As Per PCI Regulations

First Year B. Pharm. • Semester-I

PHARMACEUTICAL INORGANIC CHEMISTRY

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NIRALI PRAKASHAN

A TEXT BOOK OF

PHARMACEUTICAL INORGANIC CHEMISTRY

As Per PCI Regulations

FIRST YEAR B. PHARM

Semester I

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Price ₹ 190.00

NIRALI PRAKASHAN
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N4009

Pharmaceutical Inorganic Chemistry **ISBN 978-93-86700-38-4**

Second Edition : April 2018

Published By : **(Polyplate)** **Printed By :**

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Off J.M. Road, PUNE – 411005
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YOGIRAJ PRINTERS AND BINDERS
Works: Sr. No. 10\1,Ghule Industrial Estate,
Nanded Village Road,
TAL-HAVELI, DIT-PUNE 411041.
Mobile - 9850046517, 9404225254

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Preface

The **Pharmaceutical Inorganic Chemistry** book has been written, keeping in view the needs and interest of pharmacy students. This book might for some appears to be blend of definition, terminologies and disciplines related to an array of compounds being used therapeutically. It also includes their sources, preparation, chemical structure, identification tests, limit tests and uses in ample details to serve the purpose of pharmacy and general chemistry courses. The prime aim of the authors have always been to keep purity in the subject matter, the various terms which have been introduced and defined in an exact, accurate and lucid manner. Beside this, the entire text has been duly substantiated with figures, tables, classic text, modern presentation and application to appraise the students with relevant and easy-to-grasp content.

The present book has been written according to the **latest syllabus by PCI 2017**, New Delhi for B. Pharmacy, Semester I students. The Pharmaceutical Inorganic Chemistry book has been divided into five units, each unit containing chapters as mentioned in the syllabus. Every attempt has made to make each chapter independent and self containing. The aim and objective of this book is solely focused upon the basic knowledge of Inorganic Chemistry, to the pharmacy students engaged in the professional programme. The book is visually beautiful and the authors communicate their enthusiasm of the subject in every chapter.

Any constructive criticism, comments and suggestions for further improvement from the readers are always welcome. We wish to thank the publisher Shri. Dineshbhai Furia and Shri. Jignesh Furia for the sustained interest shown by them during the entire work. The authors acknowledge the unstinted help and excellent co-operation from Mr. Amit and Ms Roshan Khan of Nirali Publication, for bringing out this book in a record time frame.

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Syllabus

Unit I **10 Hours**

Impurities in Pharmaceutical Substances: History of Pharmacopoeia, Sources and types of impurities, Principle involved in the limit test for Chloride, Sulphate, Iron, Arsenic, Lead and Heavy metals, Modified limit test for Chloride and Sulphate.

General Methods of Preparation: Assay for the compounds superscripted with asterisk (*), Properties and medicinal uses of inorganic compounds belonging to the following classes.

Unit II **10 Hours**

Acids, Bases and Buffers: Buffer equations and buffer capacity in general, Buffers in pharmaceutical systems, Preparation, Stability, Buffered isotonic solutions, Measurements of Tonicity, Calculations and Methods of adjusting isotonicity.

Major Extra and Intracellular Electrolytes: Functions of major physiological ions. Electrolytes used in the replacement therapy: Sodium chloride* - Potassium chloride, Calcium gluconate* and Oral Rehydration Salt (ORS), Physiological acid, base balance.

Dental Products: Dentifrices, Role of fluoride in the treatment of dental caries, Desensitizing agents, Calcium carbonate, Sodium fluoride and Zinc eugenol cement.

Unit III **10 Hours**

Gastrointestinal Agents

Acidifiers: Ammonium chloride* and Dil. HCl

Antacids: Ideal properties of antacids, Combinations of antacids, Sodium Bicarbonate*, Aluminium hydroxide gel, Magnesium hydroxide mixture.

Carthartics: Magnesium sulphate, Sodium orthophosphate, Kaolin and Bentonite.

Antimicrobials: Mechanism, Classification, Potassium permanganate, Boric acid, Hydrogen peroxide*, Chlorinated lime*, Iodine and its preparations.

Unit IV **08 Hours**

Miscellaneous Compounds

Expectorants: Potassium iodide, Ammonium chloride*.

Emetics: Copper sulphate*, Sodium potassium tartarate.

