Course outline

SCIBIOM301, Pharmacology
Autumn 2019

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Classroom no: E-9
Class times: Wednesday, 10:00-12:00 and 13:00-15:00
Instructor: (title, name) Dr. Frans van Overveld
Dr. Gerda Andringa
Email: f.vanoverveld@ucr.nl
g.andringa@ucr.nl
Tel: 0118 - 655500
Office no. & location: Eleanor 2.02 and 1.12
Office hours: Mon-Fri, by appointment

I. Track information

a) Prerequisites for this course: Introduction to Life Science (SCILIFE101), Molecular and Cell Biology (SCILIFE201), and Human Physiology (SCILIFE202).
b) This course serves as prerequisite for: N/A.
c) Other courses which are relevant to this course – e.g. as part of a minor: Pharmacology (SCIBIOM307) is an essential part of the Pre-Medical program, and the Biomedical Science track.

For further information about these tracks, please see the track documents available on the UCR intranet.

II. Course description

Pharmacology is the science of drugs including their origin, composition, pharmacokinetics, therapeutic use and toxicity (Merriam-Webster Learner's Dictionary). The functioning of the (diseased) human body can be affected by (medicinal) drugs, which act through a variety of molecular mechanisms. In this course, the basic principles of pharmacology will be discussed, followed by studies of different aspects of drugs and the human body to illustrate these pharmacological principles which are used for rational drug development and physiological use. The importance of neuronal, hormonal, immunological (whole body) and biochemical (whole cell) regulation for proper physiological and cellular function, and dysregulation during pathological processes are emphasized. Identification of potential drug targets and the interaction of drugs with macromolecules (enzymes, cell surface receptors, and signaling molecules) as the main pharmacological principles are central in this course. Quantitative pharmacological, pharmacokinetic and statistical methods are used. At the end of the course students will be able to explain effectively existing drug therapies in a rational way in terms of molecular targets, cellular actions and physiological consequences of pharmacological treatment. They will be able to suggest targets for drug development on the basis of pathophysiological insights and to apply pharmacological models when describing concentration-response, time-concentration, and time-response relationships of drugs.

III. Study Load

This course earns students four credits (equivalent to 7.5 ECTS). The class meets once a week for two sessions of two hours each. Preparation time is approximately 10 hours per week.

IV. Course materials

a) Required books and literature:
- David E. Golan, Ehrin J. Armstrong, April W. Armstrong. ***Principles of Pharmacology*** *(The Patho-physiologic Basis of Drug Therapy)*. 4th Edition, 2018. Wolters Kluwer. ISBN-13: 978-1-4963-2057-5.

b) Recommended books and literature:
- Diana Hacker and Nancy Sommers. ***A Writer's Reference***. 8th Edition, 2016. MacMillan Learning. ISBN-13: 978-1-3190-8353-3.
- J.M. van Ree and D.D. Breimer. ***Algemene Farmacologie***. 2nd Edition, 2013. Reed Business Education, Amsterdam. ISBN-13: 978-9-0352-2866-5 [Dutch]. Recommended for students who will take the entrance exams for a Medical Master program in the Netherlands.

c) Other materials: N/A

V. Course organization and requirements

a) General format of class meetings

In total 22 interactive classes of two hours will be given on the major topics of pharmacology: pharmacodynamics and kinetics, routes of administration, drug metabolism and toxicity, and pharmacogenomics (see the detailed course outline in section VII). This will be done using PowerPoint® presentations and schematic information on the white board. Approximately 70 hours will be necessary to study the indicated chapters in the textbook and to prepare for the classes. Secondly, classes will be centered on key questions in pharmacology: how to handle and interpret graphs, how to develop new drugs, mode of action of drugs, therapeutic dose and toxicity, risk management, homeopathy, laboratory, and pathophysiological dysregulation, which is illustrated by studying the nervous system and by immunopharmacology of inflammation. By means of active communication, assignments and discussion, among instructor, guest speakers and students, the concept under investigation will be constructed into a model. In the course each student will produce oral and written presentations.

The slides presented during the classes and other useful material, as well as study hints will be available on the **Moodle** platform.

Especially in the second part of the course dates need to be confirmed, and activities may be moved to another timeslot.

Mobile phones and other devices which connect to the internet must not be used in class. If you are seen using these devices you will be required to hand in your device at the start of class every session from that point forward (unless the instructor has given permission for use).

