COURSE DATA

Data Subject	
Code	33052
Name	Plant physiology
Cycle	Grade
ECTS Credits	10.0
Academic year	2018 - 2019

Study (s)

Degree	Center	Acad. year	Period
1100 - Degree in Biology	Faculty of Biological Sciences	3	Annual

Subject-matter

Degree	Subject-matter	Character
1100 - Degree in Biology	10 - Plant biology	Obligatory

Coordination

Name	Department
SANZ GRAU, M AMPARO	25 - Plant Biology
SEGURA GARCIA DEL RIO, JUAN	25 - Plant Biology

SUMMARY

Plant Physiology is a subject of the third year of the Degree in Biology which forms part of the Plant Biology area, together with Botany, taught in the second year.

Plant Physiology is intended to provide basic knowledge of how plants function and of processes that occur in them as living beings, also integrating the knowledge acquired in other subjects such as Cell Biology, Botany, Biochemistry and Soil Science.

To acquire basic knowledge of Plant Physiology, students will learn water relations of the plants (absorption, transport and loss of water), mineral nutrition and transport of photoassimilates, as well as photosynthetic metabolism, which allows the reduction and assimilation of the main bioelements, and respiratory processes, participants also in the energy metabolism of the plant. There will be an approach to secondary metabolism, through which compounds of fundamental importance are produced. In addition to the basic physiological processes of plants it is important to understand the mechanisms involved in their growth and development, as well as their interactions with the environment. Therefore, along this course the students will learn from the plant hormones to the photoreceptors, through the movement of plants, different life cycle processes and the integration of all these processes in space and

time, and the adaptation mechanisms to possible adverse environmental conditions.

In short, the goal of this course is that at the end of it the students have learned how plants function at different levels of organization and how they adapt functionally to the environment in which they develop.

Plant Physiology is a subject with an important experimental content and additionally to the theoretical training, laboratory experiments will be conducted that will help to allow the acquisition of the knowledge, concepts and techniques of this scientific discipline.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

OUTCOMES

1100 - Degree in Biology

- Conocer los principios básicos del funcionamiento de las plantas.
- Conocer cómo las plantas son capaces de obtener sus nutrientes esenciales y cómo son capaces de convertir la energía solar en alimento.
- Conocer cómo las plantas reconocen, integran y responden a las señales endógenas y ambientales que les llegan, permitiendo que se adapten a situaciones fluctuantes.
- Conocer el funcionamiento de aparatos y técnicas elementales relacionadas con la asignatura.
- Conocer los ensayos prácticos que se pueden realizar para demostrar las distintas hipótesis relacionadas con la Fisiología vegetal.
- Capacidad de diseñar y llevar a cabo experimentos, así como de analizar e interpretar datos.
- Saber buscar la información bibliográfica adecuada para, en un momento dado, poder actualizar y profundizar en sus conocimientos sobre un tema especifico.
- Capacidad de análisis y síntesis de la información relativa a la materia.
- Comprender y manejar la terminología científica básica relacionada con la materia.
- Comprender e interpretar trabajos científicos relacionados con los vegetales.
- Capacidad para trabajar en grupo.
- Capacidad de comunicar ideas e información a nivel escrito y oral.
- Capacidad de interactuar tanto con el profesorado como con los compañeros.

- Habilidad para argumentar desde criterios racionales, diferenciando claramente lo que es opinable de lo que son hechos o evidencias científicas aceptadas.
- Adquisición de conciencia social y profesional sobre la problemática ambiental y la importancia de la biotecnología vegetal y sus implicaciones éticas.

LEARNING OUTCOMES

- Knowledge of the physiological processes that occur in plants and allow them to feed, grow, multiply and interact with the surrounding environment.

- Design scientific experiments to test the veracity of a theory or hypothesis.

- To propose protocols for obtaining plants with certain characteristics in terms of size, shape, production or ripening.

