Bioorganic Chemistry

Code: 102518
ECTS Credits: 6

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Degree	Type	Year
2502444 Chemistry	OT	4

Contact

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

To take this subject, students must have previously passed the subjects *Structure and Reactivity of Organic Compounds* and *Organic Synthesis Laboratory*

Objectives and Contextualisation

The general objective of the subject of Bioorganic Chemistry is to provide students with an overview of natural products (structural and biosynthetic characteristics, ecological and their applications as a source of bioactive compounds). Basic insights into the chemical structure and biosynthesis of natural products, as well as their function and usefulness as drugs and other products of interest, will be provided.

The training objectives of the subject can be summarized in:

1. To understand and know the structures of the natural products of secondary metabolism and their biosynthesis

2. To know the importance of natural products for their biological and pharmacological activity

3. To know the ecological, pharmacological importance and the general utility of natural products

4. To provide tools to students so that they can propose reasonable biosynthetic routes for natural products

Competences

- "Interpret data obtained by means of experimental measures, including the use of IT tools; identify their meaning and relate the data with appropriate chemistry, physics or biology theories."
- Adapt to new situations.
- Apply knowledge of chemistry to problem solving of a quantitative or qualitative nature in familiar and professional fields.
- Communicate orally and in writing in one's own language.
- Evaluate the health risks and environmental and socioeconomic impact associated to chemical substances and the chemistry industry.

- Handle chemical products safely.
- Handle standard instruments and material in analytic and synthetic chemical laboratories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Manage, analyse and synthesise information.
- Obtain information, including by digital means.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse chemical problems and propose suitable answers or studies to resolve them.
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show initiative and an enterprising spirit.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Use the English language properly in the field of chemistry.
- Work in a team and show concern for interpersonal relations at work.

Learning Outcomes

1. Adapt to new situations.
2. Carry out basic synthesis, separation and purification procedures in an organic chemistry laboratory.
3. Classify natural products in accordance with their biosynthesis.
4. Communicate orally and in writing in one's own language.
5. Critically analyse synthetic pathways described in the bibliography.
6. Describe and identify the main groups of natural products and the distinctive characteristics of each.
7. Describe the processes and reactions that occur in biological systems.
8. Describe the structures of the natural products of secondary metabolism.
9. Describe the synthesis of natural products in living beings.
10. Describe useful reactions in organic synthesis.
11. Design reasonable biosynthetic pathways for natural products.
12. Handle English language terms in relation to the synthesis of organic and bioorganic compounds.
13. Identify the ecologic and pharmacologic importance of natural products.
14. Identify the importance of natural products as a source of biologically active compounds.
15. Identify the main structural traits of biomolecules in order to analyse or modify them.
16. Identify the most relevant documentary sources on organic chemistry.
17. Identify the risks involved in the handling of chemical compounds used in biological chemistry, and apply suitable protocols for the storage or elimination of the waste generated.
18. Justify the results obtained in the laboratory for synthesis, separation, purification and characterisation processes of organic and bioorganic compounds on the basis of knowledge about their structure and properties.
19. Learn autonomously.
20. Manage the organisation and planning of tasks.
21. Manage, analyse and synthesise information.
22. Obtain information, including by digital means.
23. Perform synthesis of organic and bioorganic compounds using protocols written in the English language.
24. Properly handle glass and other common materials in an organic chemistry laboratory.
25. Properly interpret data obtained in the laboratory after computerised treatment and on the basis of the acquired knowledge.
26. Propose creative ideas and solutions.
27. Reason in a critical manner
28. Recognise strategies for the design of organic syntheses.
29. Recognise the common chemical compounds found in the laboratory that require special safety measures.
30. Recognise the three-dimensional view of molecules and organic reactions.
31. Resolve problems and make decisions.
32. Safely manipulate chemical reagents and organic compounds.

33. Show initiative and an enterprising spirit.
34. Show sensitivity for environmental issues.
35. Use IT to treat and present information.
36. Use basic instruments to characterise organic chemical compounds.
37. Use spectroscopic techniques for the structural elucidation of organic and bioorganic compounds.
38. Work experimentally with biological material (inert, aseptic and/or controlled atmospheres).
39. Work in a team and show concern for interpersonal relations at work.

Content

Topic 1. Biosynthetic Routes

Primary and secondary metabolism. Main biosynthetic routes: shikimate, acetate, mevalonate. Methods used in the study of biosynthetic sequences.

