

Approval date: 26/06/2024

COURSE GUIDE

**Pharmaceutical Chemistry 1 (2041137)**

<b>Grado (Bachelor's Degree)</b>	Grado en Farmacia	<b>Branch</b>	Health Sciences				
<b>Module</b>	Química	<b>Subject</b>	Química Farmacéutica				
<b>Year of study</b>	3 <sup>o</sup>	<b>Semester</b>	2 <sup>o</sup>	<b>ECTS Credits</b>	6	<b>Course type</b>	Compulsory course

**PREREQUISITES AND RECOMMENDATIONS**

- It is recommended to have taken and passed the following subjects:
  - Organic Chemistry I
  - Organic Chemistry II
  - Structural Biochemistry
  - Metabolic Biochemistry.
- The students are also recommended to have obtained a B1 certificate in English language for non-English students. Good skills for document reading, writing and for oral presentation are also required.

**BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)**

Design, synthesis and drug analysis

**SKILLS**

**GENERAL SKILLS**

- CG01 - Identificar, diseñar, obtener, analizar, controlar y producir fármacos y medicamentos, así como otros productos y materias primas de interés sanitario de uso humano o veterinario.

**SUBJECT-SPECIFIC SKILLS**

- CE01 - Identificar, diseñar, obtener, analizar y producir principios activos, fármacos y otros productos y materiales de interés sanitario
- CE03 - Llevar a cabo procesos de laboratorio estándar incluyendo el uso de equipos científicos de síntesis y análisis, instrumentación apropiada incluida.
- CE04 - Estimar los riesgos asociados a la utilización de sustancias químicas y procesos de laboratorio.



- CE08 - Conocer y comprender la naturaleza y comportamiento de los grupos funcionales en moléculas orgánicas.
- CE09 - Conocer el origen, naturaleza, diseño, obtención, análisis y control de medicamentos y productos sanitarios.
- CE11 - Conocer y aplicar las técnicas principales de investigación estructural incluyendo la espectroscopia.

### TRANSFERABLE SKILLS

- CT02 - Capacidad de utilizar con desenvoltura las TICs

### LEARNING OUTCOMES

- At the end of the course it is expected that the student will be able to:
  - Demonstrate a detailed comprehension of the theory content included in the thematic blocks.
  - Be conversant with the necessary processes applied in an Organic Synthesis laboratory, for synthesis and drug isolation, as well as its analysis and structural determination (spectroscopic and chemical methods).
  - Drug design, handling of molecular models, and computer based drug structures.

### PLANNED LEARNING ACTIVITIES

#### THEORY SYLLABUS

- **Chapter 1. Concepts in Pharmaceutical Chemistry.**
  - Basic concepts and aims of Pharmaceutical Chemistry. From biological raw material to drug. Drug and medicine. Relationships between Pharmaceutical Chemistry and other sciences. Patents.
- **Chapter 2. Classification and nomenclature of drugs.**
  - Nomenclature of drugs: types. Systematic Nomenclature: IUPAC rules. International Nonproprietary Name (INN). Others.
- **Chapter 3. Search of lead compounds.**
  - Traditional discovery of new drugs: major procedures. Drug discovery today. Stages in the development of a drug.
- **Chapter 4. Optimization of lead compounds.**
  - Qualitative structure-activity relationships: structural modification as an optimization tool. Biologically exchangeable groups: bioisosteres. Generalization of the concept: peptidomimetics.
- **Chapter 5. Biological targets and drugs receptors.**
  - Biological targets and receptors: drug-receptor interactions and molecular recognition. Stereochemistry of drugs. Affinity and efficacy of a drug. Pharmacophore group concept.
- **Chapter 6. Drug metabolic processes: other methodologies in the discovery of new drugs.**
  - Phase I metabolic processes of drugs. Phase II metabolic processes of drugs. Use in drug discovery. Prodrug concept, hard drugs and soft drugs. Bioreversible drugs design, bioprecursors and molecular transporters.
- **Chapter 7. Quantitative Drug Design: parameters and quantitative structure-activity**