- Know how to interpret scientific papers related to Plant Biology.

- Construct a written text understandable and organized.

- Preparation and presentation of seminars in groups using the technologies of information and communication.
- To establish the relationship between knowledge and its practical applications, especially those related to improving, by conventional or biotechnological methods, performance and quality of crops, resistance to pests and stress, medicine production and biodiversity conservation.

- Develop expert knowledge in Plant Biology to be able to prepare reasoned and consistent reports which may assist in judging issues and decision making.

DESCRIPTION OF CONTENTS

1. Introduction to Plant Physiology.

Introduction to Plant Physiology.- Concept and scope of Plant Physiology. Relation with other sciences. Plant Physiology programme. Bibliographic sources. Assessment.

The plant cell. Organelles characteristic of the plant cell. The cell wall: structure, composition and function. Transformations of the cell wall and areas of communication.

Lab session 1.- Experimental results in Plant Physiology. Problems and questions.

2. Water balance.

Water in plants .- Importance of water. The structure and properties of water. Water potential: concept and components. Water balance in cells and tissues.

Absorption and transport of water in the plant .- Water movement in the soil-plant-atmosphere continuum. Water absorption by the root. The root as an osmometer: Root pressure and guttation. Transport of water in the plant. Composition of the xylem sap. Mechanism of ascent of water.

Transpiration .- Concept, importance and magnitude. Transpiration rates. Transpiration through the stomata. Mechanisms for opening and closing of stomata. Factors affecting transpiration.

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

3. Mineral nutrition.

Nutrient uptake by plants .- The root as an organ of absorption. Nutrient uptake at the cellular level. Radial transport in roots. Longitudinal transport.

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

Lab session 4.- Membrane permeability. Factors which alter membrane permeability

4. Plant metabolism (1)

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

Absorption of light energy. Absorption of light and forms of energy dissipation. Photosynthetic unit, reaction centers and harvesting antennae. Thylakoid ultrastructure, composition and distribution of photosynthetic complexes.

Photosynthetic electron transport and photophosphorylation. The electron transport: cyclic, noncyclic and pseudocyclic. The water splitting complex. Photophosphorylation. Mechanism of coupling between electron transport and photophosphorylation.

Photosynthetic CO2 fixation. CO2 assimilation in plants: the Calvin-Benson cycle. Cycle regulation. Synthesis of sucrose and starch. Photorespiration. Biochemical route and physiological significance.

Adaptive pathways of prior accumulation of CO2. 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 through the phloem. Concepts of source and sink. Loading and unloading mechanisms. Mechanism of phloem transport.

Lab session 5.- Photosynthesis in isolated thylakoid vesicles. Hill reaction.

5. Plant metabolis (2)

Respiration in plants. Overview of the respiratory process. Peculiarities of the respiratory chain in plants: the alternative oxidase.

Metabolism of nitrogen and sulfur. Forms of nitrogen absorbed by the plant. Nitrogen fixation in symbiotic associations. Assimilatory reduction of nitrate and ammonium. Assimilation of sulfur.

Secondary metabolism. Major groups and important synthesis routes. Alkaloids. Terpenoids. Phenolic compounds.

Lab session 6.- Measurement of respiration rates in germinating seeds.

6. Plant Development (1)

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

Plant growth regulators. Phytohormone concept. Perception and hormonal signal transduction. Main groups of hormones: auxins, gibberellins, cytokinins, ethylene, abscisic acid. Other plant hormones, polyamines, brassinolide, jasmonates, salicylates, oligopeptides, oligosacarines.

Lab session 7.- Plant hormones: auxins.
Lab session 8.- Plant hormones: gibberellins.
Lab session 9.- Plant hormones: cytokinins.

7. Plant Development (2)

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

Rhythms and movement in plants. The biological clock. Types of movements in plants. Nutations. Nastic movements: nictinastia and tigmonastia. Tropisms: phototropism and gravitropism.

