

### Chapter 1 Topics

- History of Medicinal Drugs
- Contemporary Pharmacology Practice
- Drug Regulation
- FDA Health Concerns

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### Learning Objectives

- Recognize the important contributions, events, and resources in the development of pharmacology through the ages.
- Know what is meant by pharmacology.
- Define what drugs are, identify their sources, and understand how they work.

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### Learning Objectives

- Be familiar with the federal laws that regulate drugs and the agencies that administer them.
- Be familiar with the procedure for getting a new drug to market.

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### History of Medicinal Drugs

- Historically, religious leaders controlled medical treatment
- Knowledge of healing properties of natural substances (plants and minerals) grew from trial and error
- Concept of drugs in early Greek records as the word *Pharmakon*, meaning magic spell, remedy, or poison

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### Early Remedies



- Hippocrates (c. 460–377 B.C.)
  - Disease from natural, not supernatural causes
  - Favored empirical learning
  - Dissected human body to study organ functions
- Galen (c. A.D. 130–201)
  - Humors (blood, phlegm, black bile, yellow bile)

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### Early Remedies

- Dioscrides
  - First century A.D. compiled *de Materia Medica*
  - Described and classified 600 plants by substance, not by disease they were intended to treat

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### Drugs in the Middle Ages

- Paracelsus (1493–1541)
  - Denounced Galen's concept of humors
  - Advocated use of individual drugs, not mixtures and potions



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### Drugs in the Middle Ages

- Monasteries became centers of treatment and intellectual life
- Pharmacopoeia
  - Official listing of medical preparations
  - Nuremberg, Germany: *Dispensatorium*, 1546

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### Drugs in the Modern Age

- Claude Bernard (1813-1878)
  - Certain drugs have specific sites of action in the body
  - Used laboratory methods
  - Founded field of experimental pharmacology



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### American Pharmacology

- During 18<sup>th</sup> century, some immigrants to the colonies were apothecaries
  - Forerunner of today's pharmacists in England
- *Pharmacopoeia of the United States*, 1820
  - First official listing of drugs in the U.S.
  - Massachusetts Medical Society

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### American Pharmacology

- After American Civil War (1861-1865)
  - Defined boundaries between practice of physicians and pharmacists
- Formation of the American Pharmaceutical Association (1852)

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### Twentieth-Century Pharmacology


- 1847, Semmelweis
  - Handwashing with chlorinated lime water in maternity wards
- 1860s, Lister
  - Introduced antiseptics into surgery
- 1907, Ehrlich
  - Introduced arsphenamine to treat syphilis

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### Twentieth-Century Pharmacology

- 1923, Banting and Best
  - Extracted insulin from the pancreas to treat diabetes
- 1935, Domagk
  - First antibiotic, sulfa drug Prontosil
- 1945, Fleming
  - Discovered penicillin

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### Discussion

As the use of medicinal drugs has developed, how has the role of the pharmacist changed?  
How are biopharmaceuticals changing the options for treating diseases?

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### Contemporary Pharmacology Practice

- A science based on systematic research to determine the origin, nature, chemistry, effects, and uses of drugs
- Growth of present-day knowledge greatly stimulated by synthetic organic chemistry

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### Responsibilities of Pharmacist

- Correct dispensing of drugs
- Directs preparation of compounded drugs
- Recommends patient pharmaceutical care
- Provides medication information and counseling

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### Responsibilities of Pharmacy Technician

- Prescription processing under pharmacist supervision
- Role depends on state law, which can vary greatly from state to state
- Manages computer systems
- Ensures that safe and effective systems are in place

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### Pharmacy Technician Certification Board (PTCB)

- Develops, maintains, promotes and administers an accredited national certification program for pharmacy technicians
- Provides certification and recertification programs and services
- Certified technicians must be recertified every two years by PTCB

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### Medicinal Drugs

- Pharmacologic effects
  - Drug actions on living system
- Classifications
  - Therapeutic drugs: relieve symptoms of a disease
  - Prophylactic drugs: prevent or decrease the severity of disease

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### Pharmacognosy

- Study and identification of natural sources for drugs
  - Plants, animals, minerals, chemicals
    - Ergotamine from rye fungi
    - Digoxin from foxglove
    - Morphine from the opium poppy

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### Synthetically Produced Drugs


- Many drugs produced synthetically from chemical substances
  - Sulfonamides, aspirin, sodium bicarbonate
- Biopharmaceuticals
  - Produced by recombinant DNA technology

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### Drug Sources, Drug Names, and Therapeutic Effects

Plant: foxglove	digoxin	Cardiac
Animal: stomach of hog or cow	pepsin	Digestive enzyme
Mineral: silver	silver nitrate	Anti-infective
Synthetic: omeprazole	Prilosec	Gastric acid inhibitor
Bioengineering: erythropoietin	Epogen	Stimulates RBC formation

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### Discussion

How is the role of the pharmacy technician changing?

Why is it important that there is national certification for technicians?

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### Drug Names and Classifications

- Chemical Name
  - Chemical makeup
- Generic name
  - Name the manufacturer gives a drug
  - United States Adopted Name (USAN)
  - Nonproprietary drug, not protected by trademark
  - Lowercase letter
  - Shortened version of chemical name or indicator of class of drug

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### Drug Names and Classifications

- Brand name
  - Trade name
  - Copyrighted and used exclusively

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### Drug Names and Classifications

- Many guidelines direct the naming of a drug
  - Safety
  - Suitability
  - Drug identification
  - International information exchange

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### Alternative Medicine

- Billions of dollars are spent every year on alternative medicine
- Includes herbs, supplements, and homeopathic remedies

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### Concerns About Alternative Medicine

- Legitimate scientific data is scarce
- Patients often do not tell prescriber and pharmacist they are taking alternative medicines
  - Interaction can often occur between prescribed drug and alternative medicine
- Many alternative medicines are not covered by governmental regulations

