# COURSE SYLLABUS

## 1. COURSE DESCRIPTION

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|---|---|
| **Degree:** | **Biotecnología** |
| **Double Degree:** | |
| **Course:** | **General Chemistry** |
| **Module:** | **BLOQUE 1 MATERIAS BÁSICAS** |
| **Department:** | **Sistemas Físicos, Químicos y Naturales** |
| **Academic Year:** | **2017-18** |
| **Term:** | **First Term (Fall)** |
| **Total Credits :** | **6** |
| **Year:** | **1** |
| **Type of Course:** | **Basic** |
| **Course Language:** | **English** |

| | |
|---|---|
| **Modelo de docencia:** | **B1** |
| **a. Enseñanzas Básicas (EB):** | **60%** |
| **b. Enseñanzas de Prácticas y Desarrollo (EPD):** | **40%** |
| **c. Actividades Dirigidas (AD):** | |
| **d.** | |

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## 2. TEACHING TEAM INFORMATION

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|---|---|
| **Course Coordinator:** Patrick Merkling<br><br>**Professors** | |
| **Name:** | Patrick Merkling |
| **Faculty:** | **Facultad de Ciencias Experimentales** |
| **Department:** | Sistemas Físicos, Químicos y Naturales |
| **Academic Area:** | Química Física |
| **Category:** | Prof. Contr. Dr. |
| **Office Hours:** | TBD and by appointment (e-mail me to arrange a time) |
| **Office Number:** | **E22, 3.11** |
| **E-mail:** | **pjmerx@upo.es** |
| **Telephone:** | **954348643** |

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## 3. ACADEMIC CONTEXT

### 3.1. Course Description and Objectives

Note: This document is also available in spanish (Química General) with identical contents. I would recommend anybody go back to that document if you do not understand clearly this version.

The main purpose of this course is to provide the student with fundamentals in chemistry to build upon in future courses, and to enable him to apply them to solve practical problems both during his studies and in his future as a professional.

### 3.2. Contribution to the training plan

The assignment of General Chemistry belongs to the module "Chemistry in Molecular Biosciences". General Chemistry provides the students with the fundamentals and capabilities needed to understand the mechanisms underlying biological processes.

The general and specific skills achieved in this course are essential for understanding further advanced matters that they will study in their degree, such as Organic Chemistry, Thermodynamics and Kinetics, Instrumental Analysis Techniques, Bioanalytical Chemistry, Biochemistry, etc.

### 3.3. Recommendations or prerequisites

Recommendation: possess a background in chemistry, physics and maths from high school/secondary school.

## 4. SKILLS

### 4.1 Degree skills developed during this course

Biotechnology can be defined as a technique that uses living organisms or compounds obtained from living organisms to produce products of economical, medical or social value to humans. Therefore learning about Biotechnology at the level of the Degree requires a biological and chemical knowledge base to enable students to understand the technological processes that involve living organisms.

The Report for the verification request of the graduate degree in Biotechnology from the University Pablo de Olavide referred (among others) the following competencies:
• Understand the scientific method. Know, understand and apply the tools, techniques and experimental protocols in the laboratory and acquire the skills of observation and interpretation of the results.
• Acquire basic experimental skills appropriate to each of the subjects taught, by the description, quantification, analysis and critical evaluation of the experimental results obtained independently.
• Work properly in a biological, chemical or biochemical laboratory, know and apply standards and techniques related to health and safety, handling of laboratory animals and waste management.
• Demonstrate proper integrated view of the R + D + i be able to interrelate and connect the areas of biotechnology encompassing knowledge from biological and physicochemical principles to new scientific knowledge for practical application development and introduction in the market for new biotech products of interest

### 4.2. Module skills developed during this course

The Degree Report includes the following module-specific skills:

1. Know the origin of the atomic/molecular properties of matter, including pure substances, mixtures and solutions.
2. Know the principles of thermodynamics and their practical application to thermochemical and thermodynamic study of a reaction and dominate the thermodynamic concept of chemical equilibrium and equilibrium constant, and be able to identify the factors on which it depends.
3. Learn the common characteristics of physicochemical transport processes: diffusion, osmosis, electrophoresis, etc ...
4. Master the concept of reaction rate and rate constant and be able to identify the factors on which it depends and know how to describe proton transfer reactions and electronical and thermodynamical concepts applied to their behavior.
5. Know the basis of spectroscopical methods for quantitative chemical analysis and structural elucidation of organic compounds.