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

Fruit physiology. Fruit formation. Parthenocarpy. Fruit growth. Fruit ripening: associated physical and biochemical changes. Climacteric and non-climacteric fruit: characteristics.

Seed physiology. Development and structure of the seed. Germination: factors that affect it. Metabolism of germination. Dormancy: concept. Seed dormancy: causes. Environmental factors that cause the outbreak of dormancy. Hormonal control of dormancy in seeds. Dormancy in buds.

Senescence and abscision. Senescence in plants: types. Abscision: control and hormonal regulation.

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

Lab session 10.- Germination. Effect of different factors.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	60,00	100
Laboratory practices	30,00	100
Tutorials	10,00	100
Development of group work	20,00	0
Study and independent work	60,00	0
Preparing lectures	55,00	0
Preparation of practical classes and problem	15,00	0
TOTAL	**250,00**	

TEACHING METHODOLOGY

The course has the student as the main protagonist of their own learning, and is structured around four axes:

• **Lectures**. Teachers will explain and emphasize key concepts that help in understanding the different parts of the programme and indicate the recommended resources for further preparation of the subject in depth. In some classes, a more participatory model will be used, focusing on communication between students and between them and the teacher.

• **Lab classes**. During these classes the students will learn skills in plant physiology in a practical and direct manner. They will acquire the skills and abilities needed for effective work in the laboratory.

• **Tutorials**. The tutorials will be held in small groups. In them, the teacher will guide the student on all the elements that make up the learning process, both in terms of general approaches and specific issues of the themes already developed. They will include guiding for seminar preparation.

• **Seminars**. The seminars, of voluntary character, will consist in presentation by the students of theoretical work previously proposed by teachers. These seminars will train the students ability to outline and summarize as well as of oral and written expression. As previously stated, the theoretical work will be carried out in teams (groups of 4 or 5 students) and all members of the group should participate in the oral presentation. After each presentation, there will be a debate on the topic of the seminar, in which the leading role will fall mainly on the students.

EVALUATION

Acquisition of theoretical and practical knowledge will be assessed in accordance with the following schedule:

The maximum score is **100 points**, broken down as follows:

• Seminars: up to 10 points. Both content and presentation will be assessed (oral and written). Because of its voluntary character, the given score will be additional to that obtained in the rest of the course activities. In case of having obtained the maximum score in all other activities, the seminar will contribute to the obtention of the mention with honour

• Written assessments: up to 95 points

The examination will include questions on knowledge acquired in lectures (80 points) and practical sessions (15 points). Depending on the teacher, assessment of lab sessions may occur simultaneously to the theory or by a separate examination at the end of tha lab sessions.

- Lab sessions: up to 5 points, corresponding to the direct assessment made by the lab teacher of the attitude and aptitude of the student during lab sessions.

There will be a preliminary exam, which will allow to know about the progress of the students in the acquisition of knowledge and, where appropriate, remove that part of the subject from the final exam.

To be evaluated it is essential to have attended **lab classes** and **seminars**, since they are **mandatory**. When attendance at practical classes is less than 80% of the scheduled classes, a practical examination must be passed in the lab.

The final rating will be obtained from the sum of the parts to be evaluated. For the various parts to add, students must obtain at least 45% of the maximum score on the test.

The student will get a pass degree when the final score is 50 points or higher.

Students not reaching a pass degree in June will keep the note obtained in the seminar, at least until the 2nd examination. Similarly, assistance to lab classes will also be kept up to the 2nd examination of the following year

REFERENCES

Basic

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- Barceló J y cols. 2001. Fisiología Vegetal. Ed. Pirámide S.A. Madrid.
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- Salisbury FB, Ross CW. 1994. Fisiología Vegetal. Grupo Editorial Iberoamericana.
- Smith AM, et al. 2009. Plant Biology. Garland Science. Ed. Taylor & Francis, New York.

Additional

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