Haematinics: Ferrous sulphate*, Ferrous gluconate.

Poison and Antidotes: Sodium thiosulphate*, Activated charcoal, Sodium nitrite 333.

Astringents: Zinc sulphate, Potash alum

Unit V **07 Hours**

Radiopharmaceuticals: Radioactivity, Measurement of radioactivity, Properties of α, β, γ radiations, Half-life, Radio isotopes and study of radio isotopes - Sodium iodide, I^{131}, Storage conditions, Precautions and Pharmaceutical applications of radioactive substances.

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Unit ... 1

IMPURITIES IN PHARMACEUTICAL SUBSTANCES

SYNOPSIS

1.1 INTRODUCTION TO PHARMACEUTICAL CHEMISTRY

Pharmaceutical Chemistry is a branch of chemistry that deals with the chemical, biochemical and pharmacological aspects of drugs. It includes synthesis, isolation, identification, structural elucidation, structural modification, Structure Activity Relationship (SAR) studies, study of the chemical characteristics, biochemical changes after drug administration and their pharmacological effects.

Inorganic Chemistry:

Inorganic chemistry is the study of all the elements and their compounds except carbon and its compounds (which is studied under organic chemistry). Inorganic chemistry describes the characteristics of substances obtained from non-living things/matter and minerals which are found in the earth except the class of organic compounds.

Branches of inorganic chemistry include coordination chemistry, bioinorganic chemistry, organometallic compounds and synthetic inorganic chemistry, Inorganic compounds has applications in every aspect of the pharmacy, chemical industry–including catalysis in drug synthesis, pigments, surfactants and agriculture. In short, Inorganic chemistry is the branch of chemistry that deals with inorganic compounds.

Inorganic Compounds:

Organic compounds are those that are found in biological systems. In general organic chemists say that any molecule containing carbon is an organic compound and hence this means that inorganic chemistry deals with the compounds or molecules which lack carbon atom.

Berzelius, the 19thcentury chemist, described inorganic compounds as inanimate. The first important synthetic inorganic compound was Ammonium Nitrate used for soil fertilization.

Inorganic compounds are found in nature as minerals. Soil contains Iron Sulfide as Pyrite or Calcium Sulfate as Gypsum. They are also found as multitasking biomolecules: As electrolytes (Sodium Chloride), in energy storage (ATP) or in construction (the Polyphosphate backbone in DNA).

Inorganic compounds are synthesized for use as drugs such as Cisplatin, Magnesium Hydroxide, catalysts such as Vanadium (V) Oxide and Titanium (III) Chloride, or as reagents in organic chemistry such as Lithium Aluminium Hydride.

Medicinally useful substances are derived from either organic or inorganic sources. Naturally obtained compounds has always attracted the human attention while inorganic chemicals contributing significantly in several ailments, even after the development of many drugs from synthetic and plant sources. Many of the inorganic salts (Antimony, Arsenic and Mercury) are known to be poison; still they are used in medicine cautiously. Some of them are replaced by the organic medicines.

Study of pharmaceutical applications of inorganic compounds led to the establishment of a new avenue called **Pharmaceutical inorganic chemistry,** *"which deals with the study of both non-essential and essential elements, their preparation, standards of purity, test for identification, limit tests to be performed for determining the quality, extent of purity, different formulations, their storage conditions and therapeutic uses."*

The term 'Pharmaceutical' is used for any chemical substance useful in preventive or therapeutic or which finds use in the preparation of medicament. Some find use only in the laboratory during the preparation but may not be present in the final product; these are also incorporated under pharmaceuticals. Quality of all these pharmaceuticals must be carefully controlled. For this reason, specifications of quality are mentioned for each pharmaceutical and are reported in pharmacopoeia.

Importance of Inorganic Pharmaceuticals:

Inorganic pharmaceuticals are useful in any of the following ways:

1. **For therapeutic purpose:** Examples: Astringents, Antimicrobials etc.
2. **As pharmaceutical aids:** Examples: Bentonite, Talc etc.
3. To change the reaction of body fluid either by acidifier or alkaliser. Examples: Antacids, alkalis, mineral acids etc.
4. Replacing or replenishing the normal content of body fluids. Examples: Sodium, Potassium, Calcium, Chloride, Phosphate etc.
5. **As reagents** to carry out the reactions. Example: Catalysts (Platinum, Nickel) oxidizing and reducing agents (Lithium Aluminium Hydride).
6. **In pharmaceutical analysis**. Example: Titrants such as Potassium Permanganate, EDTA etc.

