

Toxicology

Code: 102796
ECTS Credits: 6

Degree	Type	Year	Semester
2501915 Environmental Sciences	OT	4	0

Contact

Name: Raimon Guitart Bas
Email: Raimon.Guitart@uab.cat

Use of languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Mercè Llugany Ollé
Núria Giménez Gómez

Prerequisites

It is advisable to have a good knowledge of Physics, Chemistry, Mathematics, Biology (Biochemistry, Physiology and Genetics) and Ecology. A good level of English and a critical reading ability of toxicological information (especially books and review articles) are also recommended.

Objectives and Contextualisation

Toxicology is an optional subject of the degree of Environmental Sciences. Its aim is to provide the basis of what Toxicology is today, introducing first the more basic concepts and definitions (Experimental Toxicology, Analytical Toxicology, Regulatory Toxicology ...) and then followed by the most specific study of selected chemical or physical agents. Special emphasis is put on Environmental Toxicology and Ecotoxicology, and in particular the impact of the main pollutants and poisons in animals (including humans) and in plants.

Skills

- Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
- Analyze and use information critically.
- Collect, analyze and represent data and observations, both qualitative and quantitative, using secure adequate classroom, field and laboratory techniques
- Demonstrate adequate knowledge and use the most relevant environmental tools and concepts of biology, geology, chemistry, physics and chemical engineering.
- Demonstrate concern for quality and praxis.
- Demonstrate initiative and adapt to new situations and problems.
- Learn and apply in practice the knowledge acquired and to solve problems.
- Quickly apply the knowledge and skills in the various fields involved in environmental issues, providing innovative proposals.

- Teaming developing personal values regarding social skills and teamwork.
- Work autonomously

Learning outcomes

1. Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
2. Analyze and use information critically.
3. Demonstrate concern for quality and praxis.
4. Demonstrate initiative and adapt to new situations and problems.
5. Describe the basics of plant and animal toxicology.
6. Describe, analyze and evaluate the environment.
7. Diagnose and solve environmental problems concerning the biological environment.
8. Identify organisms and biological processes in the surrounding environment and evaluate them properly and originally.
9. Identifying and using bioindicators.
10. Interpret the vegetation.
11. Learn and apply in practice the knowledge acquired and to solve problems.
12. Mostrear, characterize and manipulate specimens, populations and communities.
13. Observe, recognize, analyze, measure and properly and safely represent organisms and biological processes.
14. Participate in environmental assessments as to the biological environment.
15. Teaming developing personal values regarding social skills and teamwork.
16. Work autonomously

Content

THEORY

SECTION A: GENERAL TOXICOLOGY

UNIT 1.- INTRODUCTION TO HUMAN AND ANIMAL TOXICOLOGY. Definition and current concept of Toxicology. Everything is a poison, nothing is a poison. Origin and historical evolution of Toxicology: Paracelsus and Orfila. Toxic disasters Basic toxicological terminology. Genotoxic agents. Carcinogenesis. Teratogenesis. Toxicology branches: medical, analytical, experimental, environmental and regulatory. Classification of poisons.

UNIT 2.- EXPERIMENTAL TOXICOLOGY. General principles Calculations in Toxicology. Evaluation of toxicity. QSAR and retrospective studies. Tests of acute, prolonged and chronic toxicity. Animals of experimentation. GLP and GMP. Special tests: reproduction, teratogeny, mutagenicity, carcinogenesis. Toxicity *in vitro*. Security factors. Lethal dose and lethal concentration. Pictograms. Declarations of hazard and of precaution. NOEL and NOAEL, NOEC and NOAEC. ADI and TLV. PEC and PNEC.

UNIT 3.- TOXICOKINETICS AND METABOLISM. General introduction. Routes of exposure and absorption. Distribution. Metabolism of xenobiotics. Lethal synthesis (bioactivation). Elimination. Concept of biological half-life.

UNIT 4.- ENVIRONMENTAL TOXICOLOGY AND ECOTOXICOLOGY. General concepts Environmental Toxicology and Ecotoxicology. Living beings and pollution. Trophic webs. Sentinel species. Biomarkers in Environmental Toxicology. Environmental stress. Bioaccumulation, bioconcentration and biomagnification. The case of p, p'-DDT. Rachel Carson and Silent Spring. Lead poisoning in aquatic birds and birds of prey. Marine oil spills and impact on birds.

