



# MEDICINAL CHEMISTRY

Medicinal chemistry deals with the design, optimization and development of chemical compounds for use as drugs.



## Functional Groups

- Functional groups play a significant role in:
  - Water/lipid solubility
  - Route of administration
  - Ability to interact with the specific biological target
  - Mechanism (mode or method) of action
  - Route of metabolism and elimination
  - Duration of action
  - Susceptibility for specific therapeutic situations
  - Tendency to cause adverse effects or drug interactions
- These concepts that should always be considered when examining a drug molecule:
  - Every atom within the structure belongs to some functional group.
  - Within a drug molecule, some functional groups may be more “important” than others. The opposite may be true for a different drug molecule.
  - Altering functional groups can enhance activity, increase absorption, decrease adverse effects, and provide other therapeutic benefits.
  - These major chemical properties that need to be analyzed for every functional group:
    - Electrostatic effect:** The components that comprise the overall electronic effect of a functional group are induction and resonance.
      - Measured by a functional group's ability to donate its electrons to adjacent atoms or functional groups
    - Solubility effects:** Overall solubility is a composite sum of all the functional groups found as part of a drug molecule.
      - Size effect:** Each functional group has a finite size and some dimensions; this contributes to the overall conformation and thus the 3-D shape of a given drug.
  - The three major chemical properties combined need to be considered when evaluating the overall pharmacodynamic and pharmacokinetic properties of any given drug molecule.

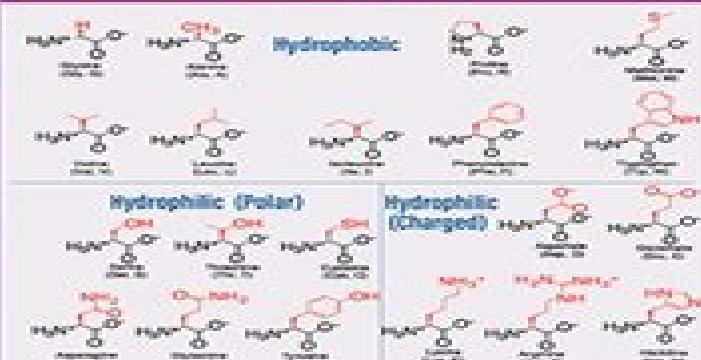
### ELECTRONEGATIVITY: KEY POINTS

- C, O, Cl, and N are the most electronegative elements.
- O will always attract electrons to it, unless it is attached to a F.
- All the halogens (F, Cl, Br, and I) as well as O and N will attract electrons away from C.
- C will slightly attract electrons away from H (inductive effect).
- The difference in electronegativity causes a dipole.

### Solubility

- Universal water and/or lipid solubility of a drug molecule affects its route(s) of administration, distribution within the body, metabolism, duration of action, and route(s) of elimination.

## Amino Acids



## pH & pK<sub>a</sub>

### pH

- pH =  $-\log[H^+]$
- Refers to the solution, not a functional group
- Indicates how many “free”  $H^+$  there are in the solution
- ICN: pH of 0.1M  $H^+$
- $pH = -\log(0.1) = -(-1) = 1$
- ICN: pH of 0.0001M  $H^+$
- $pH = -\log(0.0001) = -(-4) = 4$

### Acid Strength (pK<sub>a</sub>)

- Property of functional groups
- Affected by size and electronic effects
- Can be used to compare the relative acidity of functional groups
  - Rule 1: Lower pK<sub>a</sub> value → stronger acid (wants to lose the  $H^+$ )
  - Rule 2: Higher pK<sub>a</sub> value → stronger conjugate base/weak acid (wants to gain the  $H^+$ )

### pK<sub>a</sub>

- Low pK<sub>a</sub>: Reaction is to the right
- High pK<sub>a</sub>: Reaction is to the left

$$pK_a = -\log(K_a)$$



Henderson-Hasselbach equation:

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

- Used to calculate the:
  - pH change in buffered solutions
  - pH change in the molar ratio of salt to acid concentrations needed to prepare a buffer solution at a certain pH
  - Percent ionization of a functional group at a certain solution pH

ICN: Fluoroprotein's functional group has a pK<sub>a</sub> of 4.5, so it must be carboxylic acid. Will it be protonated or deprotonated if it is in the urine at pH 5.5?



$$5.5 = 4.5 + \log \frac{[A^-]}{[HA]}$$

$$1.0 = \log \frac{[A^-]}{[HA]}$$

$$10^1.0 = \frac{[A^-]}{[HA]}$$

$$10 = \frac{[A^-]}{[HA]}$$

$$10 = \frac{[A^-]}{[A^-] + [HA]}$$

$$10 = \frac{1}{1 + \frac{[HA]}{[A^-]}}$$

$$10 = \frac{1}{1 + \frac{10^{-4.5}}{10^{-5.5}}}$$

$$10 = \frac{1}{1 + 10^{-1}}$$

$$10 = \frac{1}{1 + 0.1}$$

Answers: More deprotonated

The protonation state affects:

