



3.3.2

Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during last five years



3.3.2

1. Cover page, content page and first page of the selected publication.



K. K. WAGH COLLEGE OF PHARMACY

(B. Pharmacy & D. Pharmacy)

Hirabai Haridas Vidyanagari, Amrutdham, Panchavati, Nashik - 422 003. (Maharashtra) India.

☎ : 0253 - 2221121, 2517003, 2510262 Web : www.pharmacy.kkwagh.edu.in

Email: principal-bpharmacy@kkwagh.edu.in, disp-bpharmacy@kkwagh.edu.in

(Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, MSBTE, Mumbai & Approved by PCI)

3.3. Research Publications and Awards

3.3.2 Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during last five year

Sr. No.	Name of the teacher	Title of the book/chapters published	National / International	Year of publication	ISBN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher
1	Dr. Vaibhav G. Bhamre, Mr. Shivraj P. Jadhav	Concepts of Physical Pharmaceutics I	National	2021-2022	9789392867392	K. K. Wagh College of Pharmacy	PharmaCareer Publications
2	Bhamare V. G., Amrutkar R. D., Patil V, Upasani C. D.	Growing impact of herbal bioenhancers in pharmaceutical industries	International	2021-2022	9783110746792	K. K. Wagh College of Pharmacy	De-Gruyter
3	Shamal. D. Dawange	A Laboratory Manual for Pharmacognosy	National	2021-2022	9788195407422	K. K. Wagh College of Pharmacy	Briliant Publication
4	Dr. K. S. Jain, D. K. Kadam	A Practical of Pharmaceutical Analysis-	National	2020-2021	9789390596898	K. K. Wagh College of Pharmacy	Nirali Prakashan
5	Dr. K. S. Jain, D. K. Kadam, K. P. Baviskar	Pharmaceutical Analysis I	National	2019-2020	978-93-90506-60-6	K. K. Wagh College of Pharmacy	Nirali Prakashan
6	Dr. K. S. Jain	A Practical book of Pharmaceutical Organic Chemistry	National	2018-2019	978-93-87686-05-2	K. K. Wagh College of Pharmacy	Nirali Prakashan
7.	Dr. K. S. Jain	Pharmaceutical Organic Chemistry– I, Simplified	National	2018-2019	978-93-87397-62-0	K. K. Wagh College of Pharmacy	Nirali Prakashan
8	Dr. K. S. Jain, M.G.Shinde	Practical Pharmaceutical Inorganic Chemistry simplified	National	2018-2019	978-93-88293-31-0	K. K. Wagh College of Pharmacy	Nirali Prakashan
9	Dr. K. S. Jain	A Text Book of Pharmaceutical Organic Chemistry – III	National	2018-2019	978-93-880706-58-2	K. K. Wagh College of Pharmacy	Nirali Prakashan



K. K. WAGH COLLEGE OF PHARMACY

(B. Pharmacy & D. Pharmacy)

Hirabai Haridas Vidyanagari, Amrutdham, Panchavati, Nashik - 422 003. (Maharashtra) India.