### relationships.

- Introduction to quantitative structure–activity relationships. Parameters used in QSAR. Introduction to molecular modeling. Other techniques used in new drugs design.
- **Chapter 8. Enzymatic inhibition: Inhibitors of cell wall biosynthesis.**
  - Enzymatic inhibition as a source of new drugs. Structure of  $\beta$ -lactam antibiotics as peptidoglycan inhibitors biosynthesis. Preparation of 6-APA and 7-ACA. Semisynthetic  $\beta$ -lactam compounds: penicillins and cephalosporins. Introduction to drug analysis. Penicillins and cephalosporins structural recognition methods.
- **Chapter 9. Enzymatic inhibition: Other antibacterial agents.**
  - Sulfonamides: Origin, acidity and structure–activity relationships. Other related sulfonamides and analogues. Others antibacterial drugs.
- **Chapter 10. Enzymatic inhibition: antitumor and antiviral drugs.**
  - Structure and synthesis of purines and pyrimidines antitumor analogs. Structure and synthesis of antiviral drugs. Other synthetic antitumor drugs.

### PRACTICAL SYLLABUS

- Practice 1. Theophylline synthesis.
- Practice 2. Phenytoin synthesis.

### RECOMMENDED READING

#### ESSENTIAL READING

- Fundamentos de Química Farmacéutica I: Teoría y Ejercicios. Ed. Técnica Avicam, 2019.
- J. Campos Rosa y M.E. Camacho Quesada. Pharmaceutical Chemistry, vol 1: Drug design and action.
- Campos Rosa y M.E. Camacho Quesada. Pharmaceutical Chemistry, vol 2: Drugs and their biological targets.
- C. Avendaño. Introducción a la Química Farmacéutica. Ed. Interamericana-McGraw-Hill. (2ª Ed.) Madrid 2001.
- W. O. Foye. Principios de Química Farmacéutica. Ed. Reverté. Barcelona. 1988. (7ª Ed. en inglés: Lea and Febiger. Filadelfia. 2013).
- Korolkovas. Fundamentos de la Química Farmacéutica. Ed. Reverté. Barcelona 1978. (Ed. En inglés: Wiley. Nueva York. 1988).
- A. Delgado y col. Introducción a la Química Terapéutica. Ed. Díaz de Santos. (2ª Ed.) Barcelona 2003.
- S. Cuéllar. Introducción a la Química de los Medicamentos. Ed. CGCF. Madrid 1999.
- T. Nogrady. Medicinal Chemistry. A Biochemical Approach. Ed. Oxford University Press. Oxford 1988.
- G. L. Patrick. An Introduction to Medicinal Chemistry. Ed. Oxford University Press. Oxford, 2013.
- E. Raviña Rubira. Medicamentos Un viaje a lo largo de la evolución histórica del descubrimiento de fármacos. Ed. Universidad de Santiago de Compostela. 2008.

#### COMPLEMENTARY READING

- IUPAC Nomenclature (<https://iupac.org/body/027/> )



- [https://iupac.org/wp-content/uploads/2021/06/Organic-Brief-Guide-brochure\\_v1.1\\_June2021.pdf](https://iupac.org/wp-content/uploads/2021/06/Organic-Brief-Guide-brochure_v1.1_June2021.pdf)
- D. Lednicer. Organic Chemistry of Drug Synthesis. Vols. 1-6. Ed. Wiley. New York 1977-1999.
- D. Mauleón y A. Delgado. Nomenclatura química sistemática de los fármacos. Ed. PPU. Barcelona 1987.
- C. Avendaño. Ejercicios de Química Farmacéutica. Ed. Interamericana-McGraw-Hill. Madrid 1997.
- P. Camps García. Fundamentos de síntesis de fármacos. Ed. Universidad de Barcelona. 2005.

