



Universitat de Lleida

DEGREE CURRICULUM
**SECONDARY METHABOLISM
OF PLANTS**

Coordination: PELACHO AJA, ANA MARIA

Academic year 2020-21

Subject's general information

Subject name	SECONDARY METHABOLISM OF PLANTS			
Code	101641			
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION			
Typology	Degree	Course	Character	Modality
	Bachelor's Degree in Biotechnology	4	OPTIONAL	Attendance-based
Course number of credits (ECTS)	6			
Type of activity, credits, and groups	Activity type	PRALAB	PRAULA	TEORIA
	Number of credits	1	0.8	4.2
	Number of groups	1	1	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 60h Independent student work 86 h			
Important information on data processing	Consult this link for more information.			
Language	Catalan 10% Spanish 60% English 30%			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
PELACHO AJA, ANA MARIA	anamaria.pelacho@udl.cat	5	
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Subject's extra information

Secondary Plant Metabolism is a 4th year elective subject that presents the diversity of products produced by plants, their role in the plant ecosystem, and their exploitation and applications in many different fields. The subject is of interest for all Biotechnologists, regardless of their branch of specialization. The metabolic processes common to all cells and plants constitute primary metabolism, while secondary metabolism allows the synthesis of unique compounds typical of certain species. In this way, plants synthesize a vast array of specific compounds, usually only produced in specific plant organs and depending on their developmental stage. Environmental conditions are key factors in the expression of secondary metabolism, frequently activated under stress conditions.

The secondary metabolism roles are crucial in the development and survival of plants and contribute to their competitiveness in the natural environment. Many secondary metabolites are involved in ecological relationships (e.g. pigments, flavors, etc.) and constitute chemical signals in the plant-environment interaction. On the other hand, secondary metabolites are essential in our life. About 80% of the world population uses plant-based compounds or preparations as remedies, and a very high percentage of drugs contain plant extracts or plant-related compounds. In addition to their unquestionable value in the pharmaceutical industry (anticholinergic, anti-parasitic, anti-inflammatory, cardiogenic, anti-carcinogenic,...), plant secondary metabolites are widely used in the food and nutrition industry (colorants, nutraceuticals, flavorings, dietary supplements,...), in agriculture (pesticides,...), in cosmetics and perfumery (essential oils, lotions, soaps,...), etc. The social and recreational uses of many secondary metabolites are also extensive, sometimes seriously threatening human life and health. Finally, aspects related to the production and exploitation of several of these compounds will be presented.

In Secondary Plant Metabolism, biosynthesis and biological significance of the main groups of secondary metabolites will be addressed. The interest offered by many of these metabolites in a diversity of applications will be also presented. Students will take this course after knowing the basics of Plant Physiology.

After completing this subject, the Biotechnology students must be able to develop biotechnological projects related to the metabolism, production and use of secondary metabolites. Likewise, they will be qualified for autonomous management and working in a laboratory or industry dealing with these compounds.

Learning objectives

Knowledge Objectives:

- To know the biomolecules involved in plant life acting as secondary metabolites, their types and general characteristics.
- To know the plant groups synthesizing 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 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 be able to selectively search, use and interpret scientific-technical information; to produce oral and written reports and presentations based on this information.
- To carry out diagnoses on the use of secondary plant metabolites in different fields: agricultural, food, industrial, health, etc.
- To apply the acquired knowledge in solving biotechnological problems related to the secondary plant metabolism.
- To independently consult the appropriate information resources to obtain a synthetic approach of the different processes influencing secondary plant metabolism.
- Establish new challenges and goals to achieve, and to propose their attainment through the application of the acquired knowledge and the establishment of own criteria in decision-making.

Significant competences

General competences

- To be able to selectively search and use the required information resources to reach the educational objectives.
- To understand the scientific and technical information from the information resources, to interpret it 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 and efficiently 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 area.
- 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 area.
- To use the scientific method to analyze data and to design experimental strategies for biotechnological applications.
- To acquire decision criteria on the analytical techniques more convenient for every specific practical case.

Specific competences (according to the Study Plan document)

- To acquire an integrated view of the plant structure and metabolism, relating them with their specific functions and processes, and with their potential technological use.
- Acquire an integrated view of cell structures, relating them to their specific functions and to the biochemical processes involved.
- To know the use of plant cells and tissues in industrial processes of human interest, in addition to agri-food processing.
- To know the technological processes based on the use of plants, and their optimization strategies.
- To know and know how to apply techniques for the analysis, detection and quantification of metabolites.
- Know and know how to apply Biotechnology that uses the secondary plant metabolism in its various areas.

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.

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 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. Medicinal plants. 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

- 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 may consist on both face-to-face lessons and virtual teaching. In principle, exams and practical activities will be face-to-face in the classroom with the professor, together with the lessons as indicated in the subject schedule. In the event that 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

Master Active Lesson	Master/online Lessons with student participation	Explaining and learning main concepts	46	Study: to know understand and synthesize knowledge	70	4	120 h
Seminar	Active classroom	Case and problem solving. Discussion or application activities	8	Learn to solve problems and cases. Discuss.	8		16 h
Practical Application	Guided activities	Executing the activity: present the information	4	Search and investigate. Study, establish relationships, synthesize	4		8 h
Others	Guided activities		2		4		6 h
Totals			60		86	4	150 h/6 ECTS

Evaluation

Exams	Seminars and supervised and online activities	Practical applications
60%	30%	10%

Type of activity	Assessment Activity		Marks percentage
	Procedure	Number	
Master / online active lessons	Exams	2	60
Practical application	Delivery / presentation of the activity, written or oral proofs	1	10
Seminars and guided activities	Delivery / presentation of tasks. Written or oral assignments	3	30
Others			
Total			100

Bibliography

Bibliography: Essentials

- Azcon - Bieto, Talon M. Fisiología y Bioquímica Vegetal. Interamericana Mc Graw – Hill.
- Lincoln Taiz, Zeiger E. Fisiología 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. 2004. 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.