

JAHANGIR MOINI

Focus on
Pharmacology

ESSENTIALS FOR HEALTH PROFESSIONALS

3rd edition



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Third Edition

Focus on

PHARMACOLOGY

ESSENTIALS FOR HEALTH PROFESSIONALS



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Dedication

This book is dedicated to the memory of my Mother, to my wife Hengameh, my daughters Mahkameh and Morvarid, and to my granddaughters, Laila Jade and Anabelle Jasmine Mabry.

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Preface



The Third Edition of *Focus on Pharmacology: Essentials for Health Professionals* has been updated with the latest drug information available. It is accompanied by a new Student Workbook, which contains many different types of review questions, including multiple-choice, fill-in-the-blank, true/false, and some labeling exercises. There are seven new chapters in this edition:

- * Chapter 2—Pharmacodynamics
- * Chapter 3—Pharmacokinetics
- * Chapter 4—Drug Toxicity and Pharmacogenomics
- * Chapter 13—Dietary Supplements and Alternative Therapies
- * Chapter 17—Antiviral Agents
- * Chapter 19—Antiprotozoal Agents
- * Chapter 29—Drugs Used to Treat Hyperlipidemia and Related Conditions

Other key changes and updates:

- * Chapter 1 was divided into four chapters (1—Introduction to Pharmacology, 2—Pharmacodynamics, 3—Pharmacokinetics, and 4—Drug Toxicity and Pharmacogenomics).
- * Basic Mathematics was renamed Principles of Math in Medicine.
- * Nutritional Aspects of Pharmacology and Herbal Substances was divided and expanded to become Chapter 12—Nutritional Aspects of Pharmacology, and Chapter 13—Dietary Supplements and Alternative Therapies.
- * Substance Abuse was renamed and expanded as Chapter 15—Substance Abuse and Misuse
- * Antibacterial and Antiviral Agents was divided into two chapters: Chapter 16—Antibacterial Agents and Chapter 17—Antiviral Agents.
- * Second-edition chapter on Antifungal, Antimalarial, and Antiprotozoal Agents was divided into two chapters: Chapter 18—Antifungal Agents, and Chapter 19—Antiprotozoal Agents.

There also have been changes to the appendices:

- * Appendix A—The Top 200 Drugs by prescription
- * The previous Appendix D (Immunization Schedules) was removed because it is now in the body of the book

Pharmacology is often a challenging subject for allied health students. To the rescue comes this text uniquely designed to use a *focused* approach to learning pharmacology. Introductory chapters lay the groundwork for learning this subject by explaining the history of pharmacology, discussing the legal and ethical principles involved, illustrating drug administration techniques, reviewing math, explaining drug calculations, and a discussion of medication errors and their prevention. Additionally, substance abuse is focused on in detail. The chapters that follow focus on drugs specific to body systems, pharmacotherapy of certain age groups (pediatrics and geriatrics), pharmacology for pregnant women, and broad drug categories such as antibiotics.



Structured Presentation of Pharmacologic Principles

Each drug chapter focuses on drugs used to treat a certain body system and its associated disorders. The chapters open with a concise review of anatomy and physiology, providing a foundation for understanding the actions, effects, and uses of each drug. These pharmacologic principles are succinctly explained by using clearly identifiable headings in question format that help focus students' attention on the most important points about a drug class or an individual drug:

- * How do they work?
- * How are they used?
- * What are the adverse effects?
- * What are the contraindications and interactions?
- * What are the most important points patients should know?

Sometimes these question headings focus on a class of drugs, for example, beta-adrenergic blockers. Other times, the question headings focus on a *prototype* (representative) drug—that is, the drug that was either the first developed in the class or is the most widely used drug in its class. Whichever approach is taken in the chapter, the five-question headings are used so students can easily focus on the key “need-to-know” drug information.

Focus On

Chloroquine

Chloroquine is one of the most commonly used drugs for prophylaxis and the treatment of acute malarial attacks that are caused by *P. vivax*, *Plasmodium malariae*, *Plasmodium ovale*, and susceptible strains of *P. falciparum*.

How does it work?
Chloroquine is a protozoacidal drug. The agent destroys *Plasmodia* organisms by interfering with their metabolism or inhibiting normal replication of the **protozoan**.

