Universitat de Lleida

DEGREE CURRICULUM

PHARMACOLOGY

Coordination: RIBAS FORTUNY, JUDIT

Academic year 2023-24

PHARMACOLOGY 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>PHARMACOLOGY</td></tr>
<tr><td>Code</td><td>101513</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Biomedical Sciences</td><td>3</td><td>COMPULSORY</td><td>Attendance-based</td></tr>
<tr><td>Master's Degree in Biomedical Research</td><td></td><td>COMPLEMENTARY TRAINING</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
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<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>2.6</td><td>3.4</td></tr>
<tr><th>Number of groups</th><td>2</td><td>1</td></tr>
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<tr><td>Coordination</td><td>RIBAS FORTUNY, JUDIT</td></tr>
<tr><td>Department</td><td>EXPERIMENTAL MEDICINE</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>H Presencials 60
H. No Presecials 90
Magistral
37
Pràctica
9
Seminari
14</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Català
Anglès</td></tr>
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PHARMACOLOGY 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
MORALES PORTILLO, ARTURO		2,15	
RIBAS FORTUNY, JUDIT	judit.ribas@udl.cat	3,75	
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TORRES BONDIA, FRANCISCO IGNACIO	ftbondia@gmail.com	1	

Subject's extra information

The term Pharmacology comes etymologically from the ancient Greek, specifically from "logos" which means study or treatise and from "pharmakon", the meaning of which is similar to what we continue to attribute to the term drug, today. Therefore, it is correct to define Pharmacology as the science that studies drugs and then to define a drug as any substance capable of interacting with a living organism and affecting its functions. From a finalist point of view, when the drug contributes to preventing, alleviating or curing diseases, we qualify it as a medicine. On the contrary, when it is the cause of illness or death, we call it toxic or poison. The duality or ambivalence of the drug, which means that in certain circumstances or at a certain dose it is a medicine while in others it is toxic, forces a more precise definition of medicine. Consequently and operationally we define medicine as the pharmaceutical preparation for therapeutic use that contains one or more drugs as an active principle. Its preparation is a specific function of the Pharmacy professional.

A noteworthy component in the definition of Pharmacology is the living organism that interacts with the drug, that is the subject of Pharmacology. Consequently and depending on this, we could distinguish a human Pharmacology, a bovine, avian Pharmacology, insects, plants, bacteria or viruses. This fact, originates on the one hand a comparative pharmacology between animal species, which is of interest when carrying out tests on animals and extrapolating the results to humans. On the other hand, the consideration of the subject of Pharmacology allows us to distinguish a medical Pharmacology that is essentially human from a Veterinary Pharmacology that usually focuses on animal species, which are of interest to man. However, we should not forget that antibiotic or antiviral pharmacology, for example, is in fact a pharmacology of bacteria and viruses applied in a human or animal host.

The object of Pharmacology is essentially drugs and therefore they are studied in all their facets: their origin and sources of obtaining, their history, their physicochemical properties, their processing and elimination by the organism, their mechanism of action and effects, the interactions between them and their possible therapeutic use. For this, knowledge and experimental methods are used that do not differ from those employed in scientific disciplines such as Chemistry, Biochemistry, Physiology, Statistics, Epidemiology, Clinical Medicine or, more recently, Cell Biology, Molecular Biology and Biotechnology. Consequently, Pharmacology is a biological, experimental and interdisciplinary science that will include multiple approaches, subdivisions and pharmacological disciplines. It is common to allude to a certain identity crisis in Pharmacology motivated by this interdisciplinarity. For example, the use of a drug to study the function of an organ can be considered as a functional study, typical of Physiology, or as a study of the effects of the drug, typical of Pharmacology. This fact could give rise to sterile discussions that would forget that knowledge is unitary and scientific disciplines are a convenient human ideation. However, a noteworthy fact is that in Pharmacology or perhaps more specifically in the pharmacologist, there is

usually a therapeutic intention or projection that is not common in other scientific approaches.