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### Drug Regulation

- The U. S. legal system regulates the manufacture, sale, and use of drugs
- State and federal laws govern the development, prescribing, and dispensing of drugs

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### The Food and Drug Administration (FDA)

- 1906, First attempt by U.S. government to regulate the sale of drugs or substances that affect the body
- 1927, Formation of Food, Drug, and Insecticide Administration
- 1930, Name changed to FDA

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### The Food and Drug Administration (FDA)

- 1938, Passage of Food, Drug, and Cosmetic Act
  - All new drugs to be proved safe before being marketed
  - New Drug Application (NDA)
- 1951, Durham-Humphrey Amendment
  - Legend drug: sold by prescription, “Rx only”
  - Over-the-counter drug (OTC): sold without Rx

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### The Food and Drug Administration (FDA)

- Regulates both legend and OTC drugs
- Regulates medical and radiological devices, food, cosmetics, biologics, and veterinary drugs
- Does not test drugs
- Companies seeking to market drugs must test and submit evidence to the FDA that the drugs are safe and clinically effective

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### Medication Guides

- FDA requires that medication guides are to be distributed to patients when certain drugs are dispensed
  - From retail pharmacies or upon discharge from the hospital
- Many retail computer systems print the medication guide automatically when the drug label is printed

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### Medication Guides

- Some medication guides prepared for entire classes of drugs
  - Examples: NSAIDs and antidepressants
- Other medication guides are prepared for specific drugs
- Medication guides must be given to patients at **all** dispensings for about 300 drugs

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### Technicians and Medication Guides

- Make sure patient receives proper medication guide
- Can put guide together with the drug for pharmacist when pharmacist verifies the drug

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### Drug Approval Process

- FDA requires the manufacturer of a new drug to provide evidence of the drug's safety and effectiveness
- New Drug Application (NDA)
  - Specifies the proposed labeling
  - Documents the drug's development and testing
  - Details manufacturing, processing, packaging
  - Quality control

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### Clinical Trials of New Drugs

- Patients typically separated into 2 groups
  - Experimental group receives drug to be tested
  - Control group receives a standard treatment for the illness or placebo
- Double blind study
  - Trial participants nor study staff know whether a particular participant is in which group
  - Best way to determine what a new drug does

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### Four Phases of Clinical Trials

Phase I	Studied in 20 to 100 healthy people
Phase II	Studied in patients who have the condition it is intended to treat
Phase III	Compared to commonly used treatments
Phase IV	Continuation of testing after approved for marketing

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### FDA Approval Process

- FDA approval process took 7 to 10 years
- FDA has made urgently needed drugs available sooner
- Prescription User Fee Act of 1992 shortened the FDA's review process for new drugs
  - Act on standard applications within 10 months
  - Act on priority applications within 6 months

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### FDA Approval Process


- FDA considers a new drug safe enough to be approved when the benefits outweigh the risk
- Drugs are not tested on pregnant women
- Based on all available information, drugs are grouped into safety categories for use during pregnancy

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### FDA Pregnancy Categories

Category	Risk Level
A	No risk
B	Risk cannot be ruled out
C	Caution is advised
D	Is a definite risk
X	Do not use

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**Discussion**

What would you do if an obviously pregnant woman is picking up a prescription for a drug with a FDA Pregnancy Category B rating?

Why might a pregnant woman take such a drug?

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**Discussion**

Does FDA approval mean that a drug is guaranteed to be safe?

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**Postmarketing Surveillance**

- Office of Compliance, a branch of the FDA, oversees drug manufacturing process
  - Ensures that manufacturers follow good manufacturing practices in FDA regulations

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**Postmarketing Surveillance**


- Professionals and consumers can report serious adverse reactions to MedWatch, FDA's Medical Products Reporting Program
- If drug poses a health risk, FDA will remove it from the market even though it has already been approved

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**Removing Drugs from the Market**

- "Safe" does not mean "harmless"—every drug has risks
- FDA evaluates significant adverse effects to determine the seriousness and likelihood that they were drug related
- If risk outweighs the benefits, FDA will ask manufacturer to withdraw a drug from the market voluntarily

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**Discussion**

Do you remember drugs that were originally considered safe, but were then removed from the market?

What was your experience with those drugs?

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### Black Box Warning

- For drugs on the market and found to be problematic, but still provide therapy for specific conditions
- Black Box warning on package insert
- Alerts prescribers to known problems
- Thousands of drugs on the market have Black Box warnings

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### Controlled Substances

- Controlled Substances Act, 1970
  - Combat escalating drug abuse
- 1973, establishment of DEA, branch of the U.S. Justice Department

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### Controlled Substances

Label	Abuse Potential
C-I	highest potential
C-II	high possibility, which can lead to severe dependence
C-III	moderate potential
C-IV	low potential
C-V	lowest potential

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### Discussion

How do the schedules for controlled substances help protect patients?

What are examples of drugs in each of the controlled schedule categories?

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### Generic Drugs

- Patent grants the sponsor the sole right to manufacture a drug while the patent is in effect
- Under a patent, generic and brand name of a drug belong to the drug sponsor
- Once patent expires, other companies can produce this drug as a generic

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### Generic Drugs

- Must be equivalent to the brand-name drugs
- FDA has an A/B rating system to establish therapeutic equivalence of generic drugs
- FDA has identified generics not therapeutically equivalent; in *Orange Book*

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### Over-the-Counter Drugs (OTCs)

- Many drugs used in treating a disease are OTCs
- Pharmacy technicians can play an important role in helping patients identify ingredients in OTC medications
- Particularly important when the ingredients of a previously purchased OTC medication have changed

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### FDA Food Health Claims

- Primary objectives of FDA
  - Weighing risks against benefits
  - Protect consumers
- 1999, FDA authorized food companies to promote disease-fighting and cancer-fighting benefits of whole grains in breakfast cereals

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### FDA Food Health Claims

- 1999, FDA authorized use of health claims about the role of soy protein in reducing risk of coronary heart disease
- These products are not substitutes for prescribed medications
  - Used in conjunction with drug therapy

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### Discussion

What would you do if a customer/patient told you they were not going to continue a prescribed cholesterol-lowering medication because they were going to be eating more whole grain cereals?