Special needs: students with documented learning disabilities or special needs should make their needs known to the instructor at the start of the course.

b) What are we expecting of students

Besides attending classes, the students have to study the corresponding chapters of the book ***Principles of pharmacology: the pathophysiologic basis of drug therapy*** by Golan et al. (see section VII, course outline) before class. The students need to bring this book every time to class and the **printed book may be also necessary for the final exam**! In the chapters, the student will find extensive descriptive texts, illustrations, and useful examples. To stimulate **regular study** and to test the level of knowledge and insight during the course, besides some graded (homework) assignments, two written exams will be given.

c) Rules for missing classes, exams and deadlines

Class attendance is mandatory. The instructor should be informed **before class** in case of illness or any other urgent reason to excuse class. According to UCR academic rules and procedures, the course is failed when 7 or more of the classes are missed (each Wednesday is considered as 2 classes!). On Tuesday **December 17**, a **late exam** is offered only for those having excused an earlier exam for a valid reason. **No late exams are possible during the semester (=including the autumn break)**.

d) Procedures for communication and use of Moodle

Moodle is the preferred mode of communication. The assignments (slides of the PowerPoint® presentations, score sheets, feedback forms, etc.) should all be posted in the Moodle directories specifically created for this purpose. **Work that is not present in Moodle will be considered as not submitted** and will be graded with **F** (fail).
All assignments will be checked for plagiarism using Urkund®. Plagiarism is a serious academic offence which carries heavy sanctions. The student should make him(her)self familiar with the UCR Plagiarism Policy (see the Student Handbook).
Outside class, the student may contact the instructors at f.vanoverveld@ucr.nl and g.andringa@ucr.nl. In addition, the instructors have set office hours from Monday to Friday by appointment.

e) Other

This course is subject to UCR academic rules and procedures. Both students and instructors are required to know and follow these rules and procedures.

VI. Assessment

a) Assessment components

Assessment of students is based on group and individual work. Each student has also to finish two individual written exams. A mid-term exam (20%) is scheduled for **9 October 2019**, and a final exam (30%) is planned for **11 December 2019**. The exams may consist of multiple choice questions, short-answer questions, and essay questions. The student will get a maximum of 120 minutes to answer all questions of the exam. An answer fulfils adequately in case pro-formulated criteria are met (using a checklist).

The other assignments in the course are both group and individual work. The group work is a presentation on a currently used psychoactive drug (15%). Individual assignments are several graded (homework) assignments about pharmacokinetics and simulation experiments (20%) and a written drug brochure (15%). At the end of the semester, an overall grade will be determined.

b) Main criteria of the assessments

The mid-term exam will evaluate knowledge and application of the main pharmacological concepts and can be compared with some example questions and the assignments made in class. In the final exam, in which may be the textbook can be used (still to be decided), the students are required to apply physiological and pharmacological concepts in the context of the pharmacology of the nervous, endocrine and the immune system. Relevant biochemical, (patho)physiological and pharmacological information, in the form of articles from scientific literature, will be discussed during the course.

VII. Course schedule

Time	Topics to be discussed	Course material used	Assignments and assessment
Week 1 28/08/2019 Session 1	Course overview, Introduction, Organization		
Session 2	CONVOCATION No Class		
Week 2 04/09/2019 Session 1	Drug-receptor interactions *Histamine + receptors*	Chapter 1 Chapter 44	
Session 2	Drug development	Chapters 51-52-53	
Week 3 11/09/2019 Session 1	Autonomic regulation	Chapter 10: pp 127-136, read 137-144; Ch. 11: pp 150-156, read 156-161	Peer review assignment (Eur. J. Pharmacol.)
Session 2	Fundamentals: Pharmacodynamics (PD)	Chapter 2	
Week 4 18/09/2019 Session 1	PD (continued)	Chapter 2	Binding studies
Session 2	ADME and pharmacokinetics (PK), uptake and absorption	Chapter 3	