☎ : 0253 - 2221121, 2517003, 2510262 Web : www.pharmacy.kkwagh.edu.in

Email: principal-bpharmacy@kkwagh.edu.in, disp-bpharmacy@kkwagh.edu.in

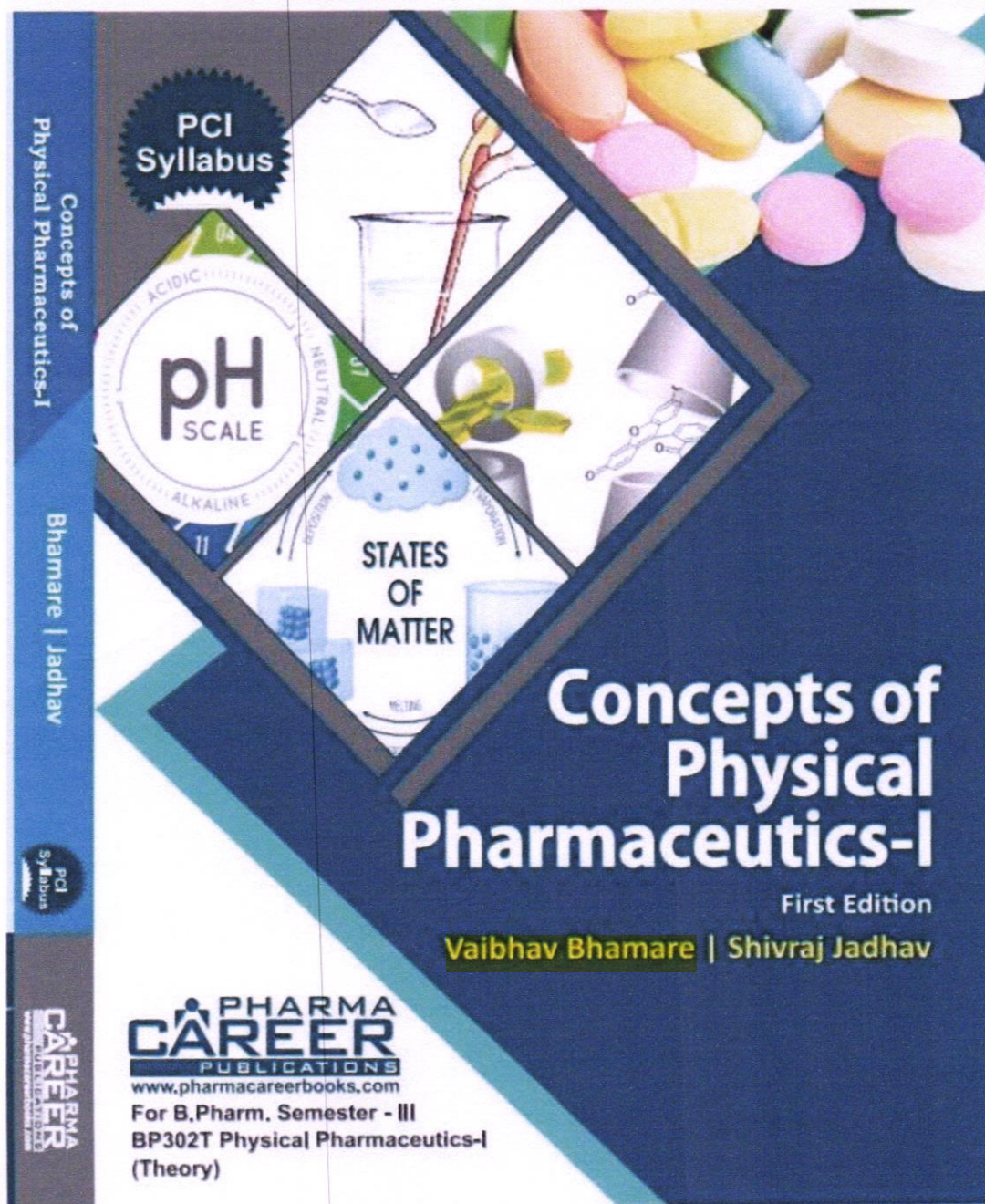
(Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, MSBTE, Mumbai & Approved by PCI)

Sr. No.	Name of the teacher	Title of the book/chapters published	National / International	Year of publication	ISBN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher
10	Dr. K. S. Jain	Pharmaceutical Inorganic Chemistry, Simplified	National	2017-2018	9789388194556	K. K. Wagh College of Pharmacy	Nirali Prakashan
11	Dr. K. S. Jain	A textbook of Pharmaceutical Organic Chemistry–II	National	2017-2018	978-93-88194-10-5	K. K. Wagh College of Pharmacy	Nirali Prakashan

Title of the book/chapters published- Concepts of Physical Pharmaceutics I

Name of the faculty- Dr. Vaibhav G. Bhamre, Mr. Shivraj P. Jadhav

Name of the publisher- PharmaCareer Publications



[Signature]

PRINCIPAL

K. K. Wagh College of Pharmacy

Nashik-422 003

Concepts of Physical Pharmaceutics - I

As per PCI Regulations
For B. Pharm : Semester-III

BP302T PHYSICAL PHARMACEUTICS - I (Theory)

FIRST EDITION

Dr. Vaibhav G. Bhamare

M.Pharm (Pharmaceutics), Ph. D., M.B.A.

Associate Professor,

K. K. Wagh College of Pharmacy,

Hirabai Haridas Vidyamagari,

Panchavati, Nashik - 422 003

Mr. Shivraj P. Jadhav

M. Pharm (Pharmaceutics),

Shree Shakti Shaikshanik Sanstha's,

Divine College of Pharmacy,

Nampur Road, Satana - 423 301

**PHARMA
CAREER
PUBLICATIONS**
www.pharmacareerbooks.com



PRINCIPAL
K. K. Wagh College of Pharmacy
Nashik-422 003

Concepts of Physical Pharmaceutics - I

First Edition : December - 2022

ISBN : 978-93-92867-39-2

© All rights reserved. No part of this book may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publishers.

Published by :

Career and Pharma Publications
Reg. Off. : 432/B, Deshmukh Bungalow,
Vakil Wadi, Nashik - 422 001.
Maharashtra, India.

Communication Address :

Second Floor, Kaveri Smruti, Vakil Wadi,
Ashok Stambh, Nashik - 422 001
Maharashtra, India.
Ph. : (0253) 2311422, 2576175
E-mail : stores@careerandyou.com
www.pharmacareerbooks.com

Typesetting :

Renuka Chandwadkar

Cover Design:

Satish More


Editor :

Sudhanva Tipare

Printer :

Trinity Academy for
Corporate Training Ltd.