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### Assignments

- Complete Chapter Review activities
- Answer questions in Study Notes document
- Study Partner
  - Quiz in review mode
  - Matching activities
  - Drug tables

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# Pharmacology


for Technicians

Fifth Edition

## Chapter 2

### Basic Concepts of Pharmacology

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## Learning Objectives

Understand **receptors** and their function in mechanisms of drug actions.

Appreciate the general principles of **pharmacokinetics** and the importance of those principles in developing and testing drugs.

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## Learning Objectives

Understand that drug effects can have beneficial and harmful effects.

Be familiar with the common terms used to describe **drug interactions**.

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## Drug Actions


Drugs work by a variety of chemical mechanisms

Body continually fights to maintain a state of **homeostasis** (stability)

Achieved by a system of control and feedback mechanisms

Drugs can be used to restore and maintain homeostasis

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## Messengers and Receptors

Cells communicate through the action of chemical **messengers**, which they produce and send into extracellular fluids

Some chemical messengers: histamine, prostaglandin, bradykinin

Messengers recognize and communicate with target cells via **receptors** (specific protein molecules)

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## Receptors

Receptor site may have **specificity**

**Affinity** is the strength by which a particular chemical messenger binds to its receptor site or cell

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## Mechanisms of Drug Action

Drugs act like chemical messengers to perform their specific actions in the body

By binding to receptors on or within body cells, drugs can

- Mimic or block the action of chemical messengers
- Exert powerful and specific actions in the body

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**Mechanisms of Drug Action**

**Agonist** drugs bind to a particular receptor and trigger the same cellular response as the body's own chemical messenger

**Antagonist** drugs compete to block the action of the endogenous messenger

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**Mechanisms of Drug Action**

Some drugs produce their effects by embedding themselves in cell membranes

Cell membranes made up mostly of **lipids**, which repel water

Effectiveness of these drugs is related to their **lipid solubility**

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**Mechanisms of Drug Action**

Some drugs combine with specific molecules in the body such as enzymes, transport proteins, and nucleic acids

Example: some antidepressants

Some drugs act without any direct interaction within the cell

Example: Mannitol interferes osmotically with water reabsorption by the kidneys

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**Pharmacokinetics**

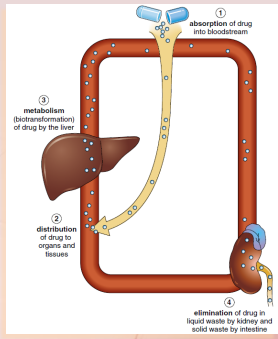
Activity of a drug within the body over a period of time

Includes **ADME**: **absorption, distribution, metabolism, and excretion** of a drug

Also includes the **metabolites** of a drug in relation to the time they are in the body

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**Absorption, Distribution, Metabolism, and Elimination of a Drug**



① absorption of drug into bloodstream

② distribution of drug to organs and tissues

③ metabolism (biotransformation) of drug by the liver

④ elimination of drug in liquid waste by kidney and solid waste by intestine

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**ADME**

**Absorption**: process whereby a drug enters the circulatory system

**Distribution**: process by which a drug moves from the blood into other body fluids and tissues and to its sites of action

Blood flow is rate-limiting factor

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**ADME**

**Metabolism:** process by which drugs are chemically converted to compounds and then excreted through **metabolic pathways**

**Metabolite** is substance into which a drug is converted by metabolism

**Induction:** drugs enhance drug metabolism

**Inhibition:** drugs decrease drug metabolism

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**ADME**

**Elimination:** removal of a drug or its metabolites from the body

**Clearance** is the rate at which a drug is eliminated from a specific volume of blood per unit of time

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**Discussion**

What are the primary sites of elimination in the body?

The kidneys and the liver, but can also be exhaled by the lungs or excreted in perspiration.

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**Pharmacokinetic Parameters**

Pharmacokinetic processes determine how a drug should be administered to obtain a specific response

Treat disease state, not produce toxicity

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**Dose**

Quantity of drug administered at one time

**Ceiling effect** is a point at which no clinical response occurs with increased dosage

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**Dose Response Curve**

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**Determining How the Body Handles a Drug**

Testing of fluids over time demonstrates how the body handles a drug

- Trough is lowest level of drug in blood
- Peak is highest level of drug in blood

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**Bioavailability**

Portion of dose that becomes biologically active in the body

- Oral drugs go into intestinal wall, liver, blood, and then to systemic site
- Metabolism in the liver before a drug reaches systemic circulation is **first-pass effect**

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**Therapeutic Range**

Optimum dosage that provides the best chance for successful drug therapy

When the amount of drug gives desired response, drug is at therapeutic level

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**Therapeutic Range**

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**Duration of Action**

Length of time a drug gives the desired response or is at therapeutic level

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**Duration of Action**

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**Discussion**

How is a drug's volume of distribution, clearance, and half-life used in dosing drugs?

Volume of distribution is important for calculating the **loading dose**, clearance for calculating the **maintenance dose**, and half-life for determining the **dosing interval**.


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**Pharmacokinetic Modeling**

Method of describing the ADME of a drug within the body mathematically

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**Drug Effects**


**Beneficial Responses**

Therapeutic Effect: action for which the drug is prescribed

Local Effect: confined to a specific part of the body

Systemic Effect: generalized, all-inclusive effect on entire body


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**Discussion**

What are some of the issues a healthcare practitioner considers when selecting a drug for an individual patient?