Topic 2. Semiochemicals

Ecological Chemistry. Classification of semiochemicals. Plant-insect interactions. Allelopathy. Phytoalexins. Pheromones.

Topic 3. Fatty acids and polyketides

The acetate hypothesis. Saturated fatty acids. Unsaturated fatty acids. Aromatic polyketides. Macrolides.

Topic 4. Shikimic acid derivatives

Phenolic compounds. Aromatic amino acids (tryptophan, phenylalanine, tyrosine) and derivatives. Transamination, *NIH* shift. Cinnamic acids and derivatives. Pharmacological applications: L-DOPA, salicin as a model of aspirin. Lignans and lignin. Flavonoids and stilbenes.

Topic 5. Terpenoids

Structural classification. The acetate-mevalonate route. Monoterpenes. Sesquiterpenes. Diterpenes. Triterpenes. Steroids. Cholesterol. Carotenoids.

Topic 6. Secondary metabolism of amino acids

Prebiotic formation of amino acids. b-Lactam antibiotics. Penicillins and cephalosporins.

Topic 7. Alkaloids I

Alkaloids derived from ornithine. Pyrrolizidine alkaloids. Tropane alkaloids: cocaine, hyoscyamine, scopolamine. Alkaloids derived from lysine. Pyridine alkaloids: nicotine. Alkaloids derived from the shikimate route I. Alkaloids derived from phenylalanine: ephedrine. Alkaloids derived from tyrosine: L-DOPA, adrenaline, mescaline. Benzylisoquinoline alkaloids. Curare and opium. Thebaine, morphine, codeine. Physiological effects and pharmacological applications.

Topic 8. Alkaloids II

Alkaloids derived from the shikimate route II. Alkaloids derived from anthranilic acid. Alkaloids derived from tryptophan. Simple indole alkaloids: serotonin. Indole-terpene alkaloids. Dimeric structures: vinblastine and vincristine. Strychnine. Quinoline alkaloids: quinine. Purine alkaloids: theobromine, caffeine, and theophylline. Physiological effects and pharmacological applications.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practical classes	16	0.64	1, 4, 23, 2, 20, 17, 25, 18, 24, 32, 34, 29, 31, 39, 38, 36, 37
Theoretical classes	35	1.4	19, 3, 4, 9, 7, 6, 8, 11, 20, 21, 14, 13, 16, 15, 22, 31
Type: Supervised			
Tutorials	5	0.2	9, 11, 21, 25, 26, 27, 31
Type: Autonomous			
Learning and problem resolution	87.2	3.49	5, 3, 4, 9, 7, 6, 8, 10, 11, 21, 14, 13, 16, 15, 22, 30, 28, 35

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Along the course, the student will participate in various formative activities, with the aim of acquiring the established knowledge and skills. Three kind of guided activities will be developed:

1.- In-person or virtual theoretical classes: Students will receive a series of knowledge articulated exclusively by the teacher. During these classes the teacher will transmit the basic knowledge of the subject, which must be complemented by consulting the material accessible through the virtual campus and the corresponding bibliography, as well as participating and carrying out the scheduled activities. Time will also be devoted to resolving student doubts and discussing the most relevant aspects of each topic. During these classes, the participation of the students will be encouraged through the resolution of cases and questions on a regular basis.

2.- In-person or virtual problem classes: During the course, sheets of exercises will be delivered to the students that they will have to solve. In the face-to-face or virtual problem classes, the solutions proposed by the students from their autonomous work will be discussed. Special emphasis will be placed on the active participation of the students.

3.- Laboratory sessions: There will be 4 sessions of 4 hours each of laboratory practices related to the subjects of the course. The student will become familiar witha series of basic laboratory techniques related to the extraction and handling of natural products and chemical reagents, as well as the use of small equipment and instrumental techniques. The laboratory work will be supervised by the teachers who will evaluate the students, considering their attention and performance in the laboratory, as well as the reports and laboratory notebooks made. A student involved in an incident that may cause serious security consequences can be excluded from the laboratory and fail the course.

The teacher will have to allocate approximately 15 minutes of some class to allow the students answering the surveys of evaluation of the educational performance and of the course subject or module.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Laboratory Module	15%	1.1	0.04	1, 19, 33, 23, 2, 20, 21, 17, 25, 18, 12, 24, 32, 34, 22, 26, 27, 29, 39, 38, 36, 35, 37
Written Test Module	85%	5.7	0.23	5, 3, 4, 9, 7, 6, 8, 10, 11, 14, 13, 16, 15, 27, 30, 28, 31

Assessment by continuous evaluation

With the aim of encouraging the constant student work to favor the learning, a continuous evaluation is recommended. This methodology will inform the professor about the content's assimilation by the student as well as their ability to apply them to problem solving. The evaluation will be done individually through two modules, which include written tests and laboratory practices, each of which will have assigned a specific weight in the final grade.

