



UNIVERSIDAD DE CORDOBA

FACULTAD DE CIENCIAS
GRADO DE BIOQUÍMICA
2024/25 YEAR
**TOXICOLOGÍA MOLECULAR Y
CELULAR**



Course details

Course name: TOXICOLOGÍA MOLECULAR Y CELULAR

Code: 101859

Degree/Master: GRADO DE BIOQUÍMICA

Year: 3

Field: TOXICOLOGÍA MOLECULAR Y CELULAR

Character: OBLIGATORIA

Duration: SECOND TERM

ECTS Credits: 6.0

Classroom hours: 60

Face-to-face classroom percentage: 40.0%

Study hours: 90

Online platform: <https://moodle.uco.es/>

Coordinating teacher

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Brief description of the contents

The objective of this course is to prepare students in the biochemical and cellular aspects of Toxicology, with special emphasis on the Environmental Toxicology and Drug Development.

Prerequisites

Prerequisites established in the study plan

Level B1 of English.

Recommendations

B2 level of English is highly recommended.

Attendance to the practical sessions is compulsory, so students who join the course once the laboratory practice sessions have started will not be admitted.

Study programme

1. Theory contents

1 INTRODUCTION. Xenobiotics: organic compounds (air and working contaminants, food additives, abuse drugs, pesticides, solvents, polycyclic aromatic hydrocarbons), toxins (micotoxins, from plants), inorganic pollutants.

2 BASIC CONCEPTS AND TOXICITY MECHANISMS. Disposition of xenobiotics. Absorption

(membranes structure, ionization, partition coefficient, absorption: mechanisms and pathways (via skin, lungs, digestive tract). Distribution (compartments, barriers, plasma proteins -types, consequences of binding-). Accumulation. Excretion. Effect of xenobiotics in human organs. Hepatic, renal and lung toxicology.

3 OXIDATIVE STRESS. Oxygen biology and oxidative stress. Oxygen chemistry and reactive oxygen species (O_2^- , H_2O_2 , $HO\cdot$, $1O_2$). Reactive nitrogen species. Organic oxygen radicals. Lipid peroxidation. Thiols redox state. Redox cycling, anti-oxidants, antioxidative enzymes.

4 GENETIC TOXICOLOGY. Types of mutations and DNA repair mechanisms. Mutagenic, carcinogenic and teratogenic agents. Assays to determine genetic alterations. General aspects of cancer. Human carcinogens. Teratogenicity.

5 BIOTRANSFORMATION. Biotransformation: effects, microsomes, mixed function oxidases. Phase I reactions. Cytochrome P450 system (components, structure, mechanism, isoenzymes, activities). Flavin monooxygenase and cytochrome b5. Non-microsomal oxidations. Cooxidations. Reduction. Hydrolytic reactions. Phase II reactions: scheme and types (glycosylation, sulfate conjugation, methylation, acetylation, conjugation with amino acids). Glutathione. GSH-transferases (types, structure, reactions, specificity). Glutathion-conjugates fate.

6 MODIFICATIONS OF BIOTRANSFORMATION. Differences between species, strains and individuals. Nutritional and physiological factors. Induction (receptors, ligands). Nuclear hormone receptors (structures, mechanisms). Ah battery (AhR, Arnt, mechanism, physiological inducers). CAR/RXR receptor. PXR receptor (CYP3A substrates/inducers, structure, function). PPARs receptors (microsomal beta-oxidation, peroxisome proliferators, mechanisms). GSTs regulation. Interaction. Inhibition (pesticides and acetylcholinesterase, stages of poisoning, nerve agents). Chronic exposure.

7 ENVIRONMENTAL TOXICOLOGY APPLICATIONS. Bioindicators, biomarkers and their types. Biological effects of metals. Conventional biomarkers. Studies on fish and bivalve from the Andalusian South Atlantic coast. Omics approaches. Aznalcóllar accident. The "Estero de Domingo Rubio". Environmental quality at Doñana National Park and surroundings.

8 CELL TOXICITY. Concept of programmed cell death. Apoptosis, necrosis and autophagy. Apoptosis signaling pathways. Methods for studying in vitro and in vivo cytotoxicity. Drug toxicology. Therapeutic index for drugs. Drugs interactions.

2. Practical contents

The practical contents are divided into **3 sessions of laboratory practice (LP)** and 7 sessions of classroom practice (CP).