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**Considerations When Selecting a Drug**

**Indications:** the diseases, symptoms, and conditions for which the drug is known to be of benefit

**Contraindications:** the diseases, symptoms, and conditions for which the drug will not be beneficial and may do harm

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**Side Effects**

Secondary responses to a drug other than the primary therapeutic effect for which the drug was intended

Allergic responses

Drug dependence, addiction, abuse, and tolerance

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## Drug Interactions

One drug can have an effect on the action of another

Foods and other substances such as alcohol and nicotine can interact with drugs

Common way a substance can interact is by inducing or inhibiting enzymes that metabolize the drug


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## Common Drug Relationships

Addition	The combined effect of two drugs equals the sum of the effects of each drug taken alone.
Antagonism	The action of one drug negates the action of a second drug.


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## Common Drug Relationships

Potentiation	One drug increases or prolongs the action of another drug, and the total effect is greater than the sum of the effects of each drug used alone. A second drug can be prescribed to increase the first drug's potency. This term is used when one of the drugs has little or no action when given alone and the second drug increases the potency of the first drug.
Synergism	Joint action of drugs in which their combined effect is more intense or longer in duration than the sum of their individual effects.

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## Ask for Complete List

Prescribers and pharmacists need a complete list of all prescription drugs, OTC medications, and herbal remedies a patient is taking

Pharmacy technician should routinely ask for this information


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## Discussion

Name a common food-drug interaction.

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## Assignments

Complete Chapter Review activities

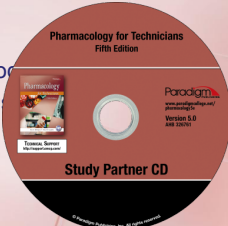
Answer questions in Study Notes document

Study Partner

Quiz in review material


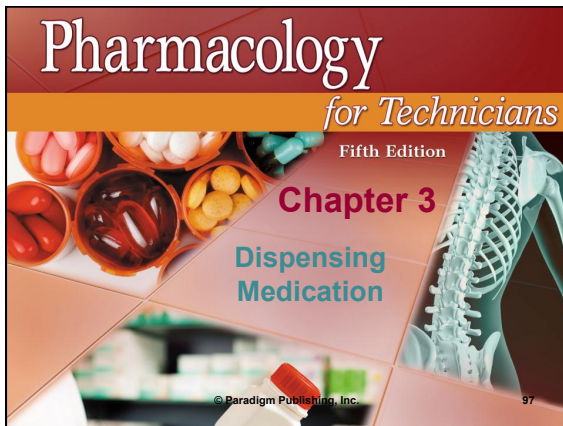
Matching activities

Drug tables



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**Chapter 3 Topics**

- The Prescription
- Correct Drug Administration “Rights”
- Dosage Forms and Routes of Administration
- Factors That Influence Drug Action


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**Chapter 3 Topics**

- Teaching Patients Medication Management
- Medication Safety


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**Learning Objectives**

- Know the components of the prescription, including the commonly used abbreviations.
- Understand the “rights” of correct drug administration.
- Recognize common dosage forms.
- Know the routes of administration.


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**Learning Objectives**

- Recognize factors that influence the effects of drugs, particularly in the elderly and pediatric populations.
- Understand the immunization process.
- Understand the role of the pharmacy technician in medication safety.

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**The Prescription**

- Written or oral direction for medication to be dispensed to a patient
- Prescription issued and dispensed in a hospital is a **medication order**
- Outside of the hospital, it is called a **prescription**

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**Essential Elements of a Prescription**

Patron, Cull, and

- Date of prescription
- Inscription: drug name, dose, and quantities of the ingredients
- Signa (sig): patient directions for the label
- Number of refills, or no refills
- Prescribing physician's signature, handwritten
- Indication whether generic is permitted

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**Prescription for a Controlled Substance**

DEA number of the prescribing physician must be on the prescription

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**Essential Prescription Elements**

**FIGURE 3.1 The Essential Elements of a Prescription**

The pharmacy technicians should always check these elements.

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**Rx**

Rx is symbol for prescription

Can only be dispensed if prescriber writes an order or prescription (cannot be sold OTC)

Pharmacy technicians should always double-check a prescription for accuracy and to ensure all legal requirements met

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**Prescription Abbreviations**


Pharmacy technician must understand the meanings of abbreviations for prescriptions

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**Prescription Abbreviations**

Abbreviation	Translation
ac	before meals
am	morning
bid	twice a day
c̄	with
cap	capsule
DAW	dispense as written
D/C	discontinue


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## Prescription Abbreviations

Abbreviation	Translation
g	gram
gr	grain
gtt	drop
h or hr	hour
IM	intramuscular
IV	intravenously
L	liter


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## Prescription Abbreviations

Abbreviation	Translation
mcg	microgram
mEq	milliequivalent
mL	milliliter
NKA	no known allergy
NKDA	no known drug allergy
npo	nothing by mouth
pc	after meals


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## Prescription Abbreviations

Abbreviation	Translation
po	by mouth
prn	as needed
q	every
qh	every hour
q <sup>2</sup> h	every two hours
qid	four times a day
qs	a sufficient quantity


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## Prescription Abbreviations

Abbreviation	Translation
stat	immediately
tab	tablet
tid	three times daily
ud	as directed
wk	week

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## Problematic Prescription Abbreviations

Certain abbreviations should never be used on Rx's or instructions

- Source of many medical errors
- Do not use abbreviations when taking a verbal order or Rx
- Additional dangerous abbreviations on ISMP Web site

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## Problematic Abbreviations

Dangerous Abbreviation	Correct Form to Use
µg	microgram or mcg
hs	half strength or hours of sleep, bedtime
qd	every day
qhs	nightly at bedtime
qod	every other day

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**Problematic Abbreviations**

Dangerous Abbreviation	Correct Form to Use
U	units
MgSO <sup>4</sup>	magnesium sulfate
MSO <sup>4</sup>	morphine sulfate
.2	0.2
2.0	2

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**Discussion**

What makes an abbreviation dangerous?


