability to outline and summarize, as well as oral and/or written expression. As previously mentioned, the seminars will be conducted in teams, and all group members must participate in the oral presentation. After each presentation, there will be a debate on the seminar topic, in which the focus will primarily be on the students.

EVALUATION

To pass the course, a minimum score of 5 out of 10 must be achieved. The following items will be assessed:

- **Knowledge**: Assessed through an in-person written exam that represents up to 80% of the final grade. This exam may include questions directly related to the learning acquired during the internship. A minimum score of 4.5 out of 10 must be achieved to be added to the grades for the rest of the course activities, in the proportions 80% knowledge and 20% other activities. A midterm exam may be taken in person, but to eliminate a subject, a score of 4.5 out of 10 must be achieved.

- Other activities: Other activities carried out throughout the course, including seminars, assignments, tutoring-related activities, etc., represent up to 20% of the final grade. At least 8% of the assessment for these activities will be related to the to the practical sessions"

. **To obtain the highest grade for the course, it is necessary to complete all the assignments indicated in this section**.

Attendance at *practical sessions, tutorials, and seminar presentations* **is mandatory**. Failure to attend could negatively impact the final grade for the course.

Students who do not pass the course in the first exam will have their grades retained for the remaining activities until the second exam.

REFERENCES

Basic

- Azcón-Bieto J, Talón M (eds) 2008. Fundamentos de Fisiología Vegetal. Interamericana McGraw-Hill.

- Barceló J, Nicolás G, Sabater B, Sánchez-Tamés R. 2001. Fisiología Vegetal. Ed. Pirámide S.A.

- Hopkins WG, Hüner NPA. 2010. Introduction to Plant Physiology. J. Wiley & Sons, 4th ed.

- Ridge I (ed). 2002. Plants. Oxford University Press.

- Salisbury FB, Ross CW. 2006. Plant Physiology. CBS Publ. & Distrib.

- Smith AM, Coupland G, Dolan L, Haberd N, Jones J, Martin C, Sablowski R, Amey A. 2009. Plant Biology. Garland Science. Ed. Taylor & Francis.

- Taiz L, Møller IM, Murphy A, Zeiger E. 2022. Plant Physiology and Development. Sinauer

Assoc./Oxford Univertsity Press, 7th ed

- Taiz L, Zeiger E, Moller IM, Murphy A. 2018. Fundamentals of Plant Physiology. Sinauer Assoc./Oxford University Press. Versió reduïda de la 6èna ed., dirigida específicament a estudiants.

Complementary

- Buchanan B, Gruissem W, Jones R. 2015. Biochemistry & molecular biology of plants, 2 ed. American Society of Plant Biologists. Wiley-Blackwell, 2nd ed.

- Evert RF. 2006. Esau's Plant Anatomy. Wiley Interscience. 2rd. ed.

- Heldt HW, Piechulla B. 2016. Plant Biochemistry. Elsevier-Academic Press, 4th ed .

- Jones R, Ougham H, Thomas H, Waaland S. 2017. The molecular life of plants. Medtech.

- Kirkham MB. 2005. Principles of soil and plant water relacions. Elsevier Academic Press.

- Marschner P (ed). 2012. Marschner's Mineral nutrition of higher plants. Academic Press. 3rd ed.

- Nobel PS. 2009. Physicochemical and Environmental Plant Physiology. Academic Press. 4th ed.

- Pérez Solsona J, Cornejo Martín MJ. 2014. Cómo y por qué trabajamos con células vegetales/How and why we work with plant cells. Publ. Universitat de València. Col·lecció: Educació. Laboratori de materials, 64.

- Scott P. 2008. Physiology and behaviour of plants. Ed. J. Wiley & Sons.

- Somerville CR, Meyerowitz EM (eds). The Arabidopsis Book. American Society of Plant Biologists, Rockville., MD (EEUU). http://www.aspb.org/publications/arabidopsis

- Journals:

Annual Review of Plant Biology. Annu. Reviews Inc.

Trends in Plant Sciences (TIPS) Elsevier Science, Ltd.

Current Opinion in Plant Biology. Elsevier Science, Ltd.