



Universitat de Lleida

# DEGREE CURRICULUM **SECONDARY METHABOLISM OF PLANTS**

Coordination: PELACHO AJA, ANA MARIA

Academic year 2022-23

## Subject's general information

<b>Subject name</b>	SECONDARY METHABOLISM OF PLANTS			
<b>Code</b>	101641			
<b>Semester</b>	2nd Q(SEMESTER) CONTINUED EVALUATION			
<b>Typology</b>	Degree	Course	Character	Modality
	Bachelor's Degree in Biotechnology	4	OPTIONAL	Attendance-based
<b>Course number of credits (ECTS)</b>	6			
<b>Type of activity, credits, and groups</b>	<b>Activity type</b>	PRALAB	PRAULA	TEORIA
	<b>Number of credits</b>	1	0.8	4.2
	<b>Number of groups</b>	1	1	1
<b>Coordination</b>	PELACHO AJA, ANA MARIA			
<b>Department</b>	HORTICULTURE, BOTANY AND LANDSCAPING			
<b>Teaching load distribution between lectures and independent student work</b>	In-situ and online lectures and student work 60h Independent student work 86 h			
<b>Important information on data processing</b>	Consult <a href="#">this link</a> for more information.			
<b>Language</b>	Catalan 15% Spanish 65% English 10%			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
PELACHO AJA, ANA MARIA	anamaria.pelacho@udl.cat	5	
SORIA VILLALONGA, YOLANDA JACINTA	yolanda.soria@udl.cat	1	

## Subject's extra information

Plant Secondary Metabolism, optional 4<sup>th</sup> year subject, presents the interest and diversity of products produced by plants, their role in the plant ecosystem, their use and applications in very diverse fields, their synthesis, production and exploitation. The subject is of interest to all Biotechnologists regardless of their branch of specialization.

Plants synthesize thousands of secondary metabolites, which are often only produced in certain species and in specific organs and developmental stages. Environmental conditions and stress are key factors in the expression of secondary metabolism.

Secondary metabolites are crucial in plant development; they contribute to plant survival and competitiveness in the natural environment and are chemical signals in the plant-environment interaction (eg pigments, aromas, etc.). Secondary metabolites are also essential in our lives: many are the source of valuable drugs (anticholinergic, antiparasitic, anti-inflammatory, cardiogenic, antineoplastic,...); others are used in the food and nutrition industry (dyes, nutraceuticals, flavorings, dietary supplements,...), in agriculture (pesticides,...), in cosmetics and perfumery (essential oils, creams, soaps,...), etc. Their social and recreational uses are also extensive, in some cases threatening human health and life.

After completing this subject, the Biotechnology students will be able to develop biotechnological projects related to the use, production and metabolism of these compounds. Likewise, they will be trained for the work and autonomous management of a laboratory or industry that deals with them.

## Learning objectives

### Knowledge Objectives:

- To know the secondary metabolites involved in plant life, their types and general characteristics.
- To know which plant groups synthesize the main secondary metabolites.
- To know the metabolic routes responsible for the production of secondary plant metabolites.
- To understand the implications for the plant itself of synthesizing secondary metabolites.
- To identify the applications of plant secondary metabolites in a diversity of fields: pharmaceutical, agricultural, food, industrial, etc.
- To identify the choices for obtaining plant secondary metabolites of industrial interest.
- To know and properly use the scientific and technical vocabulary proper of the field.

### Capacity Objectives:

- To be able to interpret and design experiments related to the secondary plant metabolism.
- To apply the acquired knowledge to solving biotechnological problems related to the secondary metabolism of plants

- To perform diagnoses on the use of plant secondary metabolites to different areas: agricultural, food, industrial, health, etc.
- To be able to search, use and selectively interpret scientific-technical information in order to get a synthetic view of the different processes determining the plant secondary metabolism, and to prepare oral and written reports and presentations based on this information.
- To develop biotechnological applications and protocols for obtaining products of human interest synthesized by plants.
- To establish new challenges and goals, and propose their achievement through the application of the acquired knowledge and the establishment of own criteria in decision-making.
- To work in biotech companies, in the research, development and production of human interest products.

## 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.
- GC11 Acquiring criteria for choosing the most appropriate analytical techniques for each specific practical case.

### Specific skills

- CE18 Acquire an integrated vision of cellular structures, relating them to their specific functions and the biochemical processes involved.
- CE44 To know the main fields of Biotechnology application and to acquire basic training in some of them.

### 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

**Lecture 1. Introduction.** Plants. The food we get from plants. Phytonutrients. Functional foods. Food and health. Objectives and organization of the course.

**Lecture 2. Concepts for primary and secondary metabolism and product.** Concepts of secondary metabolism and secondary product. Primary and secondary metabolism. Genetic coding of secondary metabolism. Chemical diversity and variability of secondary metabolism. Main groups of secondary metabolites.

**Lecture 3. Compartmentalization of secondary metabolism at cellular level.** Compartmentalization of secondary metabolism precursors and intermediates. Storage of products. Detoxification mechanisms of plants.

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**Lecture 4. Compartmentalization of secondary metabolism at plant level.** Variations in plant diversity. Variations in space. Variations in time. Geographical variations.

**Lecture 5. Plants in interaction.** Types of interaction. Plant to plant interactions. Mutualistic and symbiotic interactions. Pathogens and pests. Anthropogenic environment.