What is the role of the pharmacy technician when a prescription arrives with a dangerous abbreviation?

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**Correct Drug Administration “Rights”**

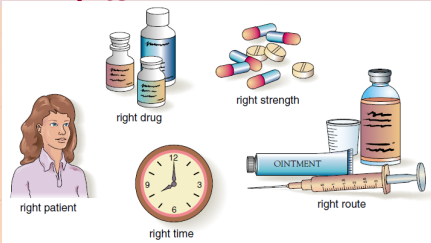
The “rights” for correct drug administration

- right patient
- right drug
- right strength
- right route
- right time



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**Correct Drug Administration “Rights”**



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**Correct Drug Administration “Rights”**

Right Patient	Always verify patient’s name with at least 2 patient identifiers
Right Drug	Always check the medication against the original prescription and the patient’s disease state. The medication label contains important drug information dispensed to patient.
Right Strength	Check original prescription for this information. Check patient’s age.

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**Correct Drug Administration “Rights”**

Right Route	Check that the physician’s order agrees with the drug’s specified route of administration.
Right Time	Check prescription to determine appropriate time for medication to be administered.

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**Discussion**

How do the “rights” for correct drug administration help avoid dispensing errors?

What other things should a pharmacy technician check when dispensing a medication?

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**Medication Label on a Dispensing Container**

**FIGURE 3.3 Medication Label on a Dispensing Container**

Important information, such as the drug name, dosage form, dosage strength, precautions, and usual dosage and frequency of administration will be provided on the medication dispensing container.

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**Dosage Forms and Routes of Administration**

Drugs administered in different ways

Route and dosage form are determined by many factors

- Disease being treated
- Body area drug needs to reach
- Convenience
- Drug's chemical composition and characteristics
- Patient age and condition

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**Dosage Forms and Routes of Administration**

**Peroral (Oral, by mouth)**

- Most economical and convenient way

**Parenteral**

- Administered by injection rather than by way of the alimentary canal

**Topical**

- Applied to the surface of the skin or mucous membranes and other routes

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**Peroral (PO) Dosage Routes**

Three common routes


- Oral (swallowed)
- Sublingual (under the tongue)
- Buccal (dissolves in the cheek)

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**Most Common Peroral (PO) Dosage Forms**

- Tablets
- Capsules
- Solutions
- Syrups
- Elixirs
- Suspensions
- Gels
- Powders
- Troches/lozenges

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## Parenteral Dosage Routes

Administration of drugs by injection into

- a muscle: intramuscular (IM)
- a vein: intravenous (IV)
- the skin: intradermal
- the tissue beneath the skin: subcutaneous
- the spinal cord: intraspinal or intrathecal


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## Most Common Parenteral Dosage Forms

- Intravenous (IV) injections
- Epidural injections
- Intramuscular (IM) injections
- Subcutaneous injections

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## Topical Dosage Routes

Applied to the surface of the skin or mucous membranes

- Inhalation
- Ophthalmic (eye) by installation
- Otic (ear)
- Nasal (nose) by installation or spray
- Rectal
- Vaginal

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## Most Common Topical Dosage Form

- Ointments
- Creams
- Gels
- Suppositories
- Patches
- Lotions
- Inhalants

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## Factors That Influence Drug Action

**Age**

Children and elderly may need reduced dose due to smaller size or inability of liver to metabolize medication

**Disease**

Specific diseases may hinder absorption, metabolism, or excretion of drugs

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## Factors That Influence Drug Action

- Psychological and genetic factors
- Immune responses

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**Special Considerations in Elderly Patients**

Aging affects chemical reactions that drugs undergo in the body and how the body reacts to the drugs

4 out of 5 elderly have at least 1 chronic disease

Many take numerous medications

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**The Elderly and Changes in Physiologic Function**

Altered drug responses in the elderly are due to age-related changes in organ function and body compositional changes

Physiologic changes

Optic	Cardiovascular
Auditory	Urinary
Gastrointestinal	Hormonal
Pulmonary	Body composition

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**The Elderly and Altered Drug Responses**

Age-related changes in organ functions and body composition can alter responses to medication

Absorption changes: GI function	Elimination changes: liver and kidneys
Distribution changes: protein binding	Metabolism changes: clearance decreases

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**The Elderly and Drug Responses**

Polypharmacy: many elderly take 3 to 12 medications

Disproportionate number of adverse drug reactions (ADRs)

Beers List contains drugs especially important to monitor in elderly

Noncompliance

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**Common Adverse Reactions in the Elderly**

Central nervous system changes	Incontinence
Constipation	Insomnia
Dermatitis	Rheumatoid symptoms
Diarrhea	Sexual dysfunction
Drowsiness	Urinary retention
Falls	Xerostomia (dry mouth)
GI upset	


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**The Pharmacy Technician and Elderly Patients**

Provide written information

Show aids to dosing and remembering to take medication

Communicate with empathy, not sympathy



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## Special Considerations in Children

Wide variation between age and degree of organ-system development

Body surface area best measure to use in determining dosage, but difficult to ascertain

Weight is most often used in determining dosage

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## Special Considerations in Children


Technicians always refer dosage questions to the pharmacist

Be sure dosage is appropriate for child's age

Always double-check all computations

Reevaluate all doses at regular intervals

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## Discussion

What should a pharmacy technician do when a parent is struggling to determine the best dose of an OTC medication for a pediatric patient?

Ask the pharmacist to determine the child's dose for the caretaker if the dose information is not provided.

