

FOOD TOXICOLOGY

Human Nutrition and Dietary Sciences (2026/27)

Code: 803985

Type: Core subject

Year: Second course

Semester: First

Department: Pharmacology and Toxicology

Credits: 6 ECTS

Teaching Staff

Responsible for the course: Del Pino Sans, Javier (E-mail: jdelpino@pdi.ucm.es)

Moyano-Cires Ivanoff, Paula (E-mail: pmoyanocires@ucm.es)

Martínez Caballero, María Aránzazu (C.U.)

Sánchez-Fortún Rodríguez, Sebastián (C.U.)

Ares Lomban, Irma (T.U.)

Ramos Alonso, Eva (T.U.)

Romero Martínez, Alejandro (T.U.)

Moyano-Cires Ivanoff, Paula (P.P.L.)

D'ors de Blas, Ana (P.A.D.)

García Lobo, Jimena (P.A.D.)

García Sánchez, José Manuel (P.A.D.)

Sola Vendrell, Emma (P.A.D.)

Martínez Caballero, Marta (P.A. Tiempo Parcial 4 +4 h.)

Pro González, Francisco Javier (P.A. Tiempo Parcial 4 +4 h.)

COMPETENCIES

Competencies corresponding to the module and subject matter to which this subject belongs.

GENERAL COMPETENCIES

CG.1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.3, 3.4, 4.2, 5.4, 6.1, 6.2, 7.1, 7.2, 7.3, 7.4 y 8.1.

COMPETENCIAS ESPECÍFICAS

CE.M1.1, 1.5, 1.7, 2.5, 3.8, 4.22, y 5.5.

COMPETENCIES

- Manage the concepts related to Food Toxicology.
- Knowledge of the different types of food contaminants and/or residues with the highest incidence, knowing and interpreting their mechanisms of toxic action, their pathophysiology, understanding how to define the magnitude of the risk they present in certain conditions, and knowing the symptoms and treatments of their poisoning.
- Learn to design experimental protocols and interpret the results of animal toxicity tests to ensure food's short and long-term safety.

- Know and prevent the risks associated with toxins and their residues present in food.
- Know how to analyze the safety standards or parameters for the toxicological evaluation of contaminants and their residues in food products.

OBJETIVES

General Objectives

The Teaching of "Food Toxicology" will be addressed in our Program with content directed toward the knowledge of

basic, experimental, and applied Toxicology covering two fundamental parts:

- **Part A: General Toxicology Principles applicable to food toxins.** It consists of 13 topics. This part of the course tries to achieve the objectives: to give students information about the historical evolution of Toxicology and the current state of Food Toxicology, to define, identify, and distinguish the processes of absorption, distribution, metabolism, and excretion of xenobiotic substances, the mechanisms of toxic action, the main manifestations of toxic effects, the etiology of poisonings and their treatment, as well as the identification and assessment of the different basic toxicological bioassays for risk analysis of xenobiotic substances or compounds present in the food.
- **Part B: Contaminants and food additives.** It consists of 17 topics covering: Toxicology of endogenous toxins derived from higher plants and fungi, the Toxicology of food contaminants, Seafood toxins, mycotoxins, bacterial toxins, and other bacterial contaminants, the Toxicology of contaminants from technological processes, Toxicology of metals and metalloids, Toxicology of pesticides/biocides, and of medicines present in foods of animal origin, Toxicology of food additives, flavorings, processing aids and contaminating materials in the food chain. This part of the course aims to achieve the following objectives: to give students knowledge of the nature and properties of toxic substances in food, to analyze the different types of food contaminants with the highest incidence in food crises, to define and interpret their mechanisms of toxic action, their pathophysiology, define the magnitude of the risk they present in certain conditions, provide knowledge of the symptoms and treatments of their poisoning as well as their possible prevention, define tolerance limits or maximum residue limits and provide the bases and regulations for the toxicological evaluation of contaminants and their residues in food products.

PROGRAM

THEORETICAL PROGRAM

Lesson 1. Concept and historical evolution of Toxicology. Toxicology subsections. Food and nutritional toxicology concept. Food safety and regulatory requirements.

Lesson 2. General etiology of poisoning. Symptoms and diagnosis. General treatment of poisoning.

Lesson 3. Toxicity criteria. Nomenclature and units in Toxicology. Units in the estimation of acceptable exposure levels for humans. Food contaminant monitoring programs. Risk indices used in epidemiology.

Lesson 4. Toxicokinetics. LADME processes. Absorption, distribution, and elimination of toxins. Compartmental analysis. Kinetic parameters involved in Toxicology.