How is it used?
Chloroquine is used for the control of acute attacks of *P. vivax* malaria and for suppression against all plasmodia except chloroquine-resistant *P. falciparum*. The drug is neither a prophylactic nor a radical curative agent in *P. vivax* malaria. In regions where *P. falciparum* is generally sensitive to chloroquine, it is markedly effective in terminating acute attacks of nonresistant *P. falciparum* malaria and usually brings about a complete cure in this type of malaria. Chloroquine is the drug of choice for the oral treatment of all malaria except that caused by resistant *P. falciparum*.

What are the adverse effects?
Adverse effects include pigmentation of the skin and nail beds, pruritus, fatigue, toxic psychosis, and ototoxicity.

Chloroquine may also cause clouding of the corneas of the eyes and retinopathy.

What are the contraindications and interactions?
Chloroquine is contraindicated in patients with liver disease, hypersensitivity to 4-aminoquinolines, psoriasis, porphyria, and renal disease. This drug should also not be used by children or by pregnant or lactating women. Certain antacids and laxatives decrease chloroquine absorption, and chloroquine may interfere with the response to the rabies vaccine.

What are the important points patients should know?
Advise patients to promptly report visual or hearing disturbances, muscle weakness, loss of balance, and symptoms of blood dyscrasia, which include fever, sore mouth or throat, unexplained fatigue, easy bruising, or bleeding. Instruct them to wear dark glasses in sunlight and bright light because of photophobia, to reduce the risk of ocular damage, and to avoid driving or other potentially hazardous activities until a reaction to the drug is known. Inform patients that this drug may cause rusty yellow or brown discoloration of the urine.

Doxycycline

Doxycycline is also known as *doxycycline calcium oral suspension* (syrup), *doxycycline hyclate* (capsules or film-coated tablets), and *doxycycline monohydrate* (for oral suspension). It is active against many different types of bacteria as well as parasites.

How does it work?
Doxycycline inhibits bacterial protein synthesis by binding to ribosomal subunits and is bacteriostatic against a broad range of Gram-positive and Gram-negative bacteria.

How is it used?
Doxycycline should be used only to treat or prevent infections that are proven or strongly suspected to be caused by bacteria, in order to reduce development of drug-resistant bacteria and maintain effectiveness of this and other antibacterial drugs. This drug is primarily indicated for Rickettsial infections such as Rocky Mountain spotted fever and typhus fever and for chlamydia. Doxycycline is used for the prevention of malaria.



Teach-and-Test Approach

Learning small amounts of information and testing themselves on what they've just learned is a proven way for students to retain new information. This text includes a large number of exercises, implemented in three ways: (1) *Practical Scenarios* (two per chapter) with critical thinking questions; (2) within-chapter *Apply Your Knowledge* questions; and (3) end-of-unit *Checkpoint Reviews*. This approach makes learning about pharmacology an engaging, interactive process. The Teach-and-Test approach truly differentiates the text from others and has been positively received by educators.

PRACTICAL SCENARIO

Each chapter concludes with two short scenarios involving fictional patients with real-life problems concerning medications. A list of two or three questions follows. These scenarios relate to the knowledge that students have gained from reading each chapter. After completing each chapter, individual students can write short answers to the questions, or the class as a whole can discuss the answers.

APPLY YOUR KNOWLEDGE

The second implementation of the “teach-and-test” approach includes exercises that are strategically placed *within* the chapters (rather than at the end). These exercise sections, called *Apply Your Knowledge*, appear after each component of the chapter content, including anatomy and physiology, and the individual pathophysiology/pharmacology sections.

The exercise sections include a variety of exercises in which students need to recall and apply the content they just learned. Exercise types include fill-in-the blank, labeling, matching, and multiple-choice, as well as more pharmacology-specific exercises such as dosage calculations and drug name exercises (sound-alike and look-alike and generic-to-brand). The goal in these sections is to provide the student with an immediate review of all vital content. All drugs and drug classes mentioned in the content are “tested” in these exercise sections.

PRACTICAL SCENARIO 2

A 75-year-old man was taking several different medications for hypertension, hyperplasia of the prostate, and rheumatoid arthritis. Four of his medications were to be taken before bed, and three were to be taken in the morning. One night, he recalled that he had forgotten to take one of his medications. He got out of bed, went into his kitchen, and avoided turning on the light so as not to disturb his son-in-law, who was sleeping in the adjacent family room. In the darkness, he inadvertently took one of the medications he had already taken earlier. After 2 hours, he woke up to go to the bathroom and felt chest pain and dizziness, which caused him to collapse, awakening his wife.