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## Immunization

A process whereby the immune system is stimulated to acquire immunity to a specific disease

Achieved via a vaccine

Two types of immunity: active and passive

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## Immunity

**Active immunity**  
Coming in contact with an infectious agent or an inactivated part of an infectious agent through a vaccine

**Passive immunity**  
Receiving antibodies formed by another person or animal that developed them in response to being infected

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## Vaccines and Infectious Diseases

Safe, effective vaccines to prevent infectious diseases responsible for substantial decline in morbidity and mortality

Smallpox, rabies, diphtheria, pertussis, tetanus, yellow fever, poliomyelitis, measles, mumps, and rubella

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**TABLE 3.6a Immunization Schedule**  
Recommended Immunization Schedule for Persons Aged 0-6 Years—UNITED STATES - 2012

Vaccine	Age											
	Birth	1 month	2 months	4 months	6 months	9 months	12 months	15 months	18 months	19-23 months	2-3 years	4-6 years
Hepatitis B	HepB											
Rotavirus			RV	RV	RV							
Diphtheria, Tetanus, Pertussis			DTaP	DTaP	DTaP				DTaP			DTaP
Hemophilus influenzae type b			Hib	Hib	Hib			Hib				
Pneumococcal			PCV	PCV	PCV							PCV
Inactivated Poliovirus			IPV	IPV								IPV
Influenza									Influenza (Yearly)			
Measles, Mumps, Rubella								MMR				MMR
Varicella								Varicella				Varicella
Hepatitis A								HepA (dose 1)				HepA Series
Meningococcal												MCV4

  Range of recommended ages for all children  
  Certain high-risk groups  
  Range of recommended ages for all children and certain high-risk groups

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**TABLE 3.6b Immunization Schedule**  
Recommended Immunization Schedule for Persons Aged 7-18 Years—UNITED STATES - 2012

Vaccine	Age		
	7-10 years	11-12 years	13-18 years
Diphtheria, Tetanus, Pertussis	Tdap	Tdap	Tdap
Human Papillomavirus		HPV (3 doses)	HPV Series
Meningococcal	MCV4		MCV4 Booster at 16 yo
Pneumococcal		PPV	
Influenza		Influenza (yearly)	
Hepatitis A		HepA Series	
Hepatitis B		HepB Series	
Inactivated Poliovirus		IPV Series	
Measles, Mumps, Rubella		MMR Series	
Varicella		Varicella Series	

  Range of recommended ages  
  Catch-up immunization  
  Certain high-risk groups

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**TABLE 3.6c Immunization Schedule**  
Recommended Adult Immunization Schedule, by Vaccine and Age Group—UNITED STATES - 2012

Vaccine	Age					
	19-21 years	22-26 years	27-49 years	50-59 years	60-64 years	≥ 65 years
Influenza						
Tetanus, diphtheria, pertussis (Tdap)			Substitute 1-time dose of Tdap for Td booster; then boost with Td every 10 years			Td/Tdap
Varicella			1 dose annually			
Human papillomavirus (HPV) Female		3 doses				
Human papillomavirus (HPV) Male		3 doses				
Hepatitis Zoster						1 dose
Measles, mumps, rubella (MMR)		1 or 2 doses			1 or 2 doses	
Pneumococcal (polysaccharide)			1 or 2 doses			1 dose
Meningococcal			1 or more doses			
Hepatitis A				2 doses		
Hepatitis B					3 doses	

  For all persons in this category who meet the age requirements and who lack documentation of vaccination or have no evidence of previous infection  
  Recommended if some other risk factor is present (e.g., on the basis of medical, occupational, lifestyle, or other indications)  
  Tdap recommended for ≥65 if contact with <12-month-old child. Either Td or Tdap can be used if no infant contact  
  No recommendation

Source: United States Department of Health and Human Services, Center for Disease Control and Prevention.

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**Allergic Response**

Allergy: state of hypersensitivity of the immune system induced by exposure to a particular substance

Many substances in the environment naturally (seasonal, food) and others in pharmaceutical products

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**Histamine**

In response to allergy, body releases chemicals such as histamine

Produce red, watery eyes; sneezing; urticaria; rash; bronchiolar constriction

This histamine is designated as H<sub>1</sub>, and is treated with histamines.

- Gastric mucosal cells release a different type of histamine, known as H<sub>2</sub>.
- H<sub>2</sub> is treated with H<sub>2</sub> blockers such as Axid, Pepcid, Tagamet, or Zantac.

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**The Pharmacy Technician and Allergies**


Most allergic reactions not serious, but some can be life-threatening

Technician role is to screen patients for allergies

Make sure allergies have been addressed before any drugs are dispensed

If no allergies, NKA should be in the record

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## Allergies

Many types of allergic disease with many causes, involving any body system

- Hay fever
- Allergic rhinitis
- Allergic dermatitis (eczema)
- Contact dermatitis
- Allergies to food or drugs can cause urticaria (hives)

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## Teaching Patients Medication Management

Compliance is important

Patient adhering to the dose schedule and other particular requirements of the specific drug regimen

Pharmacy technician can positively influence patient drug therapy by accurately collecting and recording patient's medication history in patient's profile

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## Discussion

What kinds of information help improve patient compliance?

- Methods of administration
- How to make swallowing easier
- Times and time intervals for administration
- If medication should be taken with food or not
- Possible side effects
- How long the medication should be taken

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## Discussion

What can the pharmacy technician do to help patients manage their medications properly?

- Explain that the pharmacist is available for any questions or instructions
- Read to the patient (exact wording) the label, medication guide, or educational materials dispensed with Rx
- Cannot counsel patients


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## Warning Labels



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## Medication Labels

Technicians can ensure that patients understand how to read medication labels

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**Pharmacology for Technicians**  
 Medication Label Information

**FIGURE 3.4 Medication Label Information**

The information on a prescription, as shown in (a), is translated for the patient as instructions on the medication label, as shown in (b). This label also includes the physician's name and the date the prescription was filled, the drug name, the number of refills, and the pharmacy's address and phone number.