The charge of a functional group ( $+ve$  or  $-ve$ )

# Medicinal Chemistry Study Guide

**Marc W. Harrold, Robin M. Zavod**

## **Medicinal Chemistry Study Guide:**

### **Medicinal Chemistry of Drugs Affecting Cardiovascular and Endocrine Systems** M. O. Faruk Khan,2024-02-19

The primary objective of this 4 volume book series is to educate PharmD students on the subject of medicinal chemistry. The book set serves as a reference guide to pharmacists on aspects of the chemical basis of drug action. Medicinal Chemistry of Drugs Affecting Cardiovascular and Endocrine Systems is the third volume of the series. This volume features 8 chapters focusing on a comprehensive account of drugs affecting both the cardiovascular system and the endocrine functions. The volume informs readers about the medicinal chemistry of relevant drugs which includes the mechanism of drug action, detailed structure activity relationships and metabolism. Topics covered include drugs that affect the renin angiotensin system, calcium channel blockers, diuretics, hematological agents, anticoagulants, thrombolytic and antiplatelet agents, antidiabetics, antihistamines, proton pump inhibitors and therapeutic hormones. Each chapter also offers case studies and self assessments to facilitate discussion and learning. The book equips students with a scientific foundation to competently evaluate, recommend and counsel patients and health care professionals regarding the safe, appropriate and cost effective use of medications. Students and teachers will also be able to integrate the knowledge presented in the book and apply medicinal chemistry concepts to understand the pharmacodynamics and pharmacokinetics of therapeutic agents in the body. The information offered by the book chapters will give readers a strong neuropharmacology knowledge base required for a practicing pharmacist. Readership: PharmD, pharmacology students and teachers.

### **A Laboratory Guide in Pharmaceutical Chemistry with Two Hundred Experiments** F. P. Vandenbergh,1888      **Organic Chemistry**

**Fundamentals Study Guide** Speedy Publishing,2014-11-26 In order to fully understand any subject the fundamentals must be understood and kept in the back of the mind. Organic Chemistry is one of the most difficult subjects a college student can take especially if they are not a Chemistry major. A lot goes into the fundamentals of the subject. That is why an Organic Chemistry Fundamentals book can be so helpful to a student. When studying the material if the student discovers they do not understand something they can reference the book and continue with studying in no time at all. Having a reference book is the key to success in an Organic Chemistry class.

### **Lecture Notes for Chemical Students** Edward Frankland,1876

*Studyguide for Medicinal Chemistry: an Introduction by Gareth Thomas, ISBN 9780470025987* Cram101 Textbook Reviews,2013-01-01 Never HIGHLIGHT a Book Again. Virtually all of the testable terms, concepts, persons, places, and events from the textbook are included. Cram101 Just the FACTS101 studyguides give all of the outlines, highlights, notes, and quizzes for your textbook with optional online comprehensive practice tests. Only Cram101 is Textbook Specific. Accompanys 9780470025987      *National Library of Medicine Current Catalog* National Library of Medicine (U.S.),1993      **Basic Concepts in Medicinal Chemistry** Marc Harrold,Robin Zavod,2013-01-18 Medicinal chemistry is a complex topic. Written in an easy to follow and conversational style. Basic Concepts in Medicinal Chemistry focuses on the fundamental concepts.

that govern the discipline of medicinal chemistry as well as how and why these concepts are essential to therapeutic decisions. The book emphasizes functional group analysis and the basics of drug structure evaluation. In a systematic fashion learn how to identify and evaluate the functional groups that comprise the structure of a drug molecule and their influences on solubility absorption acid base character binding interactions and stereochemical orientation. Relevant Phase I and Phase II metabolic transformations are also discussed for each functional group. Key features include Discussions on the roles and characteristics of organic functional groups including the identification of acidic and basic functional groups. How to solve problems involving pH pKa and ionization salts and solubility drug binding interactions stereochemistry and drug metabolism. Numerous examples and expanded discussions for complex concepts. Therapeutic examples that link the importance of medicinal chemistry to pharmacy and healthcare practice. An overview of structure activity relationships SARs and concepts that govern drug design. Review questions and practice problems at the end of each chapter that allow readers to test their understanding with the answers provided in an appendix. Whether you are just starting your education toward a career in a healthcare field or need to brush up on your organic chemistry concepts this book is here to help you navigate medicinal chemistry.