From the perspective of the biomedical researcher, drugs are very useful tools in the investigation of the molecular mechanisms present in cells, organisms and their disorders. These molecular mechanisms are at the same time the targets that allow the rational discovery of new drugs. New drugs that have the potential to become new medicines. New medicines that are one of the objectives of biomedical research and, especially, of pharmacological research. Pharmacology has developed its own concepts, language and experimental approaches, the learning of which is the purpose of this subject.

Learning objectives

1. Integrate prior knowledge, especially of physiology, biochemistry, cellular and molecular biology, and project them towards Pharmacology.
2. Know the language and concepts specific to Pharmacology.
3. Identify the pharmacological targets of some of the main pharmacological groups, look for alternatives and reason about their functional and/or therapeutic impact.
4. Know the experimental approaches specific to Pharmacology.

Competences

1. That students have demonstrated possession and understanding of knowledge in an area of study that is based on general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study
2. That students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
3. Apply the main methods of pharmacology and toxicology.
4. Describe the bases of pharmacodynamics and pharmacokinetics
5. Describe the basic types of medicines and their actions.
6. Describe the main types of poisons, toxins and their actions.
7. Apply clinical documentation procedures.

Subject contents

INTRODUCTION TO PHARMACOLOGY

Topic 1. Introduction to Pharmacology. Define and delimit the concepts of drug, medication, toxic or poison, basic or experimental pharmacology, clinical pharmacology, pharmacognosy, pharmacokinetics, pharmacodynamics, and pharmacotherapy. Infer the existence of the pharmacokinetic phenomena of absorption, distribution and elimination in the case of a radioactively labeled drug that has been administered orally to an experimental animal.

Topic 2. Pharmacokinetics: Absorption of drugs. Define the pharmacokinetic phenomenon of absorption. Describe the structure and composition of cell membranes. List and characterize the mechanisms of passage through cell membranes. Classify the factors that affect the absorption of a drug. Elaborate a classification of chemical substances (potential drugs) by their interaction and solubility in water. Measure the hydrosolubility of a drug using the distribution coefficient. Define galenics or formulation of a drug. Define route of enteral and parenteral absorption. Define route of administration of a drug. Explain the characteristics of each of the administration routes. Differentiate dosage by route of administration.

Topic 3. Pharmacokinetics: Distribution of drugs. Define the pharmacokinetic distribution phenomenon of a drug. Define the concept of barriers to the diffusion of a drug. List and characterize these barriers. Define the concept of compartments in an organism. Define the concepts of active drug, plasma free drug and bioavailable. Define and characterize the plasma protein compartment. Define and characterize the lipid compartment of an organism. Explain and exemplify the phenomenon of redistribution. Classify the factors that influence the distribution of drugs. Measure the distribution of a drug using the volume of distribution.

Topic 4. Pharmacokinetics: Biotransformation of drugs. Define and delimit the pharmacokinetic phenomena of biotransformation, metabolism, bioactivation and detoxification. Classify drug biotransformation reactions. Identify phase I and phase II reactions. Locate the biotransformation phenomena at the anatomical and cellular level. Classify and list the factors that affect the biotransformation of drugs.

Topic 5. Pharmacokinetics: Excretion of drugs. Define and distinguish excretion and elimination of a drug. List and describe the ways of drug excretion. Analyze the processes involved in the urinary excretion of a drug. Determine how the phenomenon of ion sequestration and possible pH modulations affect the excretion of a drug. Interpret and calculate the renal "clearance" of a drug.

Practical activity: Apply the pKa parameter to the chemical characterization of drugs. Solve how ion sequestration determines the greater/lesser absorption/elimination of a drug, depending on the basic or acidic nature of that drug and its pKa.

Unit 6. Quantitative pharmacokinetics. Define bioavailability. Interpret bioavailability diagrams. Use the concepts of absolute and relative bioavailability. Define bioequivalence. Analyze and classify drug elimination kinetics. Define half-life or half-elimination period of a drug. Formulate the problem of equilibrium in plasma concentrations when we use repeated doses of a drug. Define therapeutic range of plasma concentrations, initial or shock dose, administration interval and maintenance dose. Distinguish between linear and non-linear pharmacokinetics.

