

## COURSE DESCRIPTION

### COURSE DETAILS

Title (of the course): **TOXICOLOGÍA MOLECULAR Y CELULAR**

Code: 101859

Degree/Master: **GRADO DE BIOQUÍMICA**

Year: 3

Name of the module to which it belongs: INTEGRACIÓN FISIOLÓGICA Y APLICACIONES DE LA BIOQUÍMICA Y BIOLOGÍA

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: <http://www3.uco.es/moodlemap/>

### LECTURER INFORMATION

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## COURSE DESCRIPTION

### PREREQUISITES AND RECOMMENDATIONS

#### Prerequisites established in the study plan

Level B1 of English.

#### Recommendations

B2 level of English is highly recommended.

### INTENDED LEARNING OUTCOMES

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.

### OBJECTIVES

To prepare the student in the biochemical and cellular aspects of Toxicology, with special emphasis on the Environmental Toxicology and Drug Development



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### CONTENT

#### 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). Glutathione-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.



## COURSE DESCRIPTION

### SUSTAINABLE DEVELOPMENT GOALS RELATED TO THE CONTENT

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

### METHODOLOGY

#### General clarifications on the methodology (optional)

Case study includes preparation of reports, web page, seminars and presentations, analysis of documents, discussions and team-work.

#### 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.

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.

#### Face-to-face activities

Activity	Large group	Medium group	Total
<i>Assessment activities</i>	3	6	9
<i>Case study</i>	-	12	12
<i>Lab practice</i>	-	9	9
<i>Lectures</i>	30	-	30
<b>Total hours:</b>	<b>33</b>	<b>27</b>	<b>60</b>

#### Off-site activities

Activity	Total
<i>Exercises</i>	10
<i>Group work</i>	15

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Activity	Total
Information search	5
Reference search	5
Self-study	55
<b>Total hours</b>	<b>90</b>

## WORK MATERIALS FOR STUDENTS

Case studies - <http://www3.uco.es/moodlemap/>

Coursebook - <http://www3.uco.es/moodlemap/>

Oral presentations - <http://www3.uco.es/moodlemap/>

Placement booklet - <http://www3.uco.es/moodlemap/>

References - <http://www3.uco.es/moodlemap/>

## EVALUATION

Intended learning	Exams	Placement reports	Real and/or simulated tasks
CB1	X	X	
CB4	X	X	X
CB6		X	
CB7		X	
CB8	X	X	X
CE10	X	X	X
CE11	X	X	X
CE12	X	X	X
CE24	X	X	X
CE25	X	X	X
CE28	X	X	X
CE3	X	X	X
CE5		X	X
CE7		X	X
CE8	X	X	X
CE9	X	X	X
<b>Total (100%)</b>	<b>55%</b>	<b>30%</b>	<b>15%</b>
<b>Minimum grade</b>	<b>5</b>	<b>5</b>	<b>5</b>



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(\*)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.

### Attendance will be assessed?:

No

### General clarifications on instruments for evaluation:

Attendance at practice sessions is mandatory. The course has no other compulsory attendance activities.

To pass the course a student must achieve 50 points out of 100. The final grade will consist of the following addends:

-Final exam: up to 55 points

-Evaluation of practice sessions. Elaboration and discussion of reports, web page, seminars and presentations: up to 30 points.

-Attendance to the lectures and participation, and responses to short questions: up to 15 points.

The partial grades of the continuous evaluation instruments (evaluation of the practical sessions and answers to short questions) will be kept for one academic year.

For repeating students, the evaluation will be carried out in the same way as for newly enrolled students. This means that they have to repeat the subject with all their activities.

Teachers may decide to examine certain students exclusively orally and even take a second oral exam to confirm the results of the written exams, when there are well-founded 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.

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.

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

Those grades obtained by the student in the continuous evaluation tests that appear specifically in the teaching guide of the previous academic year will be kept.

### Qualifying criteria for obtaining honors:

According to article 80.3 of the Academic Regime Regulation.

## 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<sup>a</sup> ed, Wiley.
- Timbrell, J.A. (2009) Principles of Biochemical Toxicology, 4<sup>a</sup> 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 Tociology Testing, A Laboratory Manual. Academic Press.

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### 2. Further reading

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

## COORDINATION CRITERIA

Tasks performance

### Clarifications

The contents of the subject MOLECULAR AND CELLULAR TOXICOLOGY have been coordinated with those of the subjects of FUNDAMENTALS OF BIOCHEMISTRY and FUNDAMENTALS OF GENETICS of the first year of the Degree of Biochemistry, and with the subject of ENVIRONMENTAL BIOCHEMISTRY AND BIOTECHNOLOGY of the third year of the Degree.

## SCHEDULE

Period	Assessment activities	Case study	Lab practice	Lectures
1# Fortnight	0,0	0,0	3,0	4,0
2# Fortnight	0,0	2,0	3,0	4,0
3# Fortnight	0,0	2,0	3,0	4,0
4# Fortnight	3,0	2,0	0,0	4,0
5# Fortnight	0,0	3,0	0,0	4,0
6# Fortnight	0,0	0,0	0,0	4,0
7# Fortnight	3,0	0,0	0,0	3,0
8# Fortnight	3,0	3,0	0,0	3,0
<b>Total hours:</b>	<b>9,0</b>	<b>12,0</b>	<b>9,0</b>	<b>30,0</b>

The methodological strategies and the evaluation system contemplated in this Course Description will be adapted according to the needs presented by students with disabilities and special educational needs in the cases that are required.