## RECOMMENDED LEARNING RESOURCES/TOOLS

- Departament of Pharmaceutical and Organic Chemistry (<https://qfo.ugr.es/>)
- Nomenclatura IUPA Química Orgánica (<https://rseq.org/mat-didacticos/guia-breve-para-la-nomenclatura-de-quimica-organica/>)
- Guía Química (<http://www.chemistryguide.org/index.php>)
- Journal of Medicinal Chemistry (<http://pubs.acs.org/journal/jmcmr>)
- European Journal of Medicinal Chemistry (<https://www.journals.elsevier.com/european-journal-of-medicinal-chemistry>)
- Nature Reviews Drug Discovery (<http://www.nature.com/nrd/index.html>)
- Medicinal Research Reviews ([http://onlinelibrary.wiley.com/journal/10.1002/\(ISSN\)1098-1128](http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1098-1128))

## TEACHING METHODS

- MD01 - Lección magistral/expositiva
- MD03 - Resolución de problemas y estudio de casos prácticos
- MD04 - Prácticas de laboratorio y/o clínicas y/o oficinas de Farmacia
- MD07 - Seminarios
- MD10 - Realización de trabajos individuales
- MD12 - Tutorías
- MD13 - Participación en plataformas docentes

## ASSESSMENT METHODS (Instruments, criteria and percentages)

### ORDINARY EXAMINATION DIET

#### GENERAL ASSESSMENT CRITERIA FOR APPLICATION IN THE ORDINARY EXAMINATION DIET

1. The Evaluation and Grading Regulations for Students at the University of Granada (<https://goo.gl/uHfqly>) establish two main evaluation modalities within the ORDINARY EXAMINATION DIET: Continuous Assessment (preferred) and Single Final Assessment.
  - **Continuous Assessment:** The types of evaluation tests used during the academic year will be determined by the course instructor(s) at the beginning of the course



from those indicated in this Teaching Guide (Table 2). The weightings for the final grade of each test are listed in Table 1

- **Single Final Assessment:** Refer to the criteria outlined in the section titled SINGLE FINAL ASSESSMENT.
2. In ALL the evaluation tests the student must show a minimum and uniform knowledge of all the proposed questions, as well as the necessary skills. The minimum knowledge is reached by obtaining a 5 in all the questions or blocks of the exam.
  3. In exceptional cases or if there is any doubt about the authenticity of the assessment exercises, and according to the teacher's criteria, complementary writing and/or oral tests may be carried out to justify the student's knowledge. These tests will be governed by the evaluation criteria described in section 2.

**Table 1.** Assessment systems and their percentages in the final grade for the Continuous Assessment mode.

	EVALUATION SYSTEMS	% FINAL SCORE
Final exam	SE.1, SE.2, SE.3 and SE.4	70
Midterm exam	SE.1, SE.2, SE.3 and SE.4	20
Practices	SE.7, SE.8, SE.9, SE.10 and SE.15	5
Preparation and/or presentation of works	SE.1, SE.2, SE.3, SE.4, SE.5, SE.6, SE.11 and SE.12	5

**Table 2.** Information codes of the different evaluation systems.

**EVALUATION SYSTEMS**

SE.1 Written developmental exams	SE.9 Practice exams by an oral test
SE.2 Short answer written exams	SE.10 Preparation of report or notebook of practices
SE.3 Multiple choice written exams	SE.11 Preparation of a group work
SE.4 Oral tests	SE.12 Individual work preparation
SE.5 Exhibition of works	SE.13 Self appraisal
SE.6 Presentation of topics	SE.14 Field tests
SE.7 Practice exams through a practical test	SE.15 Assistance
SE.8 Practice exams by a written test	

The Student Assessment and Qualification Regulations of the University of Granada (<https://goo.gl/uHfqJy>) establish two main assessment modalities: **Continuous Assessment** (preferred) and **Single Final Assessment**.