It will be mandatory obtaining 5.0 points out of 10 in the global evaluation to pass the course.

1. Written test module (85%)

Along the course, two partial exams of compulsory realization will be programmed with the aim of evaluating the student knowledge related to the theoretical and practical subjects of the course, as well as their capacity to solve problems.

First partial test: It will evaluate the content of approximately 50% of the global matter of the course. It will formulate both theoretical and practical questions (problem solving) and will contribute in a 42.5% in the overall mark of the continuous evaluation. In this exam a minimum of 4 points out of 10 must be obtained to be able to average with the other qualifications of the evaluation.

Second partial test: It will evaluate the overall content of the matter of the course. It will formulate both theoretical and practical questions (problem solving), as well as questions relate to the laboratory sessions, and will contribute in a 42.5% in the overall mark of the continuous evaluation. In this exam a minimum of 5 points out of 10 must be obtained to be able to average with the other qualifications of the evaluation.

2. Laboratory Module (15%)

Attending all the laboratory sessions is mandatory. The students will deliver assessable reports on the performed experiments and the laboratory skill will be also considered.

To pass the course in the first instance, it will be mandatory obtaining 4/10 points in the first partial test and 5/10 points in the second (being the final mark of the module the simple average of the grade of the two partial tests, which must be over 5/10 points) and a minimum average mark of 5/10 (85% tests + 15% laboratory).

Second-chance Examination

The students who did not pass the continuous evaluation will have the opportunity to perform a second-chance exam, which will evaluate the overall contents of the course.To pass the course, it will be mandatory obtaining 5/10 points in this exam and the final qualification will be, in this case, the weighted average between the mark of this exam (85%) and the mark of the laboratory module (15%).

To be eligible for the second-chance exam, any student should have been previously evaluated in a set of activities corresponding to a minimum of 2/3 of the overall qualification of the course. Hence, it will be mandatory to make the two partial tests to be entitled to the second-chance examination. The part of the laboratory module is not recoverable.

Students who pass the continuous evaluation but want to improve their final mark may participate in the second-chance examination. In this case, if the answered test is delivered, the previous marks will not be considered.

Single Examination-based assessment

1. Written test module (85%)

Students who have opted for single assessment will have to take a final exam that may contain both theoretical and practical subjects of the course, as well as their capacity to solve problems. This exam will be held on the day on which the students of the continuous evaluation do the second partial exam.

2. Laboratory Module (15%)

Attending all the laboratory sessions is mandatory. The students will deliver assessable reports on the performed experiments and the laboratory skill will be also considered.

To pass the course in the first instance, it will be mandatory obtaining 5/10 points in the exam and a minimum average mark of 5/10 (85% exam + 15% laboratory).

Second-chance Examination

If the grade of the exam does not reach 5, the student will have the option of submitting to a recovery exam, which will evaluate the contents of the global syllabus of the subject. To pass the course, it will be mandatory obtaining 5/10 points in this exam and the final qualification will be, in this case, the weighted average between the mark of this exam (85%) and the mark of the laboratory module (15%).

It will be mandatory obtaining 5.0 points out of 10 in the global evaluation to pass the course.

To be eligible for the second-chance exam, any student should have been previously evaluated in a set of activities corresponding to a minimum of 2/3 of the overall qualification of the course. Hence, it will be mandatory to make the previous, final test to be entitled to the second-chance examination. The part of the laboratory module is not recoverable.

The non-assessable

A student receives the grade of non-assessable if he/she did not attend any written test and if he/she did not attend any of the laboratory practices.

Bibliography

Medicinal natural products. A biosynthetic approach. P. M. Dewick, Jonh Wiley & Sons, 2002. Electronic version in the Science Library.

*Natural products their chemistry and biological significance.*J. Mann, R.S. Davidson, J. B. Hobbs, D. V. Banthorphe and J.B. Harborne. Pearson Education Limited. 1994. ISBN 0-582-06009-5

Software

None

Language list

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	1	Catalan	first semester	afternoon
(TE) Theory	1	Catalan	first semester	morning-mixed