PRINCIPAL
K.K. Wagh College of Pharmacy
Nashik-422 003

CONTENTS

Unit	Name of Topic	Page No.
I	Solubility of Drugs	01
II	Part I - State of Matter and Properties of Matter	36
	Part II - Physicochemical Properties of Drug	73
III	Surface and Interfacial Phenomenon	91
IV	Complexation and Protein Binding	125
V	pH, Buffers and Isotonic Solution	146



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

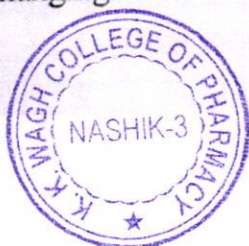
UNIT : I

SOLUBILITY OF DRUGS

Solubility expressions, Mechanisms of solute solvent interactions, Ideal solubility parameters, Solvation & Association, Factors influencing solubility of drugs, Diffusion principles in biological systems, Solubility of gas in liquids, Solubility of liquids in liquids, (Binary solutions, ideal solutions), Raoult's law, Ideal and Real solutions, Partially miscible liquids, Critical solution temperature and applications, Distribution law, its limitations and applications.

1.1 INTRODUCTION TO SOLUBILITY :

- Solubility is the important parameter to achieve desired concentration of drugs in the systemic circulation that could exert desired physiological response. Any drug to be absorbed must be present in the form of an aqueous solution at the site of absorption. Since, water remains the solvent of choice for liquid pharmaceutical formulations; poor water soluble drugs have slow absorption leading to inadequate bioavailability.
- Solubility can be defined in two ways, in quantitative way and qualitative way.
- Quantitatively solubility is defined as the maximum amount of a substance that will dissolve in a given amount of solvent at a specified temperature.
- Qualitatively solubility can be defined as spontaneous interaction between solute and solvent to form homogeneous solution.
- Generally, the solubility of a compound depends on the physical and chemical properties of the components (solute and the solvent) and several factors that have impact over process of solubilization such as temperature, pressure, pH, particle size of solute etc.
- Solubility is usually expressed as grams of solute per liter of solvent.
- A solute is any substance which can be either solid or liquid or gas dissolved in a solvent. Generally, in solution, the amount of solute is always less than solvent. For ex. Sodium Chloride, Sugar.
- A solvent is a substance that dissolves a solute. The solvent is the component of a solution that is present in higher concentration. Solvents which are generally in liquid form but can also be a solid or gas that are used to dissolve, suspend or extract other materials, usually without chemically changing either the solvents or the other materials. For ex. Water, Ethanol.



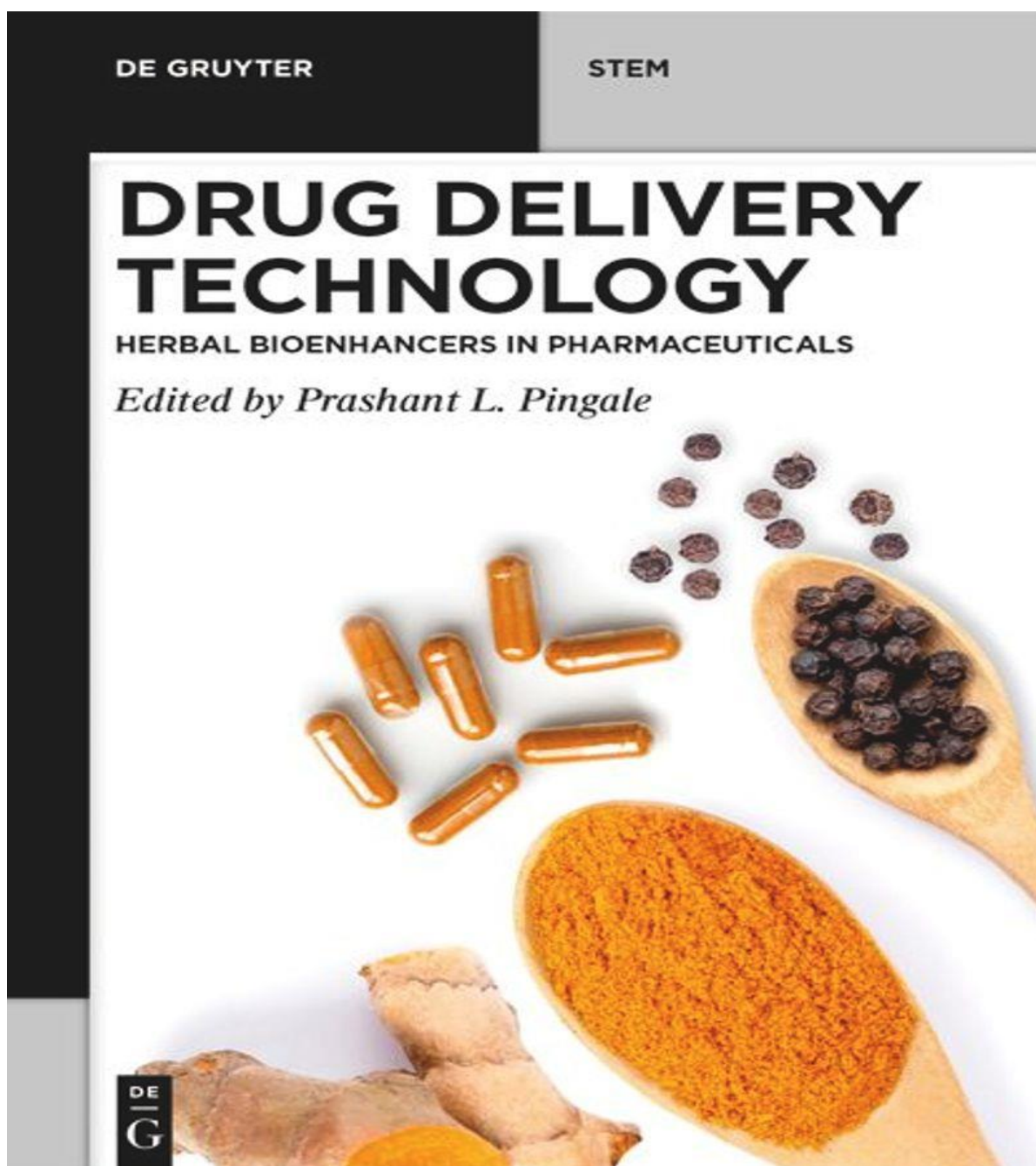
A stylized handwritten signature in blue ink, appearing to read 'A. P. P.' or similar.