**4.3. Course-specific skills**

1. Understand the atomic/molecular origin of the properties of matter, either pure substances, mixtures or solutions
2. Apply the principles of thermodynamics to thermochemical and thermodynamic study of a chemical reaction
3. Master the concept of chemical equilibrium and equilibrium constant, and be able to identify the factors on which it depends
4. Master the concept of reaction rate and rate constant and be able to identify the factors on which it depends
5. Be able to describe the proton transfer reactions and electronic and thermodynamic concepts involved in their description

## 5. COURSE CONTENTS (COURSE TOPICS)

Succinctly, the topics of the course are:

• Introduction and basic concepts, Topic 0

• Atomic and molecular structure, Topic 1

• Introduction to Thermodynamics, Topic 2

• Introduction to the fundamentals of chemical kinetics and chemical equilibrium, Topic 3

• Proton transfer reactions, Topic 4

• Electron transfer reactions, Topic 5

• Liquid phase reactions, Topic 6

Description of lab sessions:

Practice 1: Spectrophotometry

Practice 2: Calorimetry

Practice 3: Acid-base and buffer solution

Practice 4: Determination of vitamin C contained in a shake or fruit juice

## COURSE SYLLABUS

**Teaching program (EB):**

| | Contents | Nº Classes* |
|---|---|---|
| **Topic 0:** Introduction and basic concepts | Review of basic chemistry concepts and introduction to modern chemical language: stoichiometry, preparation of solutions, … | 1 |
| **Topic 1:** Atomic and molecular structure | Electromagnetic spectrum. Basics of quantum mechanics for the electronic structure of atoms. Quantum numbers and orbitals. Relationship between electronic configuration and chemical properties of the elements. Periodic classification of elements. Periodic properties: atomic radii, ionization energy,electronic affinity and electronegativity. Chemical bond: ionic and covalent bonds. Molecular geometry VSEPR theory. Hybridization of atomic orbitals. Localized and delocalized molecular orbitals. The metal bond. Intermolecular forces and states of matter. | 8 |
| **Topic 2:** Introduction to chemical thermodynamics | First law of thermodynamics and fundamentals of calorimetry. Thermochemistry and Hess' law. Second law of thermodynamics. Entropy, free energy and spontaneous processes. | 3 |
| **Topic 3:** Introduction to chemical kinetics and fundamentals of chemical equilibrium | Chemical reaction rates. Rate laws and reaction order. Activation energy. Factors that affect reaction rates. Catalysis. Equilibrium constants. Factors that affect chemical equilibrium and Le Chatelier's principle. | 5 |
| **Topic 4:** Proton transfer reactions | Concepts of acids and bases. Calculation of pH in aqueous solution. Hydrolysis. Buffer solutions. Amphoteric substances and isoelectric point. Acid-base titrations. | 5 |
| **Topic 5:** Electron transfer reactions | Oxidation-reduction reactions Relation between free energy and electrode potentials. Nernst equation. | 5 |
| **Topic 6:** Reactions in liquid state; metals | Phase changes and phase diagrams. Vapour pressure. Mixtures and principle of distillation. Physical properties of solutions. Precipitation equilibria and solubility. Complex formation. Transition metals. Crystal field theory. Metals in biology | 5 |
| | **TOTAL** | **27** |

*This is a tentative scheme and is intended as a guideline but it will depend on the progress of the class

**"Practices and Development" Sessions (EPD):** They consist of 2-hour problem-solving seminars and 3-hour laboratory sessions. 3 seminars and 4 laboratory sessions are scheduled in the weekly calendar application available through the "Facultad de Ciencias Experimentales" under section horario. Exam dates for non-official exams will also be marked in the calendar, if technically possible. I will intend to keep the information in the weekly calendar up to date throughout the course.

| | Lab session/Seminar | Nº hours |
|---|---|---|
| **Topic 0:** Introduction and fundamental concepts | None associated | |
| **Topic 1:** Atomic and molecular structure | **Laboratory Session 1** *Spectrophotometry* | **3** |
| | **Seminar 1** *Structure* | **2** |
| **Topic 2:** Introduction to chemical thermodynamics | **Laboratory session 2** *Calorimetry* | **3** |
| **Topic 3:** Introduction to chemical kinetics and fundamentals of chemical equilibrium | **Seminar 2** *Thermodynamics, equilibrium and kinetics, Precipitation and proton transfer* | **2** |
| **Topic 4:** Proton transfer reactions | **Laboratory session 3** *Acid-Base titration and buffer solution* | **3** |
| | **Seminar 3** *Proton and electron transfer* | **2** |
| **Topic 5:** Electron transfer reactions | **Laboratory session 4** *Redox titration for vitamin C determination in fruit juice* | **3** |
| | **TOTAL** | **18** |

## 6. METHODOLOGY AND RESOURCES

Classes are of two general types "basic teaching" (EB) and "practices and development" (EPD). The EPD in this course are either 3-hour lab sessions or 2-hour seminars. For more details, a table in the expanded teaching guide will be made available through the virtual platform.

Methodologically, transparencies will be used, seminars, private or small-group tutoring, laboratory sessions, and, if technology allows, use of the virtual platform.