<p><b>Rx</b> HIT HOPE MEDICAL PARK          ST. PAUL, MN (612) 555-3551</p> <p>DEA # _____          P. name <i>David Marsh</i> Date <i>10-8-14</i>          # refills _____  <i>Protonix (antigastro)</i>  <i>twenty (20) mg</i>  <i>take one (1) tab po daily</i></p> <p>Dispensed as written # refills (ref)          THIS PRESCRIPTION IS NOT VALID WITHOUT THE SIGNATURE OF THE PHARMACY          M.D. <i>Anderson</i> M.D.</p> <p>(a)</p>	<p>THE CORNER DRUG STORE          451-555-1234 NO. 450113</p> <p>DOCTOR: W.D. Anderson          NAME: David Marsh          DATE: 10/9/14</p> <p><b>Rx</b> Protonix 20 mg          PO          Take one tablet by mouth daily.          Expires 10/9/15 ONE REFILL</p> <p>(b)</p>
--	--

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**Pharmacology for Technicians**  
 Information Provided with OTC Drugs

Patients should read the information provided with OTC drugs to understand their action, interactions, cautions, and possible side effects

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**Pharmacology for Technicians**  
 Noncompliance

Patients do not comply with medication program due to

- Side effects
- Failure to understand the disease
- Confusion caused by cognitive impairment or regimen complexity
- Forgetfulness

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**Pharmacology for Technicians**  
 Medication Safety

Technicians play a critical role in medication safety

Pharmacists rely on technicians to screen for errors

Technicians must

- Verify address, date of birth, phone numbers, allergies, and conditions such as pregnancy
- Make sure patient is offered counseling from pharmacist

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**Pharmacology for Technicians**  
 E-Prescribing

Reduces errors and improves patient safety

- Eliminating illegible prescriptions
- Automatically checking for allergies, interactions, dosing errors, therapeutic duplications

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**Pharmacology for Technicians**  
 Tamper-Resistant Pads

For prescribers to file for Medicaid reimbursement, must use tamper-resistant pads for written prescriptions

If not used, technician must call and verify the prescription

Document on the Rx with the date and time called, names of person who verified it, and technician's initials

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**Medication Reconciliation**

National Patient Safety Goals: make sure that pharmacies share information from patient profiles

This process is called medication reconciliation

Technicians will play a major role in making these transitions safer

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**Assignments**

Complete Chapter Review activities


Answer questions in Study Notes document

Study Partner

Quiz in review mode

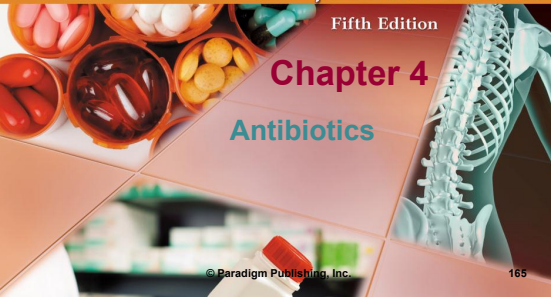
Matching activities

Drug tables




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**Pharmacology**  
*for Technicians*  
Fifth Edition



**Chapter 4**  
**Antibiotics**

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**Chapter 4 Topics**

Fighting Bacterial Infections


Major Classes of Antibiotic Drugs

Storage of Liquid Antibiotics

Ophthalmic Antibiotics

Treating Complications of Infections


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**Learning Objectives**

- Identify the major types of antibiotics by drug class.
- Know which auxiliary labels to use when dispensing major types of antibiotics.
- Define therapeutic effects, side effects, and administration routes of major antibiotics.
- Use antibiotic and general drug terminology correctly in written and oral communication.

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**Fighting Bacterial Infections**

**Bacteria**

Single-celled organisms occurring in most environments

**Infection**

Condition in which bacteria grow in body tissues and cause tissue damage by their presence or by toxins they produce

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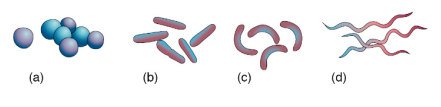
**Types of Bacteria**

**Aerobic**  
Needs oxygen to survive

**Anaerobic**  
Survives in the absence of oxygen

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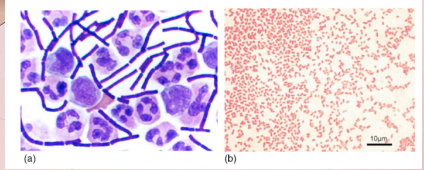
**Bacteria Shapes**



(a) Round cocci  
(b) Rod-like bacilli  
(c) Curved bacteria  
(d) Spiral-shaped spirochetes

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**Gram Stain**



(a) Gram-positive bacteria turn purple  
(b) Gram-negative bacteria appear red

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**Gram Stain Results and Related Diseases**

Shape	Gram Stain	Bacteria	Related Disease
rods	gram-positive	<i>Corynebacterium</i>	endocarditis
rods	gram-negative	<i>E. Coli</i>	UTI

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**Gram Stain Results and Related Diseases**


Shape	Gram Stain	Bacteria	Related Disease
cocci	gram-positive	<i>Staphylococcus</i>	toxic shock syndrome
cocci	gram-negative	<i>Neisseria</i>	gonorrhea

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**Gram Stain Results and Related Diseases**

Shape	Gram Stain	Bacteria	Related Disease
curved or spiral rods	gram-negative	<i>Campylobacter</i>	septicemia
spirochetes	gram-negative	<i>Treponema palladium</i>	syphilis


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### How Antibiotics Work

- Prevent folic acid synthesis
  - Sulfonamides
- Impair cell wall formation
  - Penicillins
  - Cephalosporins


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### How Antibiotics Work

- Prevent folic acid synthesis
- Impair cell wall formation
- Block protein formation
  - Macrolides
  - Tetracyclines
  - Aminoglycosides
- Interfere with DNA formation


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### How Antibiotics Work

- Prevent folic acid synthesis
- Inhibit cell wall formation
- Block protein formation
- Interfere with DNA formation
  - Quinolones
- Disrupt cell membranes
  - Cyclic lipopeptides
- Disrupt DNA structure
  - Metronidazole

