Teaching guide

IDENTIFICATION DETAILS

Degree:	Biomedicine
Scope	Biology and Genetics
Faculty/School:	Experimental Sciences
Course:	GENERAL AND ORGANIC CHEMISTRY
Type:	Basic Training
ECTS credits:	6
Year:	1
Code:	2130
Teaching period:	First semester
Subject:	Chemistry
Module:	Fundamental Sciences
Teaching type:	Classroom-based
Language:	Spanish
Total number of student study hours:	150

SUBJECT DESCRIPTION

Chemistry is the scientific discipline that studies the nature of matter and its transformations.
The chemistry subject taught in the first course of the degree in Biomedicine consists of a single subject, General and Organic Chemistry. The General Chemistry block includes the fundamental concepts of chemical equilibrium in aqueous solution together with basic notions of the energetic and kinetic aspects that regulate these balances, essential for the maintenance of life. For its part, the Organic Chemistry block will provide students with the basis for understanding the structure, properties and reactivity of a large number of organic compounds, especially those molecules that are essential from a biomedical point of view, such as proteins and drugs.

GOAL

The teaching of the General Chemistry Block (QG) of this subject will provide students with the knowledge necessary to understand the fundamental concepts of Chemical Equilibrium in solution and the basic principles of Thermodynamics and Kinetics applicable to such reactions, as well as the ability to apply these concepts in the calculation of certain parameters and variables, essential for the maintenance of life.

In addition, after teaching the Organic Chemistry Block (QO), the student will be able to identify the functional groups in an organic compound, name it, determine its three-dimensional structure, predict its reactivity and propose the mechanisms by which these reactions take place. As the final objective of the block, and applying the principles of reactivity studied, the student will be able to devise plausible synthetic routes for obtaining some simple biomolecules and other organic molecules of high biomedical interest, such as drugs or antibodies.

The specific objectives pursued with this subject are that the student, after the teaching-learning process:
1. Be able to identify the different types of chemical equilibrium in solution.
2. Calculate parameters that characterize the equilibria: pH, chemical potential, solubility...
3. Apply the fundamental principles of Thermodynamics and Chemical Kinetics to specific cases.
4. Be able to identify the different functional groups in an organic compound and name it.
5. Recognize the reactive zones of an organic compound and be able to predict its reactivity.
6. Mechanistically complete the studied organic reactions.
7. Be able to propose plausible synthetic routes for obtaining simple organic molecules.

PRIOR KNOWLEDGE

Students who, prior to the start of teaching the subject, have the level of knowledge of the 2nd year of Baccalaureate (Scientific) in the subjects Chemistry, Physics and Mathematics will be able to achieve optimal use of learning the subject General and Organic Chemistry.

COURSE SYLLABUS

The teaching of the subject General and Organic Chemistry is divided into three Blocks: General Chemistry (Block I), Organic Chemistry (Block II) and, finally, a Practical Block (Block III) in which the concepts developed in the two previous blocks are applied to real experiences in the laboratory.
Each of the Blocks consists of the topics listed below and in which the subject's syllabus is developed.

BLOCK I. GENERAL CHEMISTRY
This block is further subdivided into two, Chemical Equilibrium (I-A) and Chemical Thermodynamics and Kinetics (I-B), with the following contents.

I-A. CHEMICAL EQUILIBRIUM
In the topics of this Block, the concept of Chemical Equilibrium is studied and those types of equilibrium that are most important from a biomedical point of view are studied, such as acid-base balance and solubility balance.

Theme. Acid-Base Balance
Concepts of acid and base. pH, pOH and pK. Acid-base titrations. Assessment curves. Buffer solutions.

Henderson-Hasselbach equation. Exercises and case studies.
Theme. Redox and Solubility Equilibriums
Ion-electron settings. Reduction potential. Spontaneity of a redox process. Electrolysis. Faraday's Laws. Spontaneous redox processes: electrochemical cells. Nernst equation. Solubility and precipitation. Solubility balance: product or solubility constant. Fractional precipitation. Factors affecting the solubility of a compound: common ion effect and pH. Other factors that influence solubility. Exercises and case studies.
Theme. Complex Formation Equilibrium
Definition of complex ions. Formulation and nomenclature of coordination compounds. Complex ion formation and formation constants. Effect of pH on complex formation. Solubility of compounds through complex formation. Titrations with complexing agents. Exercises and case studies.