Time	Topics to be discussed	Course material used	Assignments and assessment
Week 5 25/09/2019 Session 1	PK: Distribution	Chapter 3	
Session 2	PK: Elimination (metabolism, excretion, half-life and clearance)	Chapters 3-4	
Week 6 02/10/2019 Session 1	PK: one vs. two compartments model	Chapter 3	Organ bath assignment
Session 2	PD+PK: continued exercises	Chapters 2-3-4	
Week 7 09/10/2019 Session 1	Exam revision		10:00 – 12:00
Session 2		Chapters 1, 2, 3, 4, 10, 11, 44, 51, 52	***Midterm Exam (see Moodle)***
Week 16/10/2019 Session 1	--- BREAK ---		
Session 2	--- BREAK ---		
Week 8 23/10/2019 Session 1	Pharmacotoxicology + Capita Selecta Toxicology	Chapter 6 Teacher: Dr Willem Schoonen	Lectures
Session 2	Toxicology in pharma industry	Chapter 6 Teacher: Dr Willem Schoonen	Workshop
Week 9 30/10/2019 Session 1	Risk management	Teacher: Dr. Jaap Hanekamp	
Session 2	Homeopathy	Teacher: TBA	
Week 10 06/11/2019 Session 1	Neuropharmacology	Selection of chapters 8 – 19 Teacher:	
Session 2	Neuropharmacology (cont'd)	Dr Gerda Andringa	

Time	Topics to be discussed	Course material used	Assignments and assessment
Week 11 13/11/2019 Session 1	Neuropharmacology		***Oral presentations***
Session 2	Neuropharmacology (cont'd)		
Week 12 20/11/2019 Session 1	Excursion day		
Session 2			
Week 13 27/11/2019 Session 1	Immunopharmacology and inflammation, part 1	*Moabs (hu) in sarcoidosis, rheumatoid arthritis, etc.; Dosis-schedule-t1/2-etc.*	PowerPoint slides / guest speaker
Session 2	Immunopharmacology and inflammation, part 2	Chapters 42-43-46-48 (selection)	
Week 14 04/12/2019 Session 1	Capita selecta / lecture / exam training		*Brochure writing*
Session 2			
Week 15 11/12/2019 Session 1	Exam revision		10:00 – 12:00
Session 2	**Final exam**		***Final exam (see Moodle)*** ***Deadline writing assignment (Brochure) Friday, December 13 (18:00)***

VIII. Student learning outcomes

The aim of this course is to make the student understand the principles of pharmacology:

1) Students will be able to explain the effectivity of existing drug therapies in a rational way in terms of molecular targets, cellular actions and physiological consequences.
2) Students will be able to suggest targets for drug development of diseases on the basis of pathophysiological insights.

3) Students will be able to apply pharmacological models in the description of concentration-response, time-concentration, and time-response relationships of drugs.
4) Students will be aware of the fact that development and use of drugs requires a multidisciplinary approach.
5) Students will have experience with team-work and will have used the required accurate and professional verbal and written communicative skills.

Period	**Teaching activities**	**Student is able to do**
Period 1 (Weeks 1-8)	Classes + self-study fundamental principles of pharmacology	SLO 1, SLO 3
Period 2 (Weeks 3-7)	Assignments and practical work	SLO 1, SLO 3, SLO 5
Period 3 (Weeks 8-11)	Activities and excursion	SLO 4
Period 4 (Weeks 9-15)	Topic-related assignments, self-study and presenting	SLO 1, SLO 2, SLO3 SLO 4, SLO 5, SLO 6

IX. Appendices

Learning Outcomes for *SCIBIOM301 Pharmacology*

Introduction

Slides Definitions and "Principles of Pharmacology"

Chapter 1: Drug-Receptor Interactions

1.1 Conformation and chemistry of proteins

1.2 Chemical bonds and their strength

1.3 Impact of drug binding on the receptor; active site; induced fit; specific inhibition

1.4 Drug selectivity

1.5 Drug and receptor interactions

1.6 Major types of drug receptors

1.7 Name and describe the ion channels

1.8 G-protein families, their activation mechanisms and resulting responses

1.9 Signaling pathways

1.10a Localization and action of β-adrenergic receptors

1.11 Working mechanisms of receptors with an enzymatic domain

1.12 Intracellular receptors and their mechanisms of action

1.13	Mechanisms of receptor regulation
Slides	Histamine and its receptor subtypes
Slides	Two-state model of the histamine receptor
Slides	Antihistamines