**CONTINUOUS ASSESSMENT**

**THEORY**

The Continuous Assessment of the subject will consist of:

- A **midterm exam** (see date in the Academic Calendar) that is not eliminatory and whose percentage for the final grade is established in Table 1.
- A mandatory **final exam** (see date in the Academic Calendar) that must be passed with a minimum grade of 5, and whose percentage for the final grade is established in Table 1.
- The **final grade** will be obtained by adding the marks obtained in the midterm exam, the final exam, the practice exam and the mark of preparation and/or presentation of works, as long as in the final exam has been obtained a minimum rating of 5.

None of the passed exams will be saved neither for the extraordinary exams, single final assessment, nor for subsequent academic courses.

**PRACTICES**

1. It is mandatory to pass the practices in order to pass the course.
2. The student must attend ALL the practical sessions as well as take and pass a knowledge test from among those described in the Assessment Systems (Table 2), or a combination of these, according to the professor's criteria.
3. In order to better weigh the grade or in the event of any reasonable doubt about the individual work carried out by the student, as well as about the knowledge acquired





- during the development of practical teaching, the teacher may take oral tests and / or INDIVIDUAL practices COMPLEMENTARY that will be governed by the evaluation criteria described in section 2 of the General Evaluation Criteria section.
4. The students summoned to practices as substitutes have the obligation to attend the day of the call at the indicated time. The student who does not justify his/her absence adequately will not be summoned again.
  5. The practices approved in an academic year will not be saved for subsequent academic courses nor for extraordinary calls.
  6. Students who have not taken all the practical classes or have not passed them, will not be able to pass the subject in the continuous (ordinary) assessment.

## EXTRAORDINARY EXAMINATION DIET

### GENERAL ASSESSMENT CRITERIA FOR APPLICATION IN THE EXTRAORDINARY EXAMINATION DIET

1. In ALL the evaluation tests the student must show a minimum and uniform knowledge of all the proposed questions, as well as the necessary skills. The minimum knowledge is reached by obtaining a 5 in all the questions or blocks of the exam.
  2. In exceptional cases or if there is any doubt about the authenticity of the assessment exercises, and according to the teacher's criteria, complementary writing and/or oral tests may be carried out to justify the student's knowledge. These tests will be governed by the evaluation criteria described in section 1.
- Students who have not passed the subject in the ordinary call will have an extraordinary call. All students may attend it, regardless of having followed a continuous assessment process or not. In the extraordinary call, students will have to take and pass a single test that will be divided in two parts:
    - Theory part:
      - A theoretical exam, comprising all the subject.
    - Practical part:
      - Comprising two exams, theoretical and practical, corresponding to the laboratory practices.
  - Passing all exams in both parts is mandatory to pass the subject. The final numerical grade recorded in the academic record will be that of the theoretical exam. All exams will be governed by the General Evaluation Criteria established in this section.

## SINGLE FINAL ASSESSMENT (evaluación única final)

### GENERAL ASSESSMENT CRITERIA FOR APPLICATION IN THE SINGLE FINAL ASSESMENT (EVALUACION UNICA FINAL)

1. In ALL the evaluation tests the student must show a minimum and uniform knowledge of all the proposed questions, as well as the necessary skills. The minimum knowledge is reached by obtaining a 5 in all the questions or blocks of the exam.
  2. In exceptional cases or if there is any doubt about the authenticity of the assessment exercises, and according to the teacher's criteria, complementary writing and/or oral tests may be carried out to justify the student's knowledge. These tests will be governed by the evaluation criteria described in section 1.
- The Regulations for the Evaluation and Qualification of Students of the University of Granada (<https://goo.gl/uHfqJy>) contemplates the realization of a **Single Final Evaluation** to which those students who for work reasons, health, disability or any other