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Critical Thinking Questions

1. Which of his medications would cause lower blood pressure, chest pain, and dizziness?
2. What are the disadvantages of taking several drugs at the same time?

Apply Your Knowledge 39.1

The following questions focus on what you have just learned about pediatric pharmacokinetics. See Appendix F for answers.

CRITICAL THINKING

1. What physiologic processes may influence pharmacokinetics in children?
2. What are the definitions of the terms *neonate*, *infant*, and *toddler*?
3. What is the cause of kernicterus?
4. What is the result of lower metabolic activities in neonates?
5. Compare the GFR of newborns to older children and adults.



CHECKPOINT REVIEWS

The third component of our teach-and-test approach is unit “tests” called *Checkpoint Reviews*. These review questions reflect the format on most certifying and licensing exams, and include multiple-choice and essay questions. Answers to the Apply Your Knowledge and Checkpoint Reviews are found at the end of the book in Appendix E.

Checkpoint Review 1

Select the best answer for the following questions.

- The half-life is the major determinant of which of the following?
 - The adverse effects of a drug after a single dose
 - The interaction with another single dose
 - The duration of elimination of a drug after administration of multiple doses
 - The duration of action of a drug after a single dose
- Hypersensitivity* is often used synonymously with which of the following terms?
 - Immunogen
 - Allergy
 - Antigen
 - Allergen
- Which of the following agencies oversees controlled substances and prosecutes individuals who illegally distribute them?
 - HIPAA
 - FDA
 - DEA
 - CDC
- Which of the following federal laws offers a 7-year monopoly on drug sales and tax breaks to induce drug companies to undertake development and manufacturing of drugs used for rare diseases that affect small numbers of people in the United States?
 - Orphan Drug Act of 1983
 - Prescription Drug Marketing Act of 1987
 - Durham-Humphrey Amendment of 1951
 - Comprehensive Drug Abuse Prevention and Control Act of 1970
- Which of the following phases of drug approval evaluates toxicology data?
 - Phase I
 - Phase II
 - Phase III
 - Phase IV
- The angle of insertion for intradermal injections is which of the following degrees?
 - 30
 - 90
 - 15
 - 45
- Which of the following is the route of administration of a drug that is placed between the gums and the cheek?
 - Buccal
 - Topical
 - Sublingual
 - Transdermal
- Which of the following is a drug that was withdrawn after postmarketing surveillance?
 - Penbutolol
 - Atenolol
 - Furosemide
 - Celecoxib
- The proprietary drug name is also called the:
 - Chemical name
 - Generic name
 - Trade name
 - None of the above
- The study of drugs derived from herbal and other natural sources is called:
 - Pharmacodynamics
 - Pharmacotherapy
 - Pharmacognosy
 - Pharmacology
- Which of the following drugs carries a black box warning?
 - Rifampin
 - Rofecoxib
 - Valdecoxib
 - Celecoxib
- Herbal products and dietary supplements are controlled by the
 - Center for Disease Control and Prevention
 - Center for Biologics Evaluation and Research
 - Center for Food Safety and Applied Nutrition
 - Center for Drug Evaluation and Research
- Which of the following can determine the dose-effect relationship?
 - Pharmacodynamics
 - Pharmacokinetics
 - Both A and B
 - Pharmacology

Drug Dosing Information

Each drug chapter includes tables of all drugs discussed in the chapter, arranged by drug classes and formatted to include generic and trade names, adult dosing, and route of administration.