## CONTINGENCY PLAN: CASE SCENARIO A

Case scenario A will correspond to a diminished on-site academic activity due to social distancing measures affecting the permitted capacity of classrooms.



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### METHODOLOGY

#### General clarifications on the methodology on case scenario A

A multimodal (hybrid) teaching system will be adopted, combining both on-site and remote classes via videoconference (synchronous) that will be held in the timetable approved by the corresponding Faculty or School. The time distribution of teaching activities (both on-site and remote) will be decided by the aforementioned Faculties and Schools bearing in mind the permitted capacity of classrooms and social distancing measures as established at that time.

Case study includes preparation of reports, web page, seminars and presentations, analysis of documents, discussions and team-work.

### EVALUATION

Intended learnig	Exams	Placement reports	Real and/or simulated tasks
CB1	X	X	
CB4	X	X	X
CB6		X	
CB7		X	
CB8	X	X	X
CE10	X	X	X
CE11	X	X	X
CE12	X	X	X
CE24	X	X	X
CE25	X	X	X
CE28	X	X	X
CE3	X	X	X
CE5		X	X
CE7		X	X
CE8	X	X	X
CE9	X	X	X
<b>Total (100%)</b>	<b>55%</b>	<b>30%</b>	<b>15%</b>
<b>Minimum grade</b>	<b>4</b>	<b>4</b>	<b>4</b>

(\*)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.



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### Attendance will be assessed (Scenario A)?:

No

### General clarifications on instruments for evaluation (Scenario A):

Attendance at practice sessions is mandatory. The course has no other compulsory attendance activities.

To pass the course a student must achieve 50 points out of 100. The final grade will consist of the following addends:

-Final exam: up to 55 points

-Evaluation of practice sessions. Elaboration and discussion of reports, web page, seminars and presentations: up to 30 points.

-Attendance to the lectures and participation, and responses to short questions: up to 15 points.

The partial grades of the continuous evaluation instruments (evaluation of the practical sessions and answers to short questions) will be kept for one academic year.

For repeating students, the evaluation will be carried out in the same way as for newly enrolled students. This means that they have to repeat the subject with all their activities.

Teachers may decide to examine certain students exclusively orally and even take a second oral exam to confirm the results of the written exams, when there are well-founded suspicions of fraud.

### Clarifications on the methodology for part-time students and students with disabilities and special educational needs (Scenario A):

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.

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.

## CONTINGENCY PLAN: CASE SCENARIO B

Case scenario B will bring about a suspension of all on-site academic activities as a consequence of health measures.

## METHODOLOGY

### General clarifications on the methodology on case scenario B

On-site teaching activities will be held via videoconference (synchronous) in the timetable approved by the corresponding Faculty or School. Alternative activities will be proposed for reduced groups in order to guarantee the acquisition of course competences.

Case study includes preparation of reports, web page, seminars and presentations, analysis of documents, discussions and team-work.

## COURSE DESCRIPTION

## EVALUATION

Intended learnig	Exams	Laboratory Practice	Real and/or simulated tasks
CB1	X	X	
CB4	X	X	X
CB6		X	
CB7		X	
CB8	X	X	X
CE10	X	X	X
CE11	X	X	X
CE12	X	X	X
CE24	X	X	X
CE25	X	X	X
CE28	X	X	X
CE3	X	X	X
CE5		X	X
CE7		X	X
CE8	X	X	X
CE9	X	X	X
<b>Total (100%)</b>	<b>55%</b>	<b>30%</b>	<b>15%</b>
<b>Minimum grade</b>	<b>4</b>	<b>4</b>	<b>4</b>

(\*)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.

Moodle Tools	Exams	Laboratory Practice	Real and/or simulated tasks
Attendance		X	
Group selection		X	
Participation		X	X
Questionnaire			X
Synchronous tests via videoconference	X		X
Task		X	

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Moodle Tools	Exams	Laboratory Practice	Real and/or simulated tasks
Videoconference	X	X	X
Workshops		X	

### Attendance will be assessed (Scenario B)?:

No

### General clarifications on instruments for evaluation (Scenario B):

Attendance at practice sessions is mandatory. The course has no other compulsory attendance activities.

To pass the course a student must achieve 50 points out of 100. The final grade will consist of the following addends:

- Final exam: up to 55 points
- Evaluation of practice sessions. Elaboration and discussion of reports, web page, seminars and presentations: up to 30 points.
- Attendance to the lectures and participation, and responses to short questions: up to 15 points.

The partial grades of the continuous evaluation instruments (evaluation of the practical sessions and answers to short questions) will be kept for one academic year.

For repeating students, the evaluation will be carried out in the same way as for newly enrolled students. This means that they have to repeat the subject with all their activities.

Teachers may decide to examine certain students exclusively orally and even take a second oral exam to confirm the results of the written exams, when there are well-founded suspicions of fraud.

### Clarifications on the methodology for part-time students and students with disabilities and special educational needs (Scenario B):

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.

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.