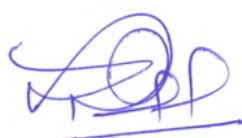
PRINCIPAL
K. K. Wagh College of Pharmacy
Nashik-422 003

Title of the book/chapters published- Growing impact of herbal bioenhancers in pharmaceutical industries

Name of the faculty- Dr. Vaibhav Bhamre, Dr. Rakesh Amrutkar, Mr. Vinod Patil, Dr. Chandrashekhar Upasani

Name of the publisher- De-Gruyter, Garmany




PRINCIPAL
K.K.Wagh College of Pharmacy
Panchavati, Nashik-422 003.

Editor

Dr. Prashant L. Pingale

GES's Sir Dr M S Gosavi College of Pharmaceutical

Education and Research

B-103 Blue Bells

Nashik-422005

India

E-Mail: prashantlpingale@gmail.com

ISBN 978-3-11-074679-2

e-ISBN (PDF) 978-3-11-074680-8

e-ISBN (EPUB) 978-3-11-074689-1

Library of Congress Control Number: 2021952048

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie;
detailed bibliographic data are available on the Internet at <http://dnb.dnb.de>.

© 2022 Walter de Gruyter GmbH, Berlin/Boston

Cover image: Gettyimages/Nikcoa

Typesetting: Integra Software Services Pvt. Ltd.

Printing and binding: CPI books GmbH, Leck

www.degruyter.com



A handwritten signature in blue ink, appearing to be "A.P.P.", written over a horizontal line.

PRINCIPAL

K.K.Wagh College of Pharmacy
Panchavati, Nashik-422 003.

Contents

List of contributing authors — VII

Namita D. Desai, Niserga D. Sawant, Pratima A. Tatke

Chapter 1

Biopotential using herbals: novel approach for poorly bioavailable drugs — 1

Surendra Agrawal, Pravina Gurjar, Ayushi Agarwal

Chapter 2

Herbal bioenhancers in microparticulate drug delivery — 27

Amarjitsing Rajput, Satish Mandlik, Shipa Dawre, Deepa Mandlik, Prashant Pingale, Shital Butani

Chapter 3

Herbal bioenhancers in nanoparticulate drug delivery system — 45

Shashikant B. Bagade, Shivane Vyas, Amit B. Page, Kiran D. Patil

Chapter 4

Role of herbal bioenhancers in tuberculosis and drug delivery thereof — 87

Madhur Kulkarni, Roopal Bhat, Suvarna Ingale, Abhijit Date

Chapter 5

Herbal bioenhancers in cancer drug delivery — 103

Rupali A. Patil, Krutika H. Pardeshi, Harshal P. Chavan, Sunil V. Amrutkar

Chapter 6

Pharmacotherapeutics and pharmacokinetics of herbal bioenhancers — 149

Vaibhav Bhamare, Rakesh Amrutkar, Vinod Patil, Chandrashekhar Upasani

Chapter 7


Growing impact of herbal bioenhancers in pharmaceutical industries — 191

Deepa Mandlik, Satish Mandlik, Amarjitsing Rajput

Chapter 8

Herbal bioenhancers and improvement of the bioavailability of drugs — 211




PRINCIPAL
K.K. Wagh College of Pharmacy
Panchavati, Nashik-422 003.