Table 17-1 ■ Examples of Effective Antiviral Agents

GENERIC NAME	TRADE NAME	AVERAGE ADULT DOSAGE	ROUTE OF ADMINISTRATION
acyclovir	Zovirax	IV: 5–15 mg/kg q8h for 7–21 days; PO: 20–400 mg (800 mg max) 4–5 times/d for 5–14 days; Topical: 5% cream 5 times/d for 4 days	IV, PO, topical
amantadine	Symmetrel	Two 100 mg tablets/d or 4 teaspoons of syrup/d; may be split into 1 tablet bid or 2 teaspoons of syrup bid	PO (tablets and syrup)
didanosine	Videx, Videx EC	EC Capsules: 400 mg once/d (or 250 mg once/d with tenofovir); Oral solution: 200 mg bid	PO (enteric-coated capsules or oral solution) (take 30 minutes before meals or 2 hours after)
ganciclovir	Cytovene, Vitrasert, Zirgan	IV infusion: 5 mg/kg over 1 hour q12h for 14–21 days; Oral: 1000 mg tid with food; Ocular implant: inserted surgically and replaced q5–8m; Ocular 0.15% gel: 1 drop in affected eye 5 times/d pm, followed by 1 drop tid for 7 days	IV, PO, ocular implant, ocular gel
ribavirin	Virazole	20 mg/mL as starting solution in SPAG-2 unit with continuous aerosol administration for 12–18 hours/d for 3–7 days (this concentration = 190 micrograms/liter of air)	Inhalation (powder for solution)
zanamivir	Relenza	10 mg, provided in 2 inhalations using Diskhaler	Inhalation (powder for PO inhalation)
zidovudine	Retrovir	200 mg tid or 300 mg bid	PO

IV, intravenous; PO, oral; bid, twice a day; tid, three times a day.



Special Populations and Important Drug-Related Points

- * **Focus Points:** These marginal features highlight significant or difficult concepts in pharmacology.
- * **Focus on Pediatrics** and **Focus on Geriatrics:** Each of these boxes highlights pediatric or geriatric information specific to pharmacology.
- * **Focus on Natural Products:** This boxed feature highlights drug interactions related to complementary and alternative medicines. Herbs, supplements, and foods are included in these boxes.

Focus Point

Mechanism of Action of HIV Medications

It is important to understand how specific drugs used against HIV are listed above. The drug called maraviroc affects Step 1, blocking the HIV receptor. The drug called enfuvirtide blocks the fusion process of HIV. Some drugs inhibit the reverse transcriptase enzyme's effects in Step 3. The integrase enzyme and its effects in Step 5. Several drugs target HIV protease and its effects in Step 10.

During all stages of HIV infection, the virus replicates very quickly, but particularly during the initial stage. This is because the amount of CD4 cells is still very large, and the response against the virus. Therefore, plasma levels of HIV can initially be high. Patients often experience acute retroviral syndrome as a result. In the early stages, the amount of CD4 cells decline sharply but eventually level off to between 1,000 and 100,000 cells per cubic millimeter. It seems, since the HIV plasma half-life is 6 hours, meaning that one-half of the virus is eliminated every 6 hours. Therefore, to remain a relatively steady level when infected, the amount of virus must be replaced between 1 and 10 billion virions per day. Even so, the patient is usually asymptomatic for approximately 10 years. After this period, advanced signs and symptoms appear.

HIV mutates very quickly due to errors in reverse transcriptase. The mutations are incorporated into HIV DNA with each replication. Therefore, HIV can become drug-resistant even though it was previously in a drug-sensitive form. The chance of drug resistance is related to the total viral load. There is more chance of at least one virus being drug-resistant in large amounts of total virions. Therefore, patients are treated with combina-

Focus Point

Medical Errors During the Prescribing Process

The three most common forms of prescribing errors include dosing errors, prescribing medications to which the patient has had an allergic response, and errors involving the prescribing of inappropriate dosage forms.



Focus Point

Heparin Injections

For subcutaneous heparin injections, make sure that 0.1 to 0.2 mL of air is in the syringe to prevent heparin leakage into tissue, thus avoiding localized hemorrhaging.



Focus on Geriatrics

Medications May Stain Teeth and Dentures

Advise elderly patients who have dentures to remove them before taking certain medications. Some oral liquid drugs, such as liquid iron or iodides, may stain the teeth.



Focus on Natural Products

Lobelia Dangers

Lobelia is found in dietary supplements that are marketed for use by children and infants as well as pregnant women. Lobelia may be very dangerous to use because it contains alkaloids with pharmacologic actions that are similar to nicotine. It can cause autonomic nervous system depression or stimulation, bronchial dilation, increased respiratory rate, respiratory depression, sweating, rapid heart rate, hypotension, and even coma or death.



Each chapter includes:

- * Chapter Objectives
- * Key Terms with pronunciations
- * Chapter Capsule: A review of each chapter objective with bulleted summaries of the key information for each objective

The focused teach-and-test approach of this textbook provides allied health students with the perfect blend of concise content and an enjoyable—even fun—learning process. Pharmacology and fun have never been joined in the same sentence—until now!