UNIT 5.- POISONING DIAGNOSIS. Common causes of poisoning. Toxicoepidemiological data. Diagnostic protocol. Clinical history. Symptoms and clinical signs. Post-mortem exams. Analytical toxicology. The Anti-Poison centers. The Antidote project. The National Institute of Toxicology.

UNIT 6.- MEDICAL TOXICOLOGY. General guidelines for treating a poisoned patient. Removal of the source of poisons. Measures to prevent the further absorption of poisons. Symptomatic treatment. Antidote treatment. Introduction to antidotes. Classification of antidotes. Main mechanisms of action of antidotes.

UNIT 7.- INTRODUCTION TO PLANT TOXICOLOGY. Particularities of the way of life of plants and its consequences. Concept of plant toxicology. Concentration-effect relationships. Input tracks and mechanisms for transporting xenobiotic substances into plants. General mechanisms of toxicity; senescence and death. Reactive oxygen species.

SECTION B: POISONOUS AGENTS (ANIMALS)

UNIT 8.- TOXIC GASES. Simple asphyxiating gases. CFC. Fluorine Chlorine Hydrogen sulphide Carbon monoxide. Carbon dioxide. Oxides of nitrogen and sulfur. Ammonia Cyanhydric acid and cyanide. Acids and bases.

UNIT 9.- NON METALS AND METALS. Fluorides. White phosphorus. Trivalent arsenic Aluminum and acid waters. Cadmium and Itai-Itai syndrome. Tributyltin. Mercuri. Methylmercury and Minamata. Thallium. Lead. Tetraethyl lead.

UNIT 10.- IONIZING RADIATIONS. Introduction. X-ray and gamma rays. Alpha and beta rays. Radon. Chernobyl and Fukushima. A- and H-bombs. Strontium-90, cesium-137 and iodine-131.

UNIT 11.- PESTICIDES. Introduction to the world of pesticides. Fungicides: derivatives of dithiocarbamic acid, pentachlorophenol and other chlorophenols, hexachlorobenzene. Insecticides: pyrethrins and pyrethroids, organochlorine insecticides, organophosphorus and carbamate insecticides. Delayed neurotoxicity (OPIDN). Rodenticides: strychnine; warfarin and other anticoagulants.

UNIT 12.- MISCELLANEOUS POISONS. Heterocyclic aromatic amines. Methanol. Ethylene glycol. VOCs. Polychlorinated and polybrominated biphenyls. Dibenzo-*p*-dioxins and polychlorinated dibenzofurans. Polybrominated diphenylethers. TEF and TEQ. Detergents. Non-steroidal anti-inflammatory drugs: diclofenac and vultures.

SECTION C: TOXIC AGENTS (PLANTS)

UNIT 13.- TOXIC CHEMICAL AGENTS. Phytotoxicity by heavy metals and metalloids. Physiological effects of overfertilization. Herbicides. Atmospheric pollutants. Particles: cement, industrial dust. Gases: SO₂, NO_x, O₃, PAN. Acid rain. Contamination in aquatic plants; eutrophication and detergents.

UNIT 14.- BIOLOGICAL TOXIC AGENTS. Toxic-producing bacteria. Botulism. Algal blooms. Mycotoxins and mycotoxicosis. Poisonous mushrooms. Introduction to the toxins of the Plant Kingdom. Toxins of insects and arachnids. Mollusk and fish toxins.

UNIT 15.- PRACTICAL APPLICATIONS OF PLANTS. Bioindicators. Development and use of tolerant plants Toxicity tests. Phytoremediation.

LABORATORY PRACTICES

(part human and animal toxicology)

One session of 4 h

1. Determination by spectrophotometric techniques of the brain acetylcholinesterase activity.
2. Preparation (clean-up) of biological samples for the analysis of POP pesticides and POP industrial type PCB by means of chromatography of gases.

(part plant toxicology)

Four sessions of 4 h

1. Visualization of toxicity by chemical agents through vital staining.
2. Phytotoxicity test by root elongation in *Zea mays*.
3. Study of the effects of UV radiation of high and low intensity in the contents of liposoluble pigments.
4. Determination of nitrogen over-fertilization.