I-B. CHEMICAL THERMODYNAMICS AND KINETICS
This block analyzes the energy changes that accompany any chemical reaction (a discipline known as Thermodynamics) and the kinetics of these reactions, together with the factors that affect this speed.

Theme. Introduction to Chemical Thermodynamics and Kinetics: Basic Principles (Flipped Classroom)
Thermodynamics: Initial Postulates of Thermodynamics. First law of thermodynamics. Second and third principles of thermodynamics. Relationship between free energy and the equilibrium constant. Chemical Equilibrium: general concepts. Exercises and case studies. Kinetics: Molecularity and order of reaction. Velocity constant and velocity equation. Factors affecting the reaction rate. Exercises and case studies.

BLOCK II. ORGANIC CHEMISTRY
In this case, the Block is subdivided into two sections, Basic Principles in Organic Chemistry (II-A) and Functional Groups and Reactivity (II-B), with the contents listed below.

II-A. BASIC PRINCIPLES IN ORGANIC CHEMISTRY
A review is made of the various theories that have existed throughout history to explain the nature of chemical bonds and their physico-chemical characteristics and then to study in depth the organic functions, their spatial distribution, the different types of isomerism that these arrangements cause and the reactivity that their presence and arrangement confer on the organic compound that contains them.

Theme. Nature of the chemical bond in a molecule
Valence layer electronic pair repulsion theory (VSEPR): molecular geometry prediction. Valence bond theory (TEV): hybridization and bond types in Organic Chemistry. Molecular orbital theory (TOM): from atomic orbitals to molecular orbitals. Exercises and case studies.
Theme. Organic Functions and Isomerism
Formulation and nomenclature in organic chemistry: functional groups. Isomerics: determination of the spatial structure of a chiral center. Basic principles of reactivity in Organic Chemistry: inductive effect and mesomeric effect. Reaction intermediates in Organic Chemistry and their stability: carbocations, carbanions and free radicals. Types of organic reactions: substitution, addition and elimination. Exercises and case studies.

II-B. FUNCTIONAL GROUPS AND REACTIVITY
In this Block, the different functional groups that exist in Organic Chemistry are studied in detail together with the reactivity that the presence of these groups confers on the organic molecule that contains them. The Topics have been sequenced in increasing order of difficulty to conclude with a topic in which the principles of reactivity studied so far are applied to essential organic molecules in the biomedical field, such as amino acids or drugs, in order to obtain a more real vision of their reactivity.

Theme. Carbonate skeleton
Alkanes: structure description and reactivity. Reactivity of unsaturated hydrocarbons: lability of the pi bond and

main reactions of unsaturated systems with their mechanisms. Benzene: structure and reactivity with its mechanisms. Aromatic compounds: resonance and reactivity associated with mechanisms. Exercises and case studies.
Theme. Functional groups with inductive effect
Halogenated derivatives: alkyl halides and aryl halides. Differences in reactivity and main reactions with their mechanisms. Hydroxyl group (and thiol group): alcohols (thiols) and phenols. Differences in reactivity between alcohols and phenols: main reactions with their mechanisms. Amines and derivatives: the amino group and derivatives (nitro group and nitrile group). Reactivity of amines and derivative groups: main reactions with their mechanisms. Exercises and case studies.
Theme. Carbonyl and carboxyl groups
The carbonyl group: aldehydes and ketones. Differences in reactivity between aldehydes and ketones: main reactions with their mechanisms. Aldol condensation reactions: intermolecular (pure and mixed) and intramolecular. The carboxyl group: acids and derivatives (esters and amides). Reactivity of the acid group: main reactions with their mechanisms. Exercises and case studies.
Theme. Synthetic routes for obtaining simple organic molecules (Flipped Classroom)
Students must propose, develop and present as a team (supervised by the subject teacher), both orally and in written form, the synthesis of simple organic molecules that are interesting from a biomedical point of view.

BLOCK III. LABORATORY PRACTICES
Teaching a scientific subject cannot be conceived without including internships in the laboratory in its programming. The Block includes carrying out the proposed practices, up to a total of three, directly related to the subject taught, as well as a Post-internship Seminar in which the work carried out in the laboratory will be analyzed and deepened.
QG practice. Solutions and Dilutions. Preparation of buffers and use of the pH meter.
QO practice. Synthesis and Purification of Acetylsalicylic Acid (Aspirin).
Practice (QO+QG). Basic Techniques in a Chemical Laboratory.