Practical activity: Problems of determining equilibria in the plasma concentrations of drugs.

Unit 7. Pharmacodynamics. Define pharmacodynamics, effect, action and mechanism of action of a drug. Classify the effects of a drug. Distinguish therapeutic effect and placebo effect. Distinguish secondary effect and collateral effect. Define undesirable effect by idiosyncrasy and overdose. Define and describe undesirable effects due to sensitization. Define and exemplify the undesirable effect of tolerance. Define and explain the physiology of the undesirable phenomena of drug dependence. Interpret effect/dose diagrams. Measure the effects of a drug. Define efficacy, maximum efficacy and potency of a drug. Interpret the parameters ED50, ID50 and LD50. Analyze the concept of the therapeutic index of a drug. Classify the mechanisms of action of drugs. Describe examples of mechanism of action based on physicochemical properties of the drug. Receiver definition. Describe examples of drugs with a receptor-based mechanism of action. Functionally classify receptors. Characterize the type of receptor bound to the ion channel. Characterize the type of receptor coupled to G proteins. Characterize the type of receptor with kinase activity. Characterize the intracellular type receptor. Describe examples of drugs with a non-receptor-based mechanism of action.

Practical activity: General theory of receivers. Interpret drug concentration/response diagrams for a receptor. Relate the above diagrams to the effect/dose diagrams. Define intrinsic activity and affinity of a drug for its receptor. Define agonism, partial agonism, competitive antagonism and non-competitive antagonism. Measure the affinity of an agonist for its receptor through pD2. Measure the affinity of a competitive antagonist for its receptor through pA2.

Topic 8. Drug interactions. Define medicinal interaction and its types: synergisms and antagonisms. Explain the pharmacokinetic and pharmacodynamic causes of drug interactions.

Unit 9. Research, production and marketing of medicines. Analyze the origins of medicines. Observe and explain the roles of the pharmaceutical industry and health authorities in the drug market. Describe the phases in the development of a medicine. Briefly characterize these phases.

Unit 10. Clinical pharmacology. Define clinical pharmacology. Define clinical trial. Differentiate bioassays in humans from actual clinical trials. Place it in the development process of a medicine. Observe and explain how a clinical trial is formulated. Identify and list the criteria used in the population design and controls of a clinical trial. Apply bias minimization techniques. Define specificity, sensitivity, power, reliability, validity and significance of a clinical trial. Distinguish between prospective, retrospective and meta-analysis. Identify ethical issues in clinical trials.

NEUROTRANSMISSION PHARMACOLOGY

Unit 11. Pharmacology of adrenergic neurotransmission. Describe the locations and functional elements of the adrenergic synapse. Expose the metabolism of adrenergic neurotransmitters. Define, based on pharmacology, the different types of adrenergic receptors. Explain the mechanisms of signal transduction from adrenergic receptors.

Exemplify this in the hepatocyte and the smooth muscle fiber. Describe direct adrenergic agonist drugs. Define indirect adrenergic agonists. Analyze the mechanisms of antagonism by pre-synaptic blockade. Describe adrenergic receptor antagonists.

Unit 12. Pharmacology of dopaminergic neurotransmission. Placing dopamine in the metabolism of adrenergic neurotransmitters. Assess its effects on adrenergic receptors. Describe the specific functions of dopamine at the level of the central nervous system, digestive system, heart and kidneys. Infer the applications of agonist drugs used in therapy. Infer the applications of antagonistic drugs used in therapy

Unit 13. Pharmacology of cholinergic neurotransmission. Describe the locations and functional elements of the cholinergic synapse. Explain the metabolism of acetylcholine. Define, based on pharmacology, the different types of cholinergic receptors. Explain the mechanisms of signal transduction from cholinergic receptors. Describe direct muscarinic cholinergic agonists. Describe the direct cholinergic agonists of the nicotinic type. To characterize acetylcholinesterase inhibitor drugs as indirect cholinergic agonists. Describe muscarinic or atropine antagonists. Describe ganglionic or gangliplegic nicotinic antagonists. Describe muscle nicotinic antagonists or curarizing. Describe antagonists that act by pre-synaptic blockade.