- duly justified cause cannot comply with the **Continuous Evaluation** method.
- To qualify for the single final evaluation, the student, in the first two weeks of teaching the subject or in the two weeks following enrolment if it has occurred after the start of the subject, will request it through the electronic procedure, to the Director of the Department alleging and proving the reasons that assist him for not being able to follow the continuous evaluation system. The Director of the Department to which the request was addressed, after hearing the teaching staff responsible for the subject, will resolve the request within 10 business days. Once this period has elapsed without the student having received an express written response, the request will be deemed estimated.
  - In the single final assessment call, students will have to take and pass a single test that will be divided in two parts:
    - Theory part:
      - A theoretical exam, comprising all the subject.
    - Practical part:
      - Comprising two exams, theoretical and practical, corresponding to the laboratory practices.
  - Passing all exams in both parts is mandatory to pass the subject. The final numerical grade recorded in the academic record will be that of the theoretical exam. All exams will be governed by the General Evaluation Criteria established in this section.

## ADDITIONAL INFORMATION

### I. EVALUATION BY INCIDENTS FOR PARTIAL TESTS AND FINAL TESTS IN ORDINARY EXAMINATION DIET, EXTRAORDINARY EXAMINATION DIET, AND SINGLE FINAL ASSESMENT

Incident Assessment is regulated in Article 9 of the Regulations for the assessment and qualification of students at the University of Granada.

For the evaluation request for incidents for partial and/or final tests of this subject, both in all its evaluation modalities, the following procedure must be followed:

#### 1. APPLICATION

It is requested in writing, with a form of various requests, in the Registry of the Secretariats of the Centers (Registro de las Secretarías de los Centros), or online in the Electronic Registry of the UGR (<https://sede.ugr.es/procs/Gestion-Academica-Solicitud-de-evaluacion-por-incidencias/>). The request must include the **postal address and email address** of the person concerned, for the purposes of notifications. **Requests made by email are not allowed.**

Below are the detailed incidents attended, the deadline to submit the application, and the supporting documentation to be provided, are detailed below:

- **Incidence 1** - Coincidence of date and time for reasons of attendance at collegiate government bodies or university representation. **Term:** From the receipt of the call to the date of the exam. **Documentation to present:** Original of the call.
- **Incidence 2** - Coincidence with official activities of high-level and high-performance athletes or by participation in sports activities of an official nature representing the University of Granada. **Term:** At least **10 business days** in advance of the exam date. **Documentation to present:** Official documentation that proves such circumstance.
- **Incidence 3** - Coincidence of date and time of two or more evaluation procedures of subjects of different courses and/or degrees. **Term:** At least **10 business days** in advance of the exam date. **Documentation to present:** The exams must be in an official call.
- **Incidence 4** - In cases of illness duly justified through an official medical certificate. **Term:** With a minimum notice of **5 calendar days before or up to 5 business days after** the date of the exam. **Documentation to present:** Official medical certificate.
- **Incidence 5** - Due to the death of a relative up to the second degree of consanguinity or affinity, which occurred in the ten days prior to the scheduled date for conducting the test. **Term:** Up to **5 calendar days** after the date of the exam. **Documentation to present:**



Official death certificate and proof of the degree of relationship.

- **Incidence 6** - Due to the beginning of an outgoing mobility stay at a destination university whose academic calendar requires the incorporation of the student on dates that coincide with the evaluation test dates. Term: At least **20 business days** in advance of the exam date. **Documentation to present:** Mobility scholarship holder's credential and accreditation of the date on which they must be at the destination.

## 2. RESOLUTION OF THE APPLICATION

The resolution of the request by the Department is notified to the interested person, at the physical address or email (either of the two) indicated in the request made.

If the application is accepted by the Department, the Professor of the Group that teaches the implied subject is also notified.

The notification must be made within a **period not exceeding 5 business days** after the resolution.