EDUCATION ACTIVITIES

The teaching-learning methodology consists of a series of Face-to-Face Work Activities (ATP) and others that the student must carry out individually, the Self-Employment Activities (ATA).
All of the activities are detailed below, together with a brief description of each one. The completion of all the activities completes the 6 ECTS (150 hours of student work) assigned to the subject General and Organic Chemistry.

FACE-TO-FACE WORK ACTIVITIES (ATP)
ATP1. Exhibition class. Master classes given by the teacher and by invited researchers in which the contents of the subjects are presented.
ATP2. Practical classes. Exercises and case studies and experimental work carried out in the laboratory.
ATP3. Teamwork based on cooperative learning. Resolution in cooperative work teams of problems, exercises and practical cases related to the content of the subject.
ATP4. Tutoring. Personalized student attention to review the contents explained in class, answer questions or discuss specific topics in order for the student to achieve the objectives pursued by the module.
ATP5. Evaluation. Carrying out evaluation tests.

SELF-EMPLOYMENT ACTIVITIES (ATA)
ACT 1. Theoretical study. Study of the theoretical contents of the programs of the subjects of the module. Use of

complementary materials designed in the virtual network spaces of the different subjects.
ATA2. Preparation of practical classes. Review and understanding of the experiments carried out in practical laboratory classes.
ATA3. Preparation of works. Carrying out practical cases and exercises to deepen the subject matter taught. Carrying out bibliographic searches, analyzing the selected material and preparing papers for subsequent presentation and discussion.
ATA4. Tutoring preparation. Preparation of the issues to be raised and discussed in the tutorials.

DISTRIBUTION OF WORK TIME

TEACHER-LED TRAINING ACTIVITIES	INDIVIDUAL WORK
70 Horas	80 Horas

LEARNING RESULTS

Correctly describe the nature of matter and the formation of different types of chemical bonds.

Know and understand chemical equilibrium reactions in solution.

Understand the principles of thermodynamics and their application to biological systems.

Know and understand the laws that explain the kinetics of a chemical reaction and the factors on which it depends.

Know the different laboratory instruments and materials (biological and non-biological) and their obtaining and handling for different purposes, observing the necessary safety principles.

Learn to identify the structure of the main organic functions and understand the basic mechanisms of their reactions.

SPECIFIC LEARNING RESULTS

(QG) Calculate parameters and variables that characterize solution equilibria: pH, solubility...

(QG) Determine the energy and kinetic variables related to a chemical equilibrium.

(QO) Correctly describe the structure of matter and the nature of the chemical bond.

(QO) Differentiate the different types of organic reactions and complete the mechanisms by which they take place.

(QO) Propose plausible routes for the synthesis of simple organic molecules.

(QG+QO) Present properly orally and/or in writing, in an appropriate manner, research work carried out as a team

on the subject taught.

(QG+QO) Solve the exercises and practical cases that arise on the subject taught.

(QG+QO) Perform real experiments in the laboratory related to the subject taught.

LEARNING APPRAISAL SYSTEM

The proposed ORDINARY EVALUATION SYSTEM is described, with the statistical weight and conditions for each of the parts of the evaluation process.

BLOCK THEORY. Evaluation of the theoretical content of the subject through oral and/or written tests with development, short answer or test-type questions (65%).
Oral and written exams will be taken to evaluate the learning of the contents presented in theoretical, practical and teamwork classes based on cooperative learning. The exams will consist of practical case and problem solving exercises with which the student will demonstrate their knowledge and understanding of the subject, as well as their ability to apply what they have learned.
In the middle of the semester, a partial-non-elimination exam will be held, which will have a value of between 10-15% of the final grade for those students who pass the grade set by the teacher. This grade will be fixed later (always prior to the completion of this exam) and will be in the range [6.5-7.5].
In order to ensure the minimum knowledge necessary for the student to continue their training under optimal conditions in subsequent years, a minimum score of 5 will be scored on the exams in this section in order to be able to apply the statistical weights and therefore to be able to pass the subject.