Laboratory Practices:

LP1: Evaluation of oxidative stress using conventional biochemical biomarkers.

LP2: Evaluation of the redox state in proteins by electrophoretic separation and fluorescent detection.

LP3: Evaluation of the cytotoxicity of compounds by microbial lethality assays.

Classroom Practices:

The results obtained in the laboratory practices will be analyzed and discussed in CP1, CP2, CP3 y CP4. The results of all the practice sessions will be presented by each student in an individual final report.

In CP5, students will learn how to obtain scientific information to prepare a report or presentation, or they will create, design and elaborate a web page on various case studies related to the subject. To do this, students will be divided into teams of 2-4 people. The final works will be discussed and orally exposed in the corresponding Medium Group evaluation session (CP6).

The last classroom practice (CP7) session will focus on the development of new drugs, including

Regulatory Preclinical trials before approval.

Bibliography

1. Basic bibliography

- Klaassen, C.D., Watkins III, J.B. (2021) Casarett & Doull's Essentials of Toxicology, 4th ed, McGraw Hill.
- Hodgson, E. (2010) A Textbook of Modern Toxicology, 4^a ed, Wiley.
- Timbrell, J.A. (2009) Principles of Biochemical Toxicology, 4^a ed, Informa Healthcare.
- Lu, F.C., Kacew, C. (2009) Lu's Basic Toxicology: Fundamentals, Targets Organs and Risk Assessment. Informa Healthacare.
- Smart, R.C., Hodgson, E. (2018) Molecular and Biochemical Toxicology, 5th ed. Wiley.
- Proudlock, R. (2016) Genetic Toxicology Testing, A Laboratory Manual. Academic Press.

2. Supplementary bibliography

- Newman, M.C. (2009) Fundamentals of Ecotoxicology, 3^a ed, CRC Press
- Repetto Jiménez, M., Repetto Kuhn, G (2009) Toxicología Fundamental, 4^a ed, Diaz de Santos.
- Smart, R.C., Hodgson, E. (2008) Molecular and Biochemical Toxicology, 4^a ed, Wiley.

Methodology

General clarifications on the methodology (optional)

The section "Information processing activities" includes the preparation of reports, web pages, seminars, analysis of documents, discussions, and group work ("Face-to-face Activities" Section), and the students study time ("Off-site Activities" Section).

Methodological adaptations for part-time students and students with disabilities and special educational needs

Adaptations of the teaching methodology for **part-time students** will be made according to the rules of the University and based on the characteristics of each individual case. In any case, the student's attendance will be facilitated to the group that best suits their needs.

The methodological strategies and evaluation system contemplated in this Teaching Guide will be adapted according to the needs presented by **students with disabilities and special educational needs** in the cases that are required. Thus, the teacher will meet with the affected students to establish the most appropriate adaptations for each particular case, following the indications of the report issued by the Inclusive Education Unit.

Face-to-face activities

Activity	Large group	Medium group	Total
<i>Assessment activities</i>	3	6	9
<i>Information processing activities</i>	-	12	12

Activity	Large group	Medium group	Total
<i>Practical experimentation activities</i>	-	9	9
<i>Projects based on the course contents</i>	30	-	30
Total hours:	33	27	60

Off-site activities

Activity	Total
<i>Exercise and problem solving activities</i>	15
<i>Information processing activities</i>	55
<i>Information search activities</i>	20
Total hours	90

Results of the training and learning process

Knowledge, competencies and skills

- CB1 Ability to reason critically and self critically.
- CB4 Having the ability to work and study independently.
- CB6 To know how to recognise and analyse a problem, identifying its main characteristics, and design a scientific resolve.
- CB7 TO know how to use basic computing tools to communicate, find information and processing data in a professional setting.
- CB8 To know how to read scientific texts in English.
- CE3 To understand the basic principles of molecular structure and chemical reactions of simple biomolecules.
- CE5 To understand the chemical and thermodynamic principles of molecular recognition and biocatalysis, as well as the role of enzymes and other proteins in determining the functions of cells and organisms.
- CE7 To understand the structure, organisation, expression, regulation and evolution of genes in living organisms, as well as the molecular background of genetic and epigenetic variations among individuals.
- CE8 To understand the biochemical and molecular bases of folding, post translational modification, intercellular trafficking, sub-cellular localisation and turnover of cell proteins.
- CE9 To understand the main physiological processes of multicell organisms as well as understanding the molecular bases of them.
- CE10 To understand the essential aspects of metabolic processes and their control, and to have a well rounded view of the regulations and adaptations of a metabolism in different physiological states.
- CE11 To have a well rounded view of cellular operations (including the metabolism and gene expression) regarding their regulation and relationships with different parts

of cells.