1.2 INTRODUCTION TO PHARMACOPOEIA

The books containing the standards for drugs and other related substances are known as pharmacopoeia and formularies - collectively these books are known as the **drug compendia**.

The word **"pharmacopoeia"** is derived from the Greek words ***'pharmacon'*** meaning 'drug or medicine' and ***'poeio'*** means 'to make'. Literally it means a list of medicinal substances, crude drugs and also contains formulae for making preparations from them.

The pharmacopoeias or formularies contain a list of drugs and other related substances regarding their source, descriptions, standard tests, formulae for preparing the same, action and uses, doses, storage conditions etc. These books are prepared under the authority of the Government of the respective countries.

These books are revised from time to time so as to introduce the latest information available as early as possible after they become established. In order to keep the size of book within reasonable limit, it becomes necessary to omit certain less frequently used drugs and pharmaceutical adjuvants from each new edition of the book. Therefore, in each new edition of these books, certain new monographs are added while the older ones are deleted. For the preparation of these books, the expert opinion of medical practitioners, teachers and pharmaceutical manufacturers are obtained.

Classification of Compendia:

The drug-compendia are classified as:

(i) Official compendia (ii) Non-official compendia

(i) Official Compendia:

Official compendia are the compilations of drugs and other related substances which are recognized as legal standards for purity, quality and strength by a government agency of respective countries of their origin.

Examples:

- British Pharmacopoeia (BP)
- British Pharmaceutical Codex (BPC)
- Indian Pharmacopoeia (IP)
- United States Pharmacopoeia (USP)
- National Formulary (NF)
- The State Pharmacopoeia of USSR and
- Pharmacopoeias of other countries

(ii) Non-official Compendia:

The books other than official drug compendia which are used as secondary reference sources for drugs and other related substances are known as non-official drug compendia.

Examples:

- Merck Index
- Extra Pharmacopoeia (Martindale)
- United States Dispensatory

Monograph:

In simple way monographs are descriptions of pharmaceutical preparations. In a broader way it is a reference work for pharmaceutical drug specifications. It is a complete description of a specific pharmaceutical, which includes chemical formulae, atomic and molecular weight, definition, statement of content, category, dose, usual strength, description, solubility, identification tests, assay, other test, limits of impurities, quantities, and conditions for storage.

The appendices include standards for apparatus, reagents and solutions, indicators, reference substances, test animals, calculation of results, other chemical techniques, processes etc. of the concerned pharmaceuticals.

By the direction of the council of the pharmaceutical society of the certain nations, the world's most comprehensive source of drug information in a single volume is published periodically in the society's department of pharmaceutical sciences.

It is the traditional activity, to help the practicing pharmacists and physicians aiming to provide unbiased concise reports on the actions and uses of most of the world's drugs and medicines. By reflecting clinical practice, every publication of Pharmacopoeia monographs is accurately organized based on the updated needs of today's pharmacist. In the form of new monographs, the details are provided for new compounds and some of the previous monographs which are not in continued use are deleted. The overall effect is to provide an increase in the average of drugs with typographically improvements to assist the reader in locating sections of a monograph. With the search for an effective treatment of diseases a few of the developing therapeutics are revised continuously in Pharmacopoeia. Example: Anti HIV agents. In Pharmacopoeia the drug's distinguished features are updated, renewed and discussed for the treatment of infections and development of antiviral, antiprotozoal and antibacterial therapy. Along with novel approaches in the treatment advances, the cardiovascular group of drugs are included. The other areas like anti-malarial drugs, anti-neoplastic agents, anti-parkinsonism drugs etc. are also included in Pharmacopoeia.

Based on the content of information, Pharmacopoeia is divided into three different major parts. Each part is comprised of several chapters.

Part I: Generally the drugs that have similar use or actions are compiled together by part I of Pharmacopoeia. In related chapters the cross references are used to guide reader and to find out the drug that may be of their interest. The common actions of the groups of drugs are provided as background information in many of the chapters.