## 7. ASSESSMENT

Up to 15 hours of student time for assessment
1. EPD Exams covering the problem set classes: 3@1 hour (spread throughout the course, usually a week after the EPD class)
2. EPD exam review: 3@20 minutes (throughout the course)
3. Final EB + EPD exam: 3 hours, split into two same-day exams (February Examination Period)
4. Final EB + EPD exam (recovery): 3 hours, split into two same-day exams (July Examination Period)
5. EPD exams (at the beginning of the laboratory sessions): 4@15 minutes
6. EB February Exam Review: 1 hour
7. EPD February Exam Review: 1 hour
8. EB July Exam Review: 1 hour
9. EPD July exam review: 1 hour

Continuous assessment consists in (1) EPD practices and seminars, (2) exams at the beginning of the seminars and (3) an optional work (EV) to be delivered through the virtual platform. Works are due on the date indicated in the Detailed Assessment Table (at the end of this section).
EB examinations, EPD and EV are weighted according to the table. In this way, the student will obtain a total score as shown in Detailed Assessment Table (at the end of this section).
The final grade for the course will be calculated using the following formula:
RAW FINAL GRADE = 0.5 x (EB) + 0.2 ×(LAB EPD)+ 0.1 ×(BEST OF EPD SEMINAR 1 AND EB) + 0.1 ×(BEST OF EPD SEMINAR2 AND EB) + 0.1 ×(BEST OF EPD SEMINAR 3 AND EB)

Regardless of the numerical value obtained in the above formula, the final score that appears in the records shall be subject to the following restrictions:
a) To pass the course you need to get at least 5 out of 10 and **a minimum in each of the parts** specified in the Detailed Assessment Table (at the end of this section).
b) To get a B-grade (**Notable**) in the course you must achieve at least **50% of the maximum grade in the theory exam**.
c) To get an A-grade (**Sobresaliente**) in the course you must achieve at least **70% of the maximum score in the theory exam**.
An optional delivery will be proposed (EV) through the virtual platform. This EV is scored out of 10.

RAW FINAL GRADE= 0.4 ×(EB) + 0.2 ×(LAB EPD)+ 0.1 ×(BEST OF EPD SEMINAR1 AND EB) + 0.1 ×(BEST OF EPD SEMINAR2 AND EB) + 0.1 ×(BEST

OF EPD SEMINAR 3 AND EB) + 0.1 ×(BEST OF EV AND EB)
If plagiarism is detected in the EV, the EV grade will necessarily be included in the final grade calculation with a 10% weight.

Attendance at EPD (Seminars and laboratory) sessions is mandatory in order to pass the course in the continuous evaluation mode. An unjustified absence at a lab session and/or not accepted by your assistant means that you abandon the continuous evaluation mode, and will forcibly switch to the single exam mode.

**Nature of optional work:**

The EV work consists in writing an article on a subject of your choice of up to 3 pages that complies with the format of the journal MoleQla (http://www.upo.es/moleqla). The topic must be related to the course and may be further narrowed by the lecturer. Should the virtual platform forum be available, you will propose the topic or a self-explanatory title of your article in it to avoid overlapping topics. You will deliver your work through an application of the virtual platform that checks automatically for plagiarism. If plagiarism is obvious, the work will entail a negative EV grade of -10 points. Plagiarism is considered a **very serious offense**. The maximum attainable grade in the course would be in this case an 8 out of 10. The finest papers will be selected for publication in the journal. If you do not wish your article to be published, you may specify it at the end of the work itself or communicate your decision at any subsequent time in the editorial process in written form or by e-mail to the lecturer. Obviously, this will neither affect the grade of the work nor the requirements on plagiarism.

**Assessment system for July exams:**
The assessment system of the EBs and lab EPDs in July will be exactly the same as in February. The student will take those modules in which he failed to obtain the minimum grade required to pass the course (see detailed assessment table).

***Detailed assessment table***

| Activity | Minimum grade[1] | Maximum grade[2] | Weighting factor | Assessment duration (hours) | Exam or due date |
|---|---|---|---|---|---|
| EB | 3.0 | 10 | 40-80% | 7 | Official examination dates scheduled by Faculty Board |
| EPD (lab) | 3.0 | 10 | 20% | 4 | Official examination dates scheduled by Faculty Board |
| EPD (seminars) | 0 | 10 | 0-30% | 4 | The week following every seminar |
| EV | - | 10 | 0 or 10% | | Last lecturing week in december |
| **TOTAL** | **5** | **10** | **100%** | 15 | |

[1]Minimum grade for each part to pass the course
[2]Maximum achievable grade for each part

## 8. BIBLIOGRAPHY

The general chemistry textbooks are quite similar to each other. The main differences are the relative importance given to the different parts, the choice of examples and style of the authors.

• P. Atkins and L. Jones. "Chemical Principles - The quest for insight", 3rd ed., W.H. Freeman and Company, 2005
• R. H. Petrucci, W. S. Hardwood and F.G. Herring "General Chemistry", Eighth Edition, Prentice Hall. 2003

Complementary texts

• K. Timberlake, "Chemistry, An Introduction to General, Organic and Biological Chemistry", 10th edition, Pearson, 2011
• K.W. Whitten et al., "General Chemistry", Fifth Edition, McGraw-Hill, 1998

• J. Crowe, T. Bradshaw, "Chemistry for the Biosciences, The essential concepts", 2nd edition, Oxford University Press, 2010
• M. Paraira, "Introducción a la formulación y nomenclatura química inorgánica-orgánica" Vicens-Vives, 1995