5. Study of the allelopathic effect of an essential oil on germination by bioassay.
6. Action of the herbicides: determination of proteins.

Methodology

Theory lectures: The teacher will explain much of the content of the syllabus with the support of visual material that will be available at the Moodle/Virtual Campus (CV) of the subject in advance. To be able to follow correctly the explanations, the students have to bring this material to class like script. These sessions will deal with the main parts of the subject, which will have to be expanded and confronted with autonomous work by the students. The teacher will indicate what topics are to study in this deeper way and the teaching material that will need to be used, that basically will consist of books and review papers. The active participation of all students during the resolution / discussion of issues / situations / problems / cases that may arise will be encouraged.

Laboratory practices: Practical sessions for the observation and execution of procedures, methodologies and techniques used in the study of poisons. Group work and active self-learning is promoted.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Laboratory work	20	0.8	11, 4, 3, 7, 12, 15
Lectures	30	1.2	11, 4, 5, 6, 7, 8, 9, 10, 13, 16
Type: Supervised			
Tutorials	2	0.08	2, 11, 4, 7, 15
Type: Autonomous			
Individual work	69.5	2.78	4, 5, 6, 7, 9, 10, 14, 1, 16
Preparation and elaboration of a scientifically written work	25	1	2, 11, 4, 3, 5, 6, 8, 9, 14, 1, 16, 15
Studying and exercises solving	2	0.08	4, 5, 6, 7, 9, 14, 16

Evaluation

The competences of this subject will be evaluated by:

- a) A first mid-term partial exam, where units 1-6 and 8-12 of theory will be evaluated. The exam will consist of 75 questions V/F, and 45 minutes of time to do it (the speed of answering is also assessed). Weight of the note on the final total: 40 %.
- b) A second partial exam at the end of the course, where units 7 and 13-15 of theory will be evaluated with approximately 45 questions V/F, plus about 10-15 of the practices, and about 15-20 referring to the student's scientific works (works that will be uploaded at the Virtual Campus), with a total of 75 questions and 45 minutes of time to do it. Weight of the note on the final total: 40 %.
- c) Preparation of a scientific poster, a written summary of $\approx 1,000$ words (references not included) and 10 questions V/F about it that will be prepared in groups of two students (if the number of students enrolled is equal to or less than 14) or in groups of three or more students (if those enrolled are more than 14) throughout the semester, on a toxicological topic, and that should be sent before the end of the course. During the preparation of this work, there will be individual or group tutorials, face-to-face or virtual, the objective will be to resolve doubts and guide their preparation. The schedules of the tutorials will be specified opportunely with the professors. Weight of the note on the final total: 20 % (10 % put by the teacher on the quality of work, collective

note to the members of each group, unless some of them state that not all members have done a job comparable and there has not been a good capacity to collaborate as a team, 10 % from the notes that you will put to the work of your colleagues, according to a system that will be specified in a timely manner).

A student will be considered as "failing grade" when the final results of the evaluation activities carried out does not allow him/her to reach a global grade equal to or greater than 5.00. When the student does not show up for any of the evaluation activities, this will score as zero (0.00). It will only be considered as final "non-evaluable" in the case that the student does not appear in two or more evaluations. In this subject a final second chance exam will be carried out, with the requirement that it is needed to have attended all the lab practices and have approved the work (poster + summary + questions). This exam is only for failing grade students, and can not be used to improve a grade that is equal to or greater than 5.00. This second chance exam will be on the whole of the subject (not based on partial), and will consist of 80 questions V/F (about 40 of the part of Animal Toxicology, about 25 of the Plant Toxicology and about 15 of practices and works), with 48 minutes to do it. The final grade will be the result of the weighted average of this exam (80 %) and of the work (20 %).

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Elaboration and writing scientific work	20	0.75	0.03	2, 11, 5, 6, 7, 8, 9, 12, 16
First partial test	40	0	0	2, 11, 4, 3, 6, 7, 8, 9, 13, 14, 1, 15
Second partial test	40	0.75	0.03	2, 11, 4, 5, 6, 7, 10, 12, 16

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