Universitat de Lleida

DEGREE CURRICULUM

SECONDARY METHABOLISM OF PLANTS

Coordination: PELACHO AJA, ANA MARIA

Academic year 2021-22

SECONDARY METHABOLISM OF PLANTS 2021-22

Subject's general information

<table>
<tr><td>Subject name</td><td>SECONDARY METHABOLISM OF PLANTS</td></tr>
<tr><td>Code</td><td>101641</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Biotechnology</td><td>4</td><td>OPTIONAL</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRALAB</th><th>PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>1</td><td>0.8</td><td>4.2</td></tr>
<tr><td>Number of groups</td><td>1</td><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>PELACHO AJA, ANA MARIA</td></tr>
<tr><td>Department</td><td>HORTICULTURE, BOTANY AND LANDSCAPING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>In-situ and online lectures and student work 60h
Independent student work 86 h</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Catalan 10%
Spanish 60%
English 30%</td></tr>
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SECONDARY METHABOLISM OF PLANTS 2021-22

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

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, cardiotonic, 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.

SECONDARY METHABOLISM OF PLANTS 2021-22

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.
- To develop biotechnological applications and protocols to obtain products of human interest
- To be able to work in biotechnology companies in the research, development and production of products of human interest.
- To 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.

Competences

General skills

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

Specific skills

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

Transversal skills

- Being able to produce comprehensible written and oral reports on the work carried out, with a justification based on the theoretical-practical knowledge obtained.
- 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.

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. Anthropic 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. Fisiologia Vegetal (Vol 1). Publicacions de la Univ. Jaume I.
- Serrano M., Piñol T. Biotecnologia Vegetal. Editorial Síntesis S.A.
- Tadeusz Aniszewski. Alcaloids – 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.
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