Acknowledgments



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Courtesy of the author

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UNIT

1



General Principles



“ To administer a drug safely, one must know its usual dose, frequency, route of administration, indications, contraindications, significant adverse reactions, and major drug interactions. ”

Chapter 1

Introduction to Pharmacology



Chapter Objectives

After completing this chapter, you should be able to:

1. Compare and define pharmacognosy and pharmacotherapeutics.
2. Define *drugs* and *CAM therapies*.
3. Compare prescription drugs with over-the-counter drugs.
4. Explain biologic agents and give four examples.
5. Describe the role of the Food and Drug Administration.
6. Explain drug approval.
7. Describe the longest stage of drug approval.
8. Define *postmarketing surveillance*.

Key Terms

biologics (p. 5)

black box warning (p. 8)

complementary and alternative medicine (CAM) therapies (p. 5)

dose (p. 5)

drug (p. 5)

medication (p. 5)

NDA review (p. 8)

pharmacognosy (p. 5)

pharmacology (p. 5)

pharmacotherapeutics (p. 5)

prescription (p. 5)

Introduction

Pharmacology is the study of drugs, including their action and effects in living body systems. Clinical pharmacology is the study of drugs in humans. It is involved with all aspects of the interaction between drugs and patients. The term *drug* is defined as “any substance or product that is used or intended to be used to modify or improve a physiologic or pathologic condition.” The terms *medication* and *medicine* refer to drugs mixed in a formulation with other ingredients to improve the stability, taste, or physical form to allow appropriate administration of the active drug.

Pharmacology deals with all the types of drugs used in society today (legal, illegal, prescription, and over-the-counter [OTC] medications). To administer a drug safely, one must know its usual **dose**, frequency, route of administration, indications, contraindications, significant adverse reactions, and major drug interactions. Knowledge of the patient’s medication allergies, weight, and liver and kidney functions is also essential.

Pharmacognosy is the study of drugs derived from herbal and other natural sources. By studying the compositions of natural substances and how the body reacts to them, one gains better knowledge for developing purified versions. **Pharmacotherapeutics** is the study of how drugs may be best used in the treatment of illnesses and which drug is most or least appropriate to use for a specific disease. In this chapter, I consider classifications of prescription and over-the-counter drugs, the role of the FDA, and drug approval.

Classification of Drugs

Therapeutic agents may be classified as drugs (medications), biologics, or complementary and alternative medicine (CAM) therapies.

- * A **drug** is any agent that produces biologic responses within the body. When a drug response is desired, it is referred to as *therapeutic*. When the response is undesired, it is referred to as *adverse*. Once a drug has been administered to a patient, it is referred to as a **medication**, yet both drugs and medications are thought of as components of normal physiological activities. Drugs differ from other products such as cosmetics, foods, and household chemicals, such as toothpaste, shampoo, and others.
- * **Biologics** are agents produced inside animal cells from the actions of microorganisms, or by the entire body itself. They are natural substances, whereas most drugs used today are synthesized in laboratories. Biologics treat many different conditions or illnesses, and include hormones, vaccines, interferons, monoclonal antibodies, and natural blood products.
- * **Complementary and alternative medicine (CAM) therapies** use herbs, plant extracts, dietary supplements, vitamins, and minerals. Additionally, therapies such as acupuncture, massage, hypnosis, and biofeedback are also considered CAM therapies.

Apply Your Knowledge 1.1

The following questions focus on what you have just learned about drug classifications.

CRITICAL THINKING

1. Describe biologic drugs.
2. Define *complementary and alternative medicine therapies*.
3. What is the definition of a *medication*?

PRESCRIPTION DRUGS

Prescription agents are legal drugs that can only be dispensed using a prescription from an authorized health practitioner. A **prescription** is an order, usually written, for medications or other therapies to be supplied to a specific individual patient. They are based on examinations and diagnoses of patients by physicians, nurse practitioners, and other health practitioners. Prescriptions contain dosage information that is designed to provide the most accurate treatment for

the diagnosed condition. Another advantage of using prescription agents is that, should there be any interactions with other drugs, supplements, or foods, the health care practitioner is able to ascertain the safe use of what is being prescribed for the patient. Sometimes, usage of a prescription medication over many years, with little or no safety concerns resulting, means that the medication may later become available over the counter (OTC).