**Vaibhav Bhamare, Rakesh Amrutkar, Vinod Patil,
Chandrashekhar Upasani**

Chapter 7

Growing impact of herbal bioenhancers in pharmaceutical industries

Abstract: Ayurvedic expertise has made a significant contribution to drug research in the world, with new methods of identifying active compounds. In comparison to modern medicines, herbal medicines have succeeded to emphasize the world for their use, with advantageous therapeutic effects and fewer adverse effects. However, in vitro/in vivo findings for these herbal drugs or extracts are not so impressively correlative. Poor lipid solubility, improper molecular size, and prolonged therapy of phytoconstituents leads to poor absorption, followed by poor bioavailability and treatment expenses. Herbal bioenhancers are nontherapeutic active phytomolecules that, when co-administered at low doses, improve the bioavailability, bioefficacy, and biological activity of different drugs without having a synergistic impact with medication. Since herbal bioenhancers are healthy, nontoxic, inexpensive, easy to obtain, nonaddictive, pharmacologically inert, and nonallergenic, they are enticing pharmaceutical industries as a valuable and most effective means of bioavailability enhancement. Nowadays, industries are focusing on improvement in pharmacokinetic parameters of potent active pharmaceutical ingredients using various bioenhancing mechanisms that can help through alteration in enzyme activity, phytosomal formulation system, escape protein modifications, effects of cholagogic or choleretic agent, and heat production in the organism. An emphasis is made to tackle multidrug resistance in the treatment of infectious diseases. Bioenhancers significantly contribute to the drug development process, with innovative methods for identifying active compounds, using natural drugs and products. Herbal bioenhancers are becoming increasingly popular as a paradigm-shifting technology for improving the bioavailability and bioefficacy of various classes of drugs, nutraceuticals, and veterinary medicines, thanks to recent advances in drug delivery.

Vaibhav Bhamare, Department of Pharmaceutics, K. K. Wagh College of Pharmacy, Nashik 422006, Maharashtra, India, e-mail: vaibhav.bhamre@gmail.com

Rakesh Amrutkar, K. K. Wagh College of Pharmacy, Nashik 422006, Maharashtra, India

Vinod Patil, SPH College of Pharmacy, Malegaon 423105, Maharashtra, India

Chandrashekhar Upasani, SNJB's SSDJ College of Pharmacy, Chandwad 423101, Maharashtra, India