PRACTICAL BLOCK. Carrying out and evaluating the experimental work carried out in the laboratory (20%).
2ND. Experimental Part.
The way in which the student performs in the laboratory, their behavior during the development of the practices, the ability to solve the experimental problems posed to them and the interpretation of the results of practical research will be evaluated. Attendance at practical sessions is mandatory. Unjustified non-attendance at any of these sessions will be a sufficient reason for the student not to pass the course in the Ordinary Call. Under certain circumstances, the existing Regulations will be applicable to allow passing the subject in the Extraordinary Call (consult conditions with the teacher of the subject).
2B. Practices Exam.
The depth of experimental learning will also be evaluated in a written test in which, and applying the concepts acquired in the laboratory, the student can solve the practical cases that arise and interpret the results of real research.
As for the previous Block, and in order to ensure the minimum knowledge necessary for the student to continue their training under optimal conditions in subsequent years, a minimum score of 5 will be scored both in sections 2A and in 2B, in order to be able to apply the statistical weights and therefore to be able to pass the subject.

WORK BLOCK. Evaluation of teamwork based on cooperative learning (15%).
At this point, the way in which the student performs in cooperative learning will be evaluated, both in the presentation of written documents and in their oral defense.

The course will be approved when the final grade obtained, after applying the statistical weights of each part, is equal to or greater than 5 (out of 10). If any student does not exceed the minimum grade required in any of the blocks mentioned in the Ordinary Call, they will not be able to pass the subject in that Call and must recover those

part (s) in the Extraordinary Call. However, the notes for the rest of the blocks will be saved, as long as they exceed 5, between the calls for an Academic Year.

ALTERNATIVE EVALUATION SYSTEMS
The evaluation system for students who enroll for the second time in the subject will be exactly the same as for first-time students enrolled in the Theory and Work Blocks. If the student has passed (grade greater than 5) the Internship Block, they will have the possibility to validate it in this 2nd enrollment.
If there are any students with a 3rd enrollment (or higher) or with an academic exemption, you should contact the teacher of the subject to find out about the evaluation criteria provided for your particular case.

IMPORTANT NOTE
Plagiarism, as well as the use of illegitimate means in evaluation tests, will be sanctioned in accordance with the university's Evaluation Regulations and Coexistence Regulations.

ETHICAL AND RESPONSIBLE USE OF ARTIFICIAL INTELLIGENCE

1.- The use of any Artificial Intelligence (AI) system or service shall be determined by the lecturer, and may only be used in the manner and under the conditions indicated by them. In all cases, its use must comply with the following principles:
a) The use of AI systems or services must be accompanied by critical reflection on the part of the student regarding their impact and/or limitations in the development of the assigned task or project.
b) The selection of AI systems or services must be justified, explaining their advantages over other tools or methods of obtaining information. The chosen model and the version of AI used must be described in as much detail as possible.
c) The student must appropriately cite the use of AI systems or services, specifying the parts of the work where they were used and describing the creative process followed. The use of citation formats and usage examples may be consulted on the Library website(https://www.ufv.es/gestion-de-la-informacion_biblioteca/).
d) The results obtained through AI systems or services must always be verified. As the author, the student is responsible for their work and for the legitimacy of the sources used.
2.- In all cases, the use of AI systems or services must always respect the principles of responsible and ethical use upheld by the university, as outlined in the Guide for the Responsible Use of Artificial Intelligence in Studies at UFV. Additionally, the lecturer may request other types of individual commitments from the student when deemed necessary.
3.- Without prejudice to the above, in cases of doubt regarding the ethical and responsible use of any AI system or service, the lecturer may require an oral presentation of any assignment or partial submission. This oral evaluation shall take precedence over any other form of assessment outlined in the Teaching Guide. In this oral defense, the student must demonstrate knowledge of the subject, justify their decisions, and explain the development of their work.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

Peter Atkins... [et al.]. Shriver and Atkins' Inorganic Chemistry/5th ed. Oxford: Oxford University Press, 2010.
(Peter Atkins... [et al.]. Shriver and Atkins' Inorganic Chemistry/5th ed. Oxford: Oxford University Press, 2010. , ||Atkins, P.; Jones, L.; Laverman, L. Chemical Principles: the Quest for insight 7th)

Wade, L.G.; Simek, J.W. Organic Chemistry 10th
(Wade, L.G.; Simek, J.W. Organic Chemistry 10th , Ed. Pearson Prentice Hall, 2022.)

Kenneth W. Whitten... [et al.]. Chemistry/10th ed. Australia: Brooks/Cole: Cengage Learning, 2014.

Additional

Maria del Pilar Cabildo Miranda [and 3 others]. Organic chemistry/Madrid:UNED - National University of Distance Education, [2008]