Part II: Monographs of new drugs, drugs under investigation, drugs which are not easily classified and obsolescent drugs still of interest are presented in part II of Pharmacopoeia. It also provides details regarding effects of required drug therapy.

Part III: Composition of the proprietary medicines that are advertised to the public in different countries is documented with omission of herbal medicine in part III of Pharmacopoeia.

Only the pharmaceuticals which are commonly and currently in use are included in the Pharmacopoeia; whereas the substances which are found to be undesirable and are not currently in use are excluded. Moreover part of Pharmacopoeia may also comprise the pharmaceuticals which are used for application or internal consumption by human beings.

In the Pharmacopoeia only minimum standards are prescribed for pharmaceuticals, but with more stringent standards the manufacturer may supply these substances. Hence a drug has to obey strictly the standards prescribed by any one of the Pharmacopoeias. The medication may be considered as substandard if it does not obey these standards and will not be prescribed by medical practitioners.

History of Pharmacopoeia:

The term ***Pharmacopoeia*** first appears as a distinct title in a work published in Basel, Switzerland in 1561 by **Dr A. Foes,** but does not appear to have come into general use until the beginning of the 17^{th} century. Today's pharmacopoeias focus mainly on assurance of quality of products by various tools of analytical sciences.

On 15^{th} December 1820, the first United State Pharmacopoeia (U.S.P) was released. In 1864, the first British Pharmacopoeia (B.P) was published with inclusion of monographs on benzoic acid, gallic acid, tartaric acid, tannic acid, camphor, lactose, sucrose and seven alkaloids along with their salts.

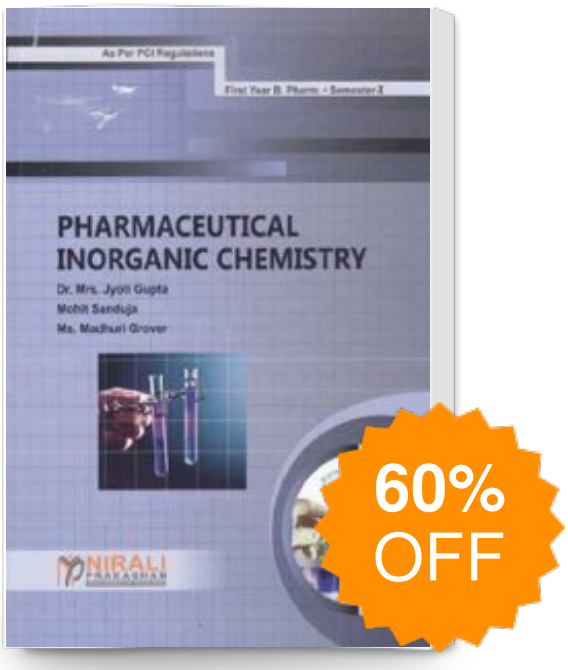
Indian Pharmacopoeia:

Indian Pharmacopoeia (IP) is an official document meant for overall Quality Control and Assurance of Pharmaceutical products marketed in India, by way of contributing on their safety, efficacy and affordability. IP contains a collection of authoritative procedures of analysis and specifications for Drugs. The IP, or any part of it, has got legal status under the Second Schedule of the Drugs & Cosmetics Act, 1940 and Rules 1945 there under.

IP prescribes standards for identity, purity and strength of drugs essentially required from health care perspective of human beings and animals. IP standards are authoritative in nature. They are enforced by the Regulatory authorities for quality control of medicines in India. During Quality Assurance and at the time of dispute in the court of law the IP standards are legally acceptable.

- The historical developments of Pharmacopoeia in India traces back to 1563 and the credit goes to **GarciadaOrta** a Portuguese physician-cum-teacher.
- The idea of indigeneous Indian Pharmacopoeia was conceived in 1837 which bore fruits in 1841 in the shape of **Bengal Pharmacopoeia** and **Conspectus of Drugs**.
- The Bengali and Hindi version of **London Pharmacopoeia** was made available in India from 1901 onwards.
- The **Indian Pharmacopoeial List**, published in 1946 formed the seeding for the true **Official Indian Pharmacopoeia** published in 1955.

Pharmaceutical Inorganic Chemistry



Publisher : Nirali Prakashan ISBN : 9789386700384 Author : Dr. Mrs. Jyoti Gupta, Mohit Sanduja, Ms. Madhuri Grover