Lesson 5. Biotransformation of toxins. Phase I reactions. Families of cytochrome P450 and toxicological aspects.

Lesson 6. Biotransformation of toxins. Phase II reactions. Enzymes that catalyze Phase II reactions. Factors that affect the biotransformation of toxins.

Lesson 7. Role of the intestinal microflora or microbiota in the toxicity of chemical compounds. Interactions of metal and N-nitroso compounds with the intestinal microbiota and their toxicological implications.

Lesson 8. Toxicodynamics. Toxic action mechanisms. Main manifestations of toxic effects. Cytotoxicity: mechanisms of cell death.

Lesson 9. Safety assessment, risk analysis, and regulation of chemical substances in food. Toxicity bioassays and types of substances or food products.

Lesson 10. Mutagenesis and carcinogenesis tests. Interpretation of results.

Lesson 11. Toxicity tests on reproduction and development. Embryotoxicity and fetotoxicity. Interpretation of results.

Lesson 12. Immunotoxicity. Allergy and sensitivity reactions to food components.

Lesson 13. Special toxicity tests. Hepatotoxicity. Nephrotoxicity. Hematotoxicity. Neurotoxicity.

Lesson 14. Toxicology of nutrients. Impact of nutrient concentration on health. Interactions between nutrients and toxic compounds. Toxic effects on nutrition.

Lesson 15. Toxicology of harmful natural substances in foods derived from higher plants. Cyanogenic glycosides. Psychoactive substances. Higher fungi. Pathophysiology. Clinical symptoms. Diagnosis. Treatment.

Lesson 16. Toxicology of cholinesterase inhibitors. Solanine. Bean glycosides. Tannins, cycasin, terpenes, and others. Lathrogenic. Pathophysiology. Clinical symptoms. Diagnosis. Treatment.

Lesson 17. Toxicology of nitrate, nitrite, and N-nitroso compounds. Oxalates. Xanthines and tyramine producers. Alkaloids. Pathophysiology. Clinical symptoms. Diagnosis. Treatment.

Lesson 18. Toxicology of harmful natural substances in seafood. Toxins from shellfish. Neurotoxins. Saxitoxin and other related toxins. Toxins present in fish. Tetrodotoxin. Ciguatoxin. Pathophysiology. Clinical symptoms. Diagnosis. Treatment.

Lesson 19. Mycotoxins in food. Mycotoxicosis. Aflatoxicosis. Fusariosis. Ochratoxicosis. Clavatoxicosis. Other mycotoxicoses. Pathophysiology. Clinical symptoms. Diagnosis. Treatment. Residues in food. Food safety parameters.

Lesson 20. Bacterial toxins in food. Toxiinfections by Salmonella, Escherichia coli, Vibrio parahaemolyticus, and other bacteria. Intoxications by Staphylococcus aureus, Bacillus cereus, Clostridium perfringens and Clostridium botulinum. Pathophysiology. Clinical symptoms. Diagnosis. Treatment.

Lesson 21. Toxicology of harmful substances resulting from technological processes. Aromatic, aliphatic, and halogenated hydrocarbons. Pathophysiology. Clinical symptoms. Diagnosis. Treatment. Plastic and non-plastic food contact materials. Risks and requirements in terms of toxicity and safety assessment.

Lesson 22. Toxicity by non-essential metals in food. Toxicology of mercury, lead, and cadmium. Toxicology of arsenic, aluminum, thallium, chromium, and others. Pathophysiology. Clinical symptoms. Diagnosis. Treatment. Residues in food. Food safety parameters.

Lesson 23. Toxicology of pesticides/biocides. Toxicology of organochlorine, organophosphate, carbamate, and pyrethroid insecticides. Pathophysiology. Clinical symptoms. Diagnosis. Treatment. Residues in food. Food safety parameters.

Lesson 24. Toxicology of herbicides and fungicides. Pathophysiology. Clinical symptoms. Diagnosis. Treatment. Residues in food. Food safety parameters.

Lesson 25. Toxicology of growth-promoting agents in animals for consumption. Beta-agonist compounds, steroid and peptide hormones, and antimicrobial additives. Cross-resistance to antimicrobials used in human therapeutics. Food fraud.

Lesson 26. Toxicology of food additives. Use of food additives in relation to their safety. Antioxidants, colorings, emulsifiers, flavorings, preservatives, sweeteners, and acidity regulators. Enzymes and processing aids. Toxicological testing requirements to establish the safety of food additives. GRAS substances. Food safety parameters.