<https://doi.org/10.1515/9783110746808-007>

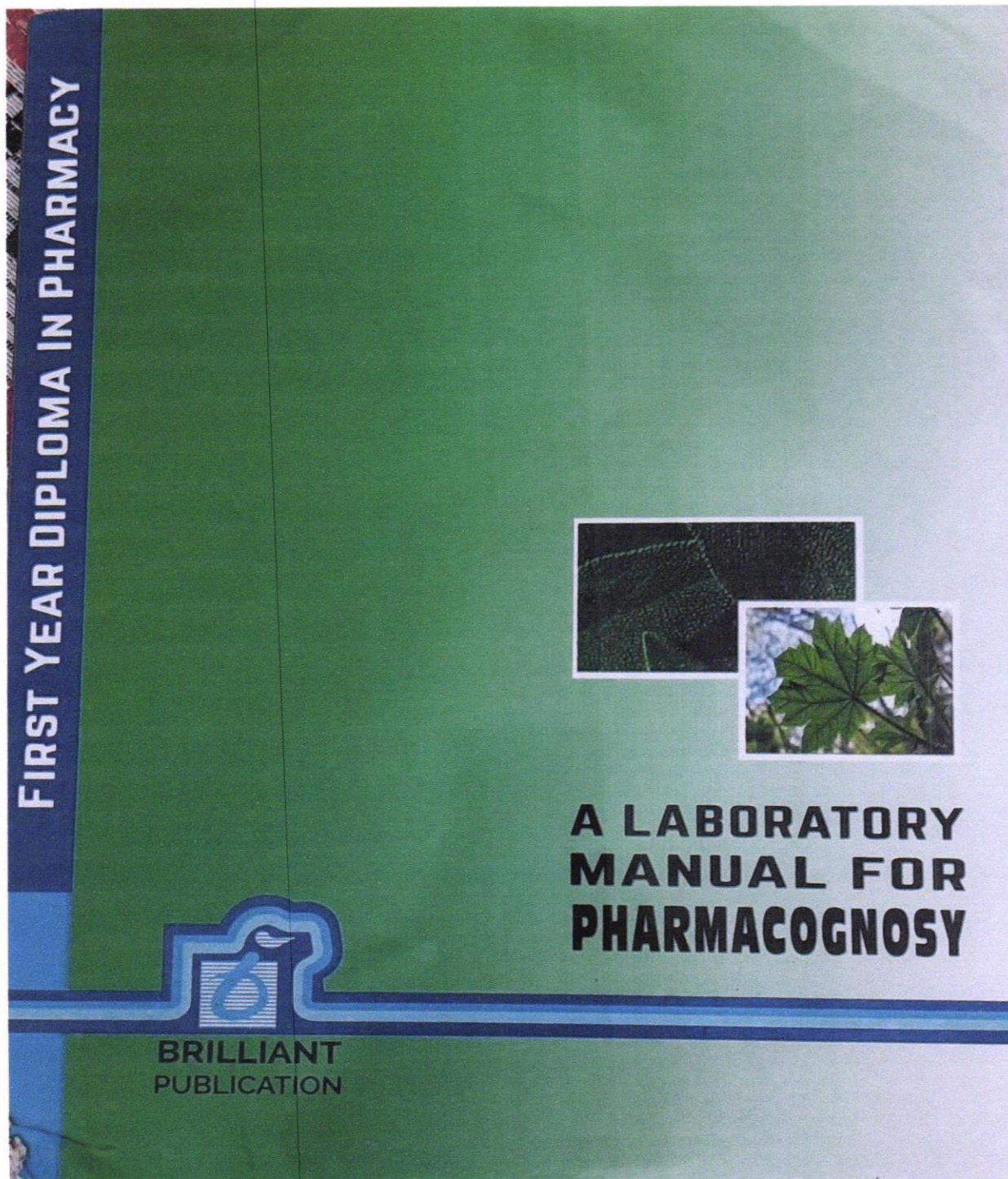


PRINCIPAL
K.K.Wagh College of Pharmacy
Panchavati, Nashik-422 003.

Title of the book/chapters published- A Laboratory Manual For Pharmacognosy

Name of the faculty- Shamal. D. Dawange

Name of the publisher- Brilliant Publication




PRINCIPAL
K. K. Wagh College of Pharmacy
Nashik-422 003

ISBN 9788195407422

A Laboratory Manual is designed as per New Syllabus prescribed by PCI Accordance of E.R 2020

PHARMACOGNOSY

FIRST YEAR DIPLOMA IN PHARMACY A LABORATORY MANUAL

Salient Features :

- All experiments covered as ER 2020 syllabus.
- Experiments covered in an easy to understand language.
- Learning objectives to aid in understanding the expected set of skills.
- Easy to use format for writing the experiments.
- Concise and Lucid language
- Well labeled diagram of Morphological and microscopically characteristics of crude drug.
- To lend a hand to professionals with scientific interest in herbalism.

- AUTHORS -

Prof. DEEPAK SOMAVANSHI
(M. Pharm)

Dr. RAJENDRA S. BHAMBAR
(M. Pharm, Ph.D., MBA)

Dr. JITENDRA Y. NEHETE
(M. Pharm, Ph.D.)

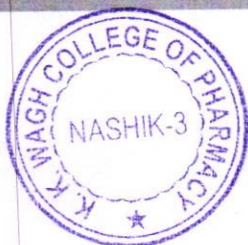
Prof. SHAMAL D. DAWANGE
(M. Pharm)

Divine College of Pharmacy, Satana, Nashik - 423301



Puneet Yash Arcade, 3rd Floor, Opp. Kokan Express,
Near Kothrud Bus Stand, Kothrud, Pune - 411038.
Mob No. - +91 7057488957 / 9156347572 / 8605467166

Brilliant Publication




PRINCIPAL
K K Wagh College of Pharmacy
Nashik-422 003

SYLLABUS

As per ER 2020, Pharmacognosy Practical Syllabus is as given below:	
Sr. No.	Title
1.	Morphological Identification of drug : Ispaghula, Senna, Coriander, Fennel, Cardamom, Ginger, Nutmeg, Black Pepper, Cinnamon, Clove, Ephedra, Rauwolfia, Gokhru, Punarnava, Cinchona, Agar.
2.	Gross anatomical studies (Transverse Section) of the following drugs: Ajwain, Datura, Cinnamon, Cinchona, Coriander, Ashwagandha, Liquorice, Clove, Curcuma, Nuxvomica, Vasaka.
3.	Physical and chemical tests for evaluation of drugs: Asafoetida, Benzoin, Pale catechu, Black catechu, Castor oil, Acacia, Tragacanth, Agar, Guar gum, Gelatin.




PRINCIPAL
 K.K.Wagh College of Pharmacy
 Panchavati, Nashik-422 003.

EXPERIMENT NO - 01

◆ **Aim – To study morphological characteristics of Ispaghula**

- **Synonyms** - Ispaghula, Ispagol, Ishabgula, Spongel seeds.




- **Botanical Source** - Ispaghula consists of dried seeds of *Plantago ovata*, belonging to family Plantaginaece.