- CE12 To have an well rounded view of intercellular communication systems and intercellular signaling which standardise proliferation, differentiation, development and the function of tissues and organs in order to understand the complexity of the interactions.
- CE24 To have the mathematical, statistical, and computing skills to obtain, analyse and interpret data. In order to understand simple models of biological systems and processes on cell and molecular levels
- CE25 To know how to search for, and find and interpret information from the main biological databases (genomic, transcriptomic, proteomic, metabolomic, and similar derivatives from other forms of bulk analysis.) and bibliographic data and to use the bi tools.
- CE28 The ability to communicate information relating to Biochemistry and Molecular Biology, including planning, writing and presenting a scientific report.

Assessment methods and instruments

Intended learning outcomes	Examination	Means of practical execution	Oral means	Students assignments
CB1	X		X	X
CB4	X	X	X	X
CB6			X	X
CB7			X	X
CB8	X	X	X	X
CE10	X	X		
CE11	X	X		
CE12	X	X		
CE24	X	X	X	X
CE25	X	X	X	X
CE28	X	X	X	X
CE3	X	X		
CE5		X		
CE7		X		
CE8	X	X		
CE9	X	X		
Total (100%)	55%	15%	15%	15%
Minimum grade (*)	5	5	5	5

(*)Minimum mark (out of 10) needed for the assessment tool to be weighted in the course final mark. In any case, final mark must be 5.0 or higher to pass the

course.

General clarifications on instruments for evaluation:

Attendance to the Practical Sessions is mandatory.

To pass a student must achieve 50 POINTS OUT OF 100.

The final grade will be composed of the following items:

- **Final Exam** (up to 55 points).

- **Evaluation of the Practical Sessions** (up to 30 points). These will be evaluated by means of the elaboration and discussion of the individual reports of laboratory practices elaborated by the students ("Students assignments"), which will account for up to 15 points. The use of "Oral means" will be used to evaluate practical cases through the design of a web page, presentations or seminars, and this evaluation instrument will account for the remaining 15 points. remaining.

- **The Participation in the Theory Classes and the Answers to Short Questions**, instruments included under the heading "Theory Classes". included under the heading "Means of practical execution", will account for up to 15 points.

The partial grades of the continuous evaluation instruments (evaluation of the Practical Sessions and Class Participation-Answers to Short Questions) will be maintained for one academic year.

Repeating students will keep the grade obtained in the Practical Sessions, so they will not have to retake this evaluation instrument.

Teachers may decide to examine certain students exclusively orally, and may even conduct a second oral examination to confirm the results of the written examinations, when there are reasonable suspicions of fraud.

Clarifications on the methodology for part-time students and students with disabilities and special educational needs:

Adaptations of the evaluation for **part time students** will be made according to the rules of the University and based on the characteristics of each individual case. In any case, the student's attendance will be facilitated to the group that best suits their needs.

The methodological strategies and the evaluation system contemplated in this Teaching Guide will be adapted according to the needs presented by **students with disabilities and special educational needs** in the cases that are required. Thus, the teacher will meet with the affected students to establish the most appropriate adaptations for each particular case, following the indications of the report issued by the Inclusive Education Unit.

Clarifications on the evaluation of the extraordinary call and extra-ordinary call for completion studies:

The grades obtained by the student in the continuous evaluation tests specifically included in the teaching guide of the previous academic year will be respected.

Qualifying criteria for obtaining honors:

According to article 80.3 of the Academic Regime Regulation.

Sustainable development goals

Good health and well-being
Quality education
Clean water and sanitation
Affordable and clean energy
Industry, innovation and infrastructure
Sustainable cities and communities
Responsible consumption and production
Climate action
Life below water
Life on land

Other Faculty

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The methodological strategies and the evaluation system contemplated in this Teaching Guide will respond to the principles of equality and non-discrimination and must be adapted according to the needs presented by students with disabilities and special educational needs in the cases that are required. Students must be informed of the risks and measures that affect them, especially those that may have serious or very serious consequences (article 6 of the Safety, Health and Welfare Policy; BOUCO 23-02-23).