Lesson 27. Toxicology of alcohol. Metabolic and nutritional effects of alcohol. Hypervitaminosis A and D. Physiopathology. Clinical symptoms. Diagnosis. Treatment.

Lesson 28. New foods and functional ingredients. Toxicity requirements and safety assessment.

Lesson 29. Residues. Waste sorting. Implications on public health and the environment. Minimization and treatment of waste in the agri-food industry. Control and surveillance. Toxicology of drug residues in food of animal origin. Food safety parameters.

Lesson 30. Food toxicovigilance. National and European organizations related to food safety. Joint FAO and WHO program. Other international agencies.

Place of theoretical classes: assigned classroom in the School of Medicine.

PRACTICAL PROGRAM

5 practical sessions will be carried out: duration 3 hours/practice, 15 practical hours per student.

1. Toxicity tests. Toxicity tests for single administration (acute toxicity) and for repeated administration (sub-chronic and chronic toxicity). Models and calculations of toxicity indices. Determination of the LD50 and LC50 by the Reed-Muench and Miller and Tainer methods.

2. Classification, packaging, and labeling of dangerous substances and mixtures. Intrinsic danger. Regulations on the evaluation and authorization of substances and mixtures (REACH Regulation). New classification system (CLP Regulation). Practical cases.

3. Toxicological investigation. Presentation of cases of food poisoning. Sampling. Main samples for toxicological analysis. Rules for the collection, preparation, and submission of samples for chemical-toxicological research. Investigation of extractive, volatile, and fixed toxins. Writing and presentation of the results of clinical and laboratory research. Toxicological reports. Electronic information sources in Toxicology. Databases.

4. Taxonomy of toxic plants. Differentiation and identification of the main toxic plants that affect the nervous, cardiovascular, digestive, and hepatic systems, and those that cause hematuric syndrome and photosensitization.

5. Taxonomy of toxic plants. Differentiation and identification. Environmental risk assessment. Exposure assessment. Calculation models. Practical cases.

Place of practical classes: computing room of the School of Medicine.

SEMINARS

Complementary seminars will be held beside the theoretical classes with a presentation of specific cases of substances with a high rate of presence in food and their safety evaluation.

TEACHING METHOD

Lectures, problem-based learning, practical classes, monographic seminars, and individualized tutorship sessions. Teaching materials will be provided to facilitate the learning of the topics covered in the subject.

ASSESSMENT CRITERIA

A summative and formative evaluation will be carried out at the end of the semester. The evaluation will be at the discretion of the faculty. An evaluation will be made once the program has been delivered. This evaluation will consist of:

- Exam on the theoretical content of the subject (80%).
An average of 2 questions will be formulated per Lesson or Topic of the theoretical class program, with a total of 60 questions. The questions will be of the "multiple choice" and "single answer" type.
The student will pass the subject when they obtain at least 60% correct answers to all the questions asked.
- Continuous evaluation of the theoretical content of the subject (5%).
Throughout the course, there will be 3 continuous assessments with "multiple choice" and "single answer" type questions, one for every 10 Topics explained in the theoretical program.
- Evaluation of work in the laboratory and seminars (15%):
Multiple choice exam (an average of 2 questions will be asked per practice). The questions will be of the "true/false" type.

In order to pass the subject, in addition to passing the evaluation of the theoretical classes, the student must have demonstrated proficiency in the practical classes and in the seminars (with the presentation of the practical notebook). Attendance to practical classes and seminars is mandatory to pass the course.

Attitude to follow in the event of a voluntary or accidental violation of the rules for conducting the exam.

The voluntary or accidental infraction of the norms of taking the exam prevents its assessment, so the offending student will take an oral exam of the subject to establish their knowledge of the subject. If intentionality in the deception is confirmed, it will be considered a very serious ethical breach, and the Services Inspectorate will be informed to take the disciplinary measures that it deems appropriate.

BASIC BIBLIOGRAPHY

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- Camean, A.M. y Repetto, M. (2012), Toxicología Alimentaria, Ed. Díaz de Santos, Madrid.
- Concon, J.M. (1988), Food Toxicology (Part A & Part B), Ed. Marcel Dekker Inc., New York, USA.
- Derache, R. (1990), Toxicología y Seguridad de los Alimentos, Ed. Omega, Barcelona.
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- Lindner, E. (1994), Toxicología de los Alimentos, Ed. Acribia, S.A., Zaragoza.
- Recuerda Girela, M.A. (2011), Tratado de Derecho Alimentario. Thomson Reuters, Cizur (Navarra).