Practical activity:

1- Computer simulation on vegetative pharmacology of blood pressure in spinal rat.

2- Computer simulation of ganglionic pharmacology in spinal cat.

3- Computer simulation of neuromuscular junction in organ bath.

Unit 14. Pharmacology of the action potential. Positioning cocaine as a voltage-gated sodium channel blocker and as a psychoactive drug. Characterizing local anesthetics as voltage-gated sodium channel blockers. Explain local anesthesia. Characterize local anesthetics as cardiac antiarrhythmic drugs.

Unit 15. General pharmacology of receptors. Pharmacology in other neurotransmission systems. The concept of autacoid, hormone and neurotransmitter.

PHARMACOLOGY IN SUBSTITUTE THERAPIES

Unit 16. Pharmacology of diabetes. Distinguish the different types of diabetes. Summarize the biochemical characteristics of insulin. Explain the regulation of pancreatic insulin secretion. Expose the mechanism of action and effects of insulin. Describe its pharmacokinetics and the formulations that modulate it. Delimit the therapeutic application of insulin. Explain the mechanism of action of sulfonylureas and their effects. Describe its pharmacokinetics. Place them therapeutically. Pharmacologically characterize the biguanides. Describe other therapeutic approaches to type II diabetes.

PHARMACOLOGY OF IMMUNITY

Unit 17. Immunoactivating and immunosuppressive pharmacology. Define passive and active immunotherapy. Distinguish suppression/activation, specificity/non-specificity and processing/non-processing of antigens in the modulation of the immune system. Define vaccines as specific immunoactivating drugs based on antigen processing. Identify the types of vaccines and their mechanism of action. List and place therapeutically the most frequent types of vaccines. Characterize the pharmacokinetics of vaccines. Interpret vaccination schedules as part of your dosage. Anti-allergic vaccines. Define immunoglobulins and antisera as passive specific immunoactivating drugs. Distinguish immunoglobulin from antiserum. Place monoclonal antibodies, humanized monoclonal antibodies and immunotoxins in this context. Characterize the pharmacokinetics of these products, place them in therapeutics. Define the concept of non-specific immunoactivating drug. Reason the therapeutic application of human recombinant cytokines. Explain the mechanism of action and indications of interferons. Place cyclosporine, tacrolimus and sirolimus as non-specific immunosuppressants. Explain its mechanism of action. Describe the most relevant pharmacokinetic aspects of them. Describe the rest of immunosuppressive pharmacology. Expose the therapeutic strategy in organ transplantation.

PHARMACOLOGY OF INFLAMMATION

Unit 18. Anti-inflammatory drugs. Noxes and defense mechanisms of the organism. Identify the cell types involved in the inflammatory and immune response. Analyze the functionality and elements involved in

inflammation. Characterize the prostanoids. Characterize leukotrienes and PAF. Relating eicosanoids and PAF to anti-inflammatory therapy. Summarize the history of non-steroidal anti-inflammatory drugs (NSAIDs). Classify NSAIDs based on their chemical structure. Describe the most relevant aspects of its pharmacokinetics. Explain the mechanism of action of NSAIDs. Reason the desirable and undesirable effects of NSAIDs. Summarize its indications and contraindications. Summarize the functional and biochemical characteristics of glucocorticoids as adrenal hormones. Distinguish between natural glucocorticoids and the different generations of synthetic corticosteroids. Describe the pharmacokinetic properties of glucocorticoids. Explain its mechanism of action. Expose its effects and deduce the indications.