Chapters 10+11: Autonomic Regulation, Cholinergic and Adrenergic Pharmacology

10.1	Synthesis of acetylcholine
10.2	Storage and release of acetylcholine
10.3	Cholinergic receptors: muscarinic and nicotinic receptors
10.4	Degradation of acetylcholine
10.5	Physiologic effects of cholinergic transmission: neuromuscular junction, autonomic effects, CNS effects, the non-neuronal cholinergic system
10.6	Pharmacologic classes and agents: inhibitors, agonists, and antagonists
11.1	Catecholamine synthesis, storage, and release
11.2	Reuptake and metabolism of catecholamines
11.3	Catecholamine receptors: α_1- and α_2-adrenoceptors, β-adrenoceptors
11.4	Regulation of receptor response
11.5	Physiologic and pharmacologic effects of endogenous catecholamines: epinephrine, norepinephrine, dopamine
11.6	Pharmacologic classes and agents: inhibitors, agonists, and antagonists
Slides	Study all slides. Know the differences between the sympathetic and parasympathetic pathways. Receptor types that are involved and their ligands. Compare also with the somatic nervous system. Properties of adrenergic receptors

Chapter 2: Pharmacodynamics

2.1	Drug-receptor binding; free vs. bound ligands; drug-receptor binding curves
2.2	Dose-response relationships: graded vs quantal (formulas)
2.3	Explain ED50, TD50, LD50
2.4	Interactions between drugs and receptors: what are agonists, what are antagonists, what are they doing; explain competition and non-competition (formulas)
2.5	Explain partial agonists, inverse agonists and spare receptors
2.6	Compare the therapeutic index and therapeutic window (formula)

Chapter 3: Pharmacokinetics

3.1	Describe the physiological membrane barriers and their related functions (diffusion formula)
3.2	What is the bioavailability of a drug (formula)
3.3	Routes of drug administration: pro's and con's
3.4	Volume of distribution and distribution over the body (formula)
3.5	Kinetics of drug distribution: metabolism, renal excretion, liver excretion
3.6	Concept of clearance (formula)
3.7	Drug kinetics and half-life (formulas)
3.8	Therapeutic dosing; loading dose and maintenance dose (formulas)
Table 3.6	Summary of key pharmacokinetic relationships

Chapter 4: Drug Metabolism

4.1	Define drug metabolism; what are phase 1 and phase 2 reactions
4.2	Administration routes and implications for drug metabolism
4.3	Describe and give examples of metabolic reactions
4.4	Drug transporters
4.5	Explain the induction and inhibition of P450 and their impact on its substrates; be able to give an example
4.6	What are the individual factors that may affect drug metabolism

Chapter 6: Drug Toxicity

6.1	Define pharmacovigilance
6.2	What is the margin of safety; know an example of a drug that was withdrawn from market
6.3	Describe the factors that influence drug toxicity
6.4	What are on- and off-target adverse events
6.5	Define hypersensitivity; describe the 4 different types of hypersensitivity; what is the underlying mechanism of action
6.6	Give an example of harmful immune responses
6.7	Describe idiosyncratic toxicity
6.8	Drug overdose
6.9	Drug-drug interactions
6.10a	Contrast necrosis and apoptosis

6.11	Hepatotoxicity: subtoxic vs. toxic damage
6.12	List the drug categories in pregnancy

Chapter 7; Pharmacogenomics

7.1	Define pharmacogenomics; what are SNPs
7.2	Explain genetic polymorphisms and drug metabolism
7.3	Be able to use a list of polymorphism characteristics to draw a conclusion on a clinical outcome (see in-class assignment)
7.4	Describe the use of warfarin and its relation to polymorphisms; what about the therapeutic index and drug-drug interactions

Principles of Neuropharmacology

8	Principles of cellular excitability and electrochemical transmission
9	Principles of nervous system physiology and pharmacology
10	Cholinergic pharmacology
11	Adrenergic pharmacology
12	Local anesthetic pharmacology
13	Pharmacology of GABAergic and glutamatergic neurotransmission
14	Pharmacology of dopaminergic neurotransmission
15	Pharmacology of serotonergic and central adrenergic neurotransmission
16	Pharmacology of abnormal electrical neurotransmission in the central nervous system
17	General anesthetic pharmacology
18	Pharmacology of analgesia
19	Pharmacology of drugs of abuse
	SLIDES and NOTES

Principles of Inflammation and Immune Pharmacology

42	Principles of inflammation and the immune system
43	Pharmacology of eicosanoids
44	Histamine pharmacology
45	Pharmacology of hematopoiesis

46	Pharmacology immunosuppression
47	Integrative inflammation pharmacology: peptic ulcer disease
48	Integrative inflammation pharmacology: asthma
49	Integrative inflammation pharmacology: gout
	SLIDES and NOTES