- **Morphology Ispaghula seed –**

Colour	Pinkish gray to brown
Odour	None
Taste	Mucilaginous
Shape	Ovate, boat shaped, cymbiform
Size	1.5–3.5 mm long, 1–1.8 mm wide.
Weight of 100 seeds	0.15–0.19 g
Surface	Smooth
Nature	Seeds are hard, translucent
External Features	The dorsal (convex surface) consist of a small elongated reddish brown spot at the center while the ventral (concave surface) has a cavity which is covered with a thin whitish membrane.




PRINCIPAL
 K.K.Wagh College of Pharmacy
 Panchavati, Nashik-422 003.



FIRST YEAR B. PHARM | SEMESTER-I

A PRACTICAL BOOK OF PHARMACEUTICAL ANALYSIS

Dr. K. S. JAIN

Ms. D. K. KADAM



NIRALI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE



A blue ink signature of the Principal.

PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

A Practical Book of **PHARMACEUTICAL ANALYSIS**

As Per PCI Regulations

FIRST YEAR B. PHARMACY
Semester - I

Dr. K. S. Jain

M. Pharm., Ph.D., FIC
Principal & Profesor,
Deptt. of Pharmaceutical Chemistry,
K.K.Wagh Education Society's,
K.K.Wagh College of Pharmacy,
Hirabai Haridas Vidyanagari, Amrut Dham, Panchavati,
Nashik, 422003.

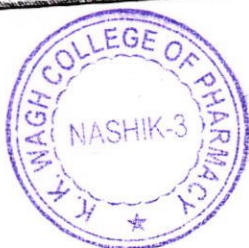
Ms. D. K. Kadam


M. Pharm.,
Asst. Professor,
Deptt. of Pharmaceutical Chemistry,
K.K.Wagh College of Pharmacy,
Nashik, 422003.

Price ₹ 85.00

 **NIRALI[®]**
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

N3918




PRINCIPAL
K.K. Wagh College of Pharmacy
Nashik-422 003

A Practical Book of Pharmaceutical Analysis

ISBN 978-93-90596-89-8

First Edition : February 2021

© : Authors

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the author or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

Published By :
NIRALI PRAKASHAN

Abhyudaya Pragati, 1312, Shivaji Nagar,
Off J.M. Road, PUNE - 411005
Tel - (020) 25512336/37/39, Fax - (020) 25511379
Email : niralipune@pragationline.com

Polyplate

Printed By :
YOGIRAJ PRINTERS AND BINDERS
Works: Sr. No. 10\1, Ghule Industrial Estate,
Nanded Village Road,
TAL-HAVELI, DIST-PUNE 411041.
Mobile - 9850046517, 9404225254

DISTRIBUTION CENTRES

PUNE

Nirali Prakashan : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra
(For orders within Pune) Tel : (020) 2445 2044, Mobile : 9657703145

Email : bookorder@pragationline.com, niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhyari, Near Pari Company, Pune 411041
(For orders outside Pune) Tel : (020) 24690204 Fax : (020) 24690316; Mobile : 9657703143

Email : dhyari@pragationline.com, bookorder@pragationline.com

MUMBAI

Nirali Prakashan : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,
Girgaum, Mumbai 400004, Maharashtra; Mobile : 9320129587
Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976

Email : niralimumbai@pragationline.com

DISTRIBUTION BRANCHES

JALGAON

Nirali Prakashan : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001,
Maharashtra, Tel : (0257) 222 0395, Mob : 94234 91860

KOLHAPUR

Nirali Prakashan : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank
Kolhapur 416 012, Maharashtra. Mob : 9850046155

NAGPUR

Nirali Prakashan : Above Maratha Mandir, Shop No. 3, First Floor,
Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra
Tel : (0712) 254 7129

DELHI

Nirali Prakashan : 4593/15, Basement, Agarwal Lane, Ansari Road, Daryaganj
Near Times of India Building, New Delhi 110002 Mob : 08505972553
Email : niralidelhi@pragationline.com


BENGALURU

Nirali Prakashan : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,
Malleswaram, Bengaluru 560003, Karnataka; Mob : 9449043034
Email : niralibangalore@pragationline.com

Other Branches : Hyderabad, Chennai

Note: Every possible effort has been made to avoid errors or omissions in this book. In spite this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on  www.facebook.com/niralibooks