## 3. PROCEDURE AND DEADLINES AFTER THE RESOLUTION OF THE APPLICATION

The student with an accepted application resolution must contact the Professor within a period that should **never exceed 12 calendar days** after the date of the resolution of his application. For this purpose, the use of e-mail is allowed, putting as the sending address the UGR e-mail address of the Professor of the subject for which the incident assessment is requested, and the e-mail address of the Department Director.

If after this period the student has not contacted, it is understood that they have waived the evaluation for incidents requested and it will be recorded as "Not presented" in the evaluation grade and/or in the corresponding Records.

Once the student has contacted the Professor, they continue according to the procedure established in Article 9 of the Regulations for Evaluation and Qualification of students at the University of Granada.

## 4. EVALUATION FOR INCIDENTS BY COINCIDENCE IN DATE AND TIME OF TWO OR MORE EVALUATION PROCEDURES

In the event that the reason for the evaluation request due to incidents is due to the coincidence of the date and time of two or more evaluation procedures for subjects of different courses and / or degrees, the student must after his request:

1. Proof of having presented and taken the final test of the coincident subject established in its official announcement, by means of a form model that can be requested at the Department Secretary and that must be signed by the professor of said subject and stamped by the corresponding Department.
2. Deliver this receipt to the teacher responsible for carrying out the incident evaluation.

If the student does not appear for the first of the exams affected by the incident, he will lose his right to be evaluated in the call for evaluation by incidents for the second exam. In other justified cases, the cause of force majeure and / or supervening that has prevented the examination on the official date must be duly proven. The resolution of applications based on the coincidence of date and time of two or more evaluation procedures of subjects of different courses and / or degrees, is carried out according to the procedure established in Agreement 2/COA 05-08-2020 of the Faculty of Pharmacy.

**In all the cases, accepting a request for Evaluation by Incidents implies that the student waives their right to appear on the scheduled date of the corresponding official examination session as established in the exam calendar.**

## II. GRADING SYSTEM

In the case of subjects whose Teaching Guides include a final exam that represents 50% or more of the total weighting of the final grade of the subject and the student 50% or more of the total weighting of the final grade of the subject and the student decides not to take it, it will be decided not to take the exam, it will be recorded in the minutes with the notation "Not presented". When the student has completed the activities and tests of the **Continuous Assessment** process included in the subject's Teaching Guide that constitute more than 50% of the total weighting of





the final grade for the of the total weighting of the final grade of the subject, it will appear in the minutes with the corresponding grade.

### III. STUDENTS WITH SPECIFIC EDUCATIONAL SUPPORT NEEDS (NEAE)

In accordance with the recommendations of the CRUE and the Secretariat for Inclusion and Diversity of the University of Granada, the systems for the acquisition and evaluation of competences included in this teaching guide will be applied in this teaching guide will be applied in accordance with the principle of design for all people, facilitating learning and the demonstration of knowledge according to the needs and functional diversity of the students. The teaching methodology and assessment will be adapted to the needs and functional diversity of the students with specific educational support needs (SEN), in accordance with Article 11 of the Regulations for the Evaluation and Grading of students at the University of Granada, published in the Official Bulletin of the University of Granada no. 112 of 9 November 2016.

### IV. UGR INCLUSION AND DIVERSITY

In the case of students with disabilities or other specific educational support needs, the tutoring system must be adapted to their needs, in accordance with the recommendations of the tutoring system must be adapted to their needs, in accordance with the recommendations of the University's Inclusion Unit of the University, and the Departments and Centres will proceed to establish the appropriate measures to ensure that tutorials are held in accessible places. Likewise, at the request of the lecturer, support may be requested from the competent University unit in the case of special methodological adaptations.

Información de interés para estudiantado con discapacidad y/o Necesidades Específicas de Apoyo Educativo (NEAE): [Gestión de servicios y apoyos \(https://ve.ugr.es/servicios/atencion-social/estudiantes-con-discapacidad\)](https://ve.ugr.es/servicios/atencion-social/estudiantes-con-discapacidad).