**About the Authors**

Marc W Harrold BS Pharm PhD is Professor of Medicinal Chemistry at the Mylan School of Pharmacy Duquesne University Pittsburgh PA. Professor Harrold is the 2011 winner of the Omicron Delta Kappa Teacher of the Year award at Duquesne University. He is also the two time winner of the TOPS Teacher of the Pharmacy School award at the Mylan School of Pharmacy. Robin M Zavod PhD is Associate Professor for Pharmaceutical Sciences at the Chicago College of Pharmacy Midwestern University Downers Grove IL where she was awarded the 2012 Outstanding Faculty of the Year award. Professor Zavod also serves on the adjunct faculty for Elmhurst College and the Illinois Institute of Technology. She currently serves as Editor in Chief of the journal Currents in Pharmacy Teaching and Learning.

*Basic Concepts in Medicinal Chemistry* Marc W. Harrold, Robin M. Zavod, 2023

Designed to help students incrementally build their knowledge of fundamental concepts of medicinal chemistry and their applications to therapeutic decisions it is progressively organized. Specific sections of the text have been updated to make potentially confusing concepts easier to understand. Numerous examples and review questions further reinforce learning and analytical skills. This updated and expanded edition of the popular textbook *Basic Concepts in Medicinal Chemistry* has been enhanced with new subject material numerous self assessment tools and special features to advance and strengthen the learning process.

New in the Third Edition Enhanced explanations discussions and examples in many key chapters Additional summary tables to help readers better select the proper drug binding interaction Expanded discussion on Pharmacogenomics including multiple specific examples Updated examples throughout the text to include a wider range of drugs and drug classes Increased focus on application of concepts to therapeutic decisions and pharmacy practice

**Medical Technology Examination Review and Study Guide** Anna P. Ciulla, Georganne K. Buescher, Joan H. Youse, 1988

**A Text-book of medical chemistry** Elias Hudson Bartley, 1895

**Chemistry: General, Medical, and Pharmaceutical, Etc. (Second Edition of "An Introduction to Pharmaceutical Chemistry" .) John Attfield,1875** **Pharmaceutical Chemistry - I** Dr. A. V. Kasture,Dr. S. G. Wadodkar,2015-07 Quality Control in Pharmacy Errors in Analysis Impurities in Pharmaceutical Substances and Limit Tests Water Solubility of Pharmaceuticals Acids Bases and Buffers Antioxidants Gastrointestinal Agents Topical Agents Dental Products Inhalants Expectorants Emetics and Respiratory Stimulants Major Intra and Extracellular Electrolytes Official Compounds of Iron Official Compounds of Iodine Official Compounds of Calcium Radiopharmaceuticals and Contrast Media Antidotes in Poisoning Identification Tests for Ions and Radicals Appendix Index Bibliography *Chemistry: General, Medical, and Pharmaceutical, Including the Chemistry of the U.S. Pharmacopœia* John Attfield,1879 Catalog of Copyright Entries, Third Series Library of Congress. Copyright Office,1971 **A Text-book of the principles and practice of medicine** Henry Munson Lyman,1892 **Chemistry: general, medical, and pharmaceutical** John Attfield,1875 **Text-book of Medical Chemistry for Medical and Pharmaceutical Students and Practitioners** Elias Hudson Bartley,1894

**Introduction To Medicinal Chemistry** ,2024-04-02 Introduction to Medicinal Chemistry serves as a comprehensive guide to exploring the dynamic and evolving field of medicinal chemistry Written with precision and expertise this book provides a practical journey into the principles and applications underpinning the development of pharmaceutical agents With a focus on the intersection of chemistry and medicine the text delves deeply into the molecular mechanisms controlling drug action emphasizing the importance of understanding structure activity relationships This book highlights the complexities of drug design synthesis and optimization through the fundamental concepts of medicinal chemistry It meets the needs of both novice learners and experienced practitioners in the field offering a balanced mix of theoretical foundations and practical applications Readers will find explanations on the chemical basis of various diseases identification of drug targets and design of molecules with therapeutic potential Notably the author uses a clear writing style which highlights complex concepts and facilitates an intuitive understanding of the subject matter The inclusion of case studies and real world examples further enhances the practical relevance of the book fostering a deeper appreciation for the role of medicinal chemistry in modern health care Introduction to Medicinal Chemistry stands as an indispensable resource for students researchers and professionals seeking a holistic understanding of the principles of drug discovery and development Its broad coverage and accessible approach make it an invaluable tool for those wishing to unravel the secrets of medicinal chemistry and contribute to the advancement of pharmaceutical science **A Manual of medical jurisprudence** Alfred Swaine Taylor,1892 Applied Medical Chemistry Lawrence Wolff,1885

## Reviewing **Medicinal Chemistry Study Guide**: Unlocking the Spellbinding Force of Linguistics

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