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### Dispensing Issues of Antibiotics

**Warning!**

- Mix exactly as directed by manufacturer
- Swab counting tray with alcohol between drugs to prevent cross-contamination

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### Side Effects of Antibiotics


Most antibiotics taken on an empty stomach to attain faster absorption

Exceptions

- nitrofurantoin
- cefuroxime




**TAKE WITH FOOD**



**Take on an empty stomach**

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### Antimicrobial Resistance

Developing largely because of

- Overuse
- Misuse

Superinfection may occur


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**Antimicrobial Resistance**  
Pharmacy technician—place a label on antibiotics advising patient to take all of the medication


**TAKE ALL OF THIS MEDICATION**

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**Discussion**  
How might the widespread use of antibacterial soaps affect the population?


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**Major Classes of Antibiotic Drugs**


Sulfonamides	Ketolides
Pencillins	Quinolones
Cephalosporins	Streptogramins
Tetracyclines and Tigecycline	Aminoglycosides
Macrolides	Cyclic Lipopeptides

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**Sulfonamides**  
AKA “sulfa drugs”  
Effective against a broad range of microorganisms  
Block specific step in biosynthetic pathway for making folic acid  
Interfere with PABA and folic acid formation, thereby destroying bacteria

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**Penicillins**  
Low toxicity  
Derivatives created by manipulating basic molecular structure of drug  
Kills bacteria by preventing them from forming rigid cell wall  
Because human cells do not have rigid cell walls, they are not affected

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**Cephalosporins**  
Mechanism of action similar to penicillins  
Person allergic to penicillin has about 1% chance of being allergic to cephalosporins

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### Drugs Related to Penicillins and Cephalosporins

New beta-lactam drugs differ slightly in structure

Carbapenems, carbacephems, and monobactam

Some used for serious infections

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### Tetracyclines

Broad-spectrum bacteriostatic antibiotics

Inhibit protein synthesis in bacteria by binding to ribosomes

Suppress infection, but require phagocytes to eradicate bacteria completely

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### Macrolides

Inhibit protein synthesis by combining with ribosomes

Used primarily to treat pulmonary infections

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### Ketolides


Bind to ribosomal subunits and block protein synthesis

May inhibit newly forming ribosomes

Bacteria resistant to macrolides, lincomycin derivatives, and streptogramins is also resistant to ketolides

Used to treat bacterial infections in lungs and sinuses

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### Quinolones

Strong, rapid bactericidal action against

- Most gram-negative bacteria
- Many gram-positive bacteria

Antagonize enzyme responsible for coiling and replicating DNA, causing DNA breakage and cell death

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### Streptogramins


Inhibit protein synthesis within the bacterial ribosomes

Alternative to vancomycin

Side effects similar to quinolones: nausea, vomiting, joint swelling, dizziness

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### Aminoglycosides

Used to treat serious infections  
Inhibits bacterial protein synthesis by binding to ribosomal subunits  
After first dose, dosage adjusted according to plasma concentrations


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### Cyclic Lipopeptides

Bind bacterial membranes causing cell membrane to depolarize  
Leads to  
Inhibition of DNA and RNA synthesis  
Bacterial death


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### Other Antibiotics

Several important antibiotics are structurally distinct from those in other classes  
Each other


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### Vancomycin (Vancocin)

**Warning!**  
Bacterial resistance increasing due to overuse  
Strict CDC guidelines for handling and use


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### Clindamycin (Cleocin)

Broad-spectrum antibiotic used for  
Acne  
Penicillin alternative in dental prophylaxis  
Anaerobic pneumonia  
Bone and bowel infections  
Intra-abdominal and female genital infections


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### Clindamycin (Cleocin)

**Warning!**  
If patient develops diarrhea, drug must be discontinued

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**linezolid (Zyvox)**  
First oxazolidinone approved by FDA  
Inhibits bacterial protein synthesis  
Drug must be protected from light


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**metronidazole (Flagyl)**  
Pharmacy technician—place **No Alcohol** warning sticker on medication




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**pentamidine (NebuPent, Pentam)**  
Second-line agent for *Pneumocystis carinii*  
Mechanism of action unknown  
Patient may develop sudden hypotension (low blood pressure)

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**Storage of Liquid Antibiotics**  
After lyophilized (powdered) antibiotics are mixed  
Some need refrigeration  
Others stored at room temperature  
Pharmacy technician may tell storage information to patient

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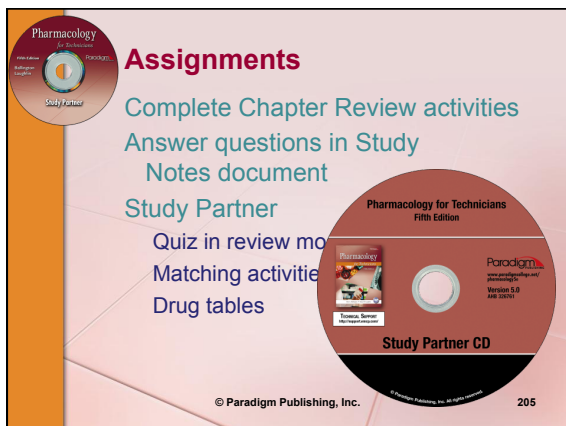
**Ophthalmic Antibiotics**  
Some antibiotics have ophthalmic (eye) dosage forms  
Very few antibiotics have otic forms  
Very painful in the eye  
Otic medicines have different pH than the eye

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**Discussion**  
Why is resistance developing to antibiotics? Is this a problem?  
What role can the pharmacy technician play in regard to this problem?

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**Assignments**

- Complete Chapter Review activities
- Answer questions in Study Notes document
- Study Partner
  - Quiz in review mode
  - Matching activities
  - Drug tables

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