PRINCIPAL

K.K. Wagh College of Pharmacy
Nashik-422 003

Contents

Unit 1 : General Introduction

1.1 Volumetric Glassware	1.16
1.1.1 Pipettes	1.1
1.1.2 Burettes	1.3
1.1.3 Measuring Cylinders	1.4
1.1.4 Volumetric Flasks	1.5
1.1.5 Erlenmeyer Flasks	1.5
1.1.6 Weighing Bottles and Specific Gravity Bottles	1.6
1.1.7 Beakers	1.8
1.2 Cleaning of Glassware	1.9
1.3 Some Basic Concepts	1.9
1.3.1 Preparation of Aqueous Solutions	1.9
1.3.2 Per cent Solutions	1.11
1.4 Volumetric Methods	1.11
1.4.1 Definitions of Terms	1.11
1.4.2 Requirements for Volumetric Methods	1.12
1.4.3 Classification of Volumetric Methods	1.12
1.4.4 Steps Involved in Quantitative Analysis	1.13
1.4.5 End Point Detection	1.14
1.4.6 Calibration of Volumetric Glasswares	1.15
• Question Bank for Viva-Voce	1.16

Unit 2 : Limits Tests

Experiment 1 : To Perform Limit Test for Chlorides	2.1 - 2.20
Experiment 2 : To Perform Limit Test for Sulphate	2.3
Experiment 3 : To Perform Limit Test for Iron	2.6
Experiment 4 : To Perform Limit Test for Arsenic	2.9
• Question Bank for Viva-Voce	2.11
	2.17

Unit 3 Preparation and Standardization of Some Volumetric Reagent Solutions

Experiment 1 : To Prepare and Standardize 0.1 N Sodium Hydroxide	3.1 - 3.14
Experiment 2 : To Prepare and Standardize 0.5 M Sulphuric Acid	3.1
Experiment 3 : To Prepare and Standardize 0.1 N Sodium Thiosulfate	3.3
Experiment 4 : To Prepare and Standardize 0.1 N Potassium Permanganate	3.4
Experiment 5 : To Prepare and Standardize 0.1 M Ceric Ammonium Sulphate	3.6
• Question Bank for Viva-Voce	3.10
	3.11



[Signature]

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

Unit 4 : Assay of the Compounds Along with Standardization of Titrant 4.1 - 4.14

- Experiment 1 :** Assay of Ammonium Chloride by Acid-Base Titration 4.1
Experiment 2 : Assay of Ferrous Sulphate by Cerimetry 4.2
Experiment 3 : Assay of Copper Sulphate by Iodometry 4.3
Experiment 4 : Assay of Calcium Gluconate by Complexometry 4.5
Experiment 5 : Assay of Hydrogen Peroxide by Permanganometry 4.7
Experiment 6 : Assay of Sodium Benzoate by Non-Aqueous Titration 4.9
Experiment 7 : Assay of Sodium Chloride by Precipitation Titration 4.10
• Question Bank for Viva-Voce 4.12

Unit 5 : Determination of Normality by Electro-Analytical Methods 5.1 - 5.10

1. Conductometric Titrations 5.1

- Experiment 1 :** Determination of the Strength of a Solution of Strong Acid (Hydrochloric Acid) by A Standard Solution of Strong Base (Sodium Hydroxide) 5.1
Experiment 2 : To Carry Out the Conductometric Titration of Mixture of Acids [0.1N HCl + 0.1N CH₃COOH] vs. Strong Base (1 N NaOH) 5.5

2. Potentiometric Titrations 5.7

- Experiment 3 :** Determination of Strength of Strong Acid Against Strong Base by Potentiometric Titration 5.7
• Question Bank for Viva-Voce 5.9

Bibliography

B.1 - B.1

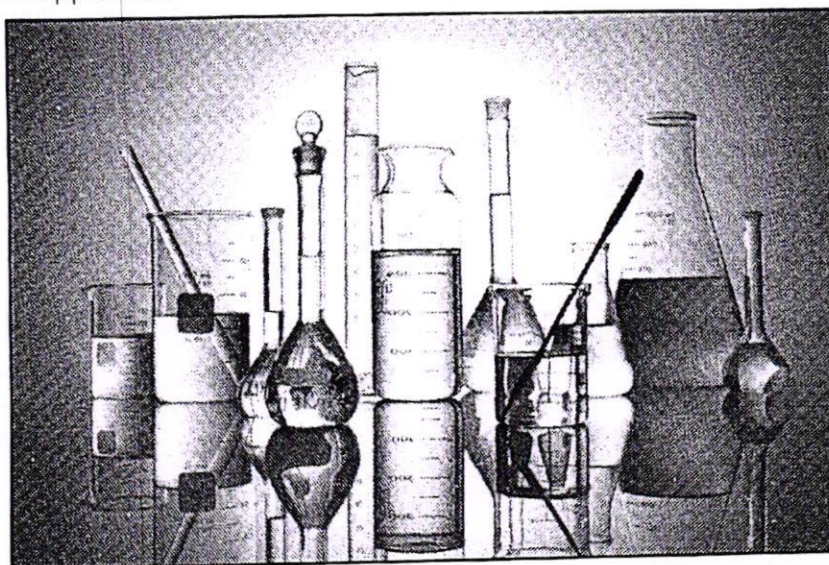



PRINCIPAL
K.K. Wagh