INFORMATIONAL PHARMACOLOGY

Unit 19. Nucleic acids as drugs. Characterize the types of synthetic DNA and RNA. Define hybridons or antisense oligonucleotides. Explain its mechanism of action. Profile its pharmacokinetics. Explain the triplex strategy with oligonucleotides. Define the phenomenon of RNA interference. Discuss the use of siRNA in human therapeutics.

Methodology

1. Master class. To be developed with the class group. Attendance is not monitored and is assessed on the theory test.
2. Problem solving classes. To be developed with groups of 20 students. Attendance is not monitored and assessed with a specific exam.
3. Discussion seminars. To be developed with groups of 20 students around the teaching files published on the virtual campus. Attendance is not monitored and is assessed on the theory test.
4. Practical activities: Based on simulation programs of experimental pharmacology preparations. To be developed in the computer room with groups of 20 students. Attendance is not monitored and assessed with a specific exam.

Development plan

A calendar / schedule describing the teaching activities to be developed will be made available to the students. Topics expected to be explained on a specific day, date and times of the practical sessions, etc.

Evaluation

Learning Assessment		
	% final grade	Type of Evaluation
Lectures and Seminars	50	Test Exam
Practical Activities	22	Exam on computer simulations
Lectures (Introduction) and Problems	28	Problem-based exam
Mentoring Meetings	0	Not scheduled
Tasks	0	Not appliable

1. There will be a first exam based on the Introduction, with problems of pharmacokinetics and pharmacodynamics. It will generate 28% of the final grade of the subject, therefore it will not be recoverable.
2. There will be a second exam based on the practical activities (computer simulations). It will generate 22% of the final grade of the subject, therefore it will not be recoverable.
3. There will be a theoretical exam. It will generate 50% of the final grade of the subject, therefore it will be recoverable.
4. The final grade of the subject is 5, i.e. 50%, adding up the three exams taken. There is no minimum grade in any of the 3 exams that is incompatible with passing the subject.
5. In all the exams and especially in the theoretical one, if the blank answers exceed 50% of all those in the

exam, it will mean that the exam is void, that is to say the grade NP (Not Presented).

6. The exams will be objective and test-type. Each question will present 4 options of which only one is correct. A blank answer adds 0 points. The wrong answer subtracts ¼ of the value assigned to the question.
7. A correction coefficient will be added to the final grade, the calculation of which will be explained on the first day of the course. This coefficient will be applied only to students who pass a grade of 6 (60%) in the theoretical exam. At the discretion of the teachers, the coefficient can be modified or no longer applied when aberrant results are generated.

Bibliography

Books or journals:

- Farmacología. Rang, H.P. et al. (8ª ed.), Elsevier España S.A., 2008

- Farmacología humana. Florez J. et al. (6ª ed.), Elsevier Masson, 2008

- Trends in Pharmacological Sciences (TIPS), Elsevier

Computer simulations:

1. Neuromuscukar junction v2.0

2. Rat phrenic nerve hemidiaphragm v2.1

3. The pithed rat v2.0

4. The anesthetised cat v1.0

(c) John Dempster, 1993, Dept. of Physiology and Pharmacology, Univ. of Strathclyde, Glasgow, Scotland

Internet :

- Agencia Española del Medicamento, Ministerio de sanidad y Consumo: http://www.agemed.es/

- Agencia Europea del Medicamento: http://www.emea.europa.eu/

- U.S. Food and Drug Administration, Center for Drug Evaluation and Research: http://www.fda.gov/cder

Internet Divers:

- Annual Review of Pharmacology and Toxicology: http://arjournals.annualreviews.org/loi/pharmtox

- Fundació Institut Català de Farmacologia: *http://www.icf.uab.es/*

- Medline plus: http://medlineplus.gov/spanish/

- Rx List, the internet drug index: http://www.rxlist.com/

- Vademecum online: http://www.vademecum.es/

Internet (Self-assessment tests**):**

- Michael Gordon, Ph.D. Learning Modules, University of Kansas School of Medicine: http://www.pharmacology2000.com/index.htm