**Lecture 6. Significance of secondary products for the producing organisms.** Special physiological functions associated with secondary metabolites. Intraspecific signals and communication. Interspecific signals and communication.

**Lecture 7. Basic principles of the secondary metabolite biosynthesis.** Classification in relation to their biosynthetic pathway. Classification according to their chemical structure. Secondary metabolites most significant for medicinal and industrial use.

**Lecture 8. Terpenes.** What are terpenes? Where are they in plants?. Structure. Classification. Biosynthesis. Functions and uses of the terpene family in healthcare, agriculture and food. Essential oils.

**Lecture 9. Phenolic compounds.** What are phenolic compounds?. Biosynthesis. Functions and uses of the different phenolic compounds in healthcare, agriculture and food. Ecological impact of phenolic compounds.

**Lecture 10. Nitrogen-containing secondary metabolites.** What are the nitrogen-containing secondary metabolites?. Biosynthesis. Non-protein amino acids. Cyanogenic glycosides. Glucosinolates. Alkaloids. Recreational use and psychoactive activity of alkaloids. Functions and uses in healthcare, agriculture and food.

**Lecture 11. Plants producing secondary metabolites.** Traditional use of medicinal plants. Synthesis of secondary metabolites with a significant impact on medicine. Production and marketing of medicinal and aromatic plants. Identification of secondary metabolites.

**Lecture 12. Obtaining and producing secondary metabolites.** Production in plants. Extraction. Factors affecting the production of secondary metabolites in plants. In-vitro production. Transgenesis-mediated production.

## Practical activities

- Laboratory practice.
- Activities with practical application.
- On-line and supervised activities. Course works and presentations

## 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 classroom 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.

Type of activity	Description	On-site/online activity of the student		Off-site activity of the student		Assessment	Total time
		Objectives	Hours	Student work	Hours	Hours	Hours
<b>Master Active Lesson</b>	Master/online Lessons with student participation	Explaining and learning main concepts	45	Study: to know understand and synthesize knowledge	75	4	120 h

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<b>Seminars and practical applications</b>	Active classroom and Guided activities	Case and problem solving. Discussion or application activities. Executing the activity: present the information.	<b>5</b>	Search and investigate. Study, establish relationships, synthesize Learn to solve problems and cases. Discuss.	<b>8</b>		<b>13 h</b>
<b>Laboratory</b>	Laboratory practice	Carrying out the laboratory practices. To underspand phenomenoms, measuring,...	<b>10</b>	Study and produce the reports	<b>8</b>		<b>18 h</b>
<b>Exams</b>							<b>4 h</b>
<b>Totals</b>			<b>60</b>		<b>86</b>	<b>4</b>	<b>155 h/6 ECTS</b>

## 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

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## Evaluation

Exams	Seminars and laboratory practice	Supervised and online activities
60%	20%	20%

Type of activity	Assessment Activity		Marks percentage
	<b>Procedure</b>	<b>Number</b>	
<b>Master / online active lessons</b>	Exams	2	<b>60</b>
<b>Seminars and laboratory practice</b>	Delivery / presentation of the activity, written or oral proofs	2	<b>20</b>

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<b>Supervised and online activities</b>	Delivery / presentation of assigned tasks. Written or oral assignments	2	20
<b>Others</b>			
<b>Total</b>			100

## Bibliography

### Bibliography: Essentials

- Azcon - Bieto, Talon M. Fisiología y Bioquímica Vegetal. Interamericana Mc Graw – Hill.
- Lincoln Taiz, Zeiger E. Fisiologia Vegetal (Vol 1). Publicacions de la Univ. Jaume I.
- Serrano M., Piñol T. Biotecnología Vegetal. Editorial Síntesis S.A.
- Tadeusz Aniszewski. Alkaloids – secrets of life. Editorial Elsevier.
- Seigler D.S. Plant secondary metabolism. Ed. Kluwer.

### Bibliography: Supplementary

- Specilized Scientific Journals to be introduced during the course.
- Arteca R.N. 1996. Plant growth substances, principles and applications. Chapman & Hall, New York.
- Buchanan B.B., Gruisen W.G. y Jones R.L. 2015. Biochemistry & Molecular Biology of Plants. American Society of Plant Biologists.
- Chopra V.L., Malik V.S., Bhat S.R. (Eds.) 1999. Applied plant biotechnology. Enfield, N.H. Science Publishers.
- Christou P., Klee H. 2005. Handbook of Plant Biotechnology. J Wiley & Sons. Chichester.
- Dey P.M. y Harbone J.B (Eds.) 1997. Plant biochemistry. Academic Press, San Diego.
- Fett-Neto, A.G. (Ed.). 2016. Biotechnology of Plant Secondary Metabolism. Methods and Protocols. Springer.
- Heldt H.W. y Heldt T F. 2005. Plant biochemistry. Academic Press, San Diego.
- Roberts K. (Ed.). 2007. Handbook of Plant Science, Vols 1 y 2. John Wiley & Sons, Chichester.
- Wink M. (Ed.) 1999. Biochemistry of plant secondary metabolism. Sheffield Academic Press CRC Press.
- Wink M. (Ed.) 2010. Functions and biotechnology of plant secondary metabolites. Chichester, U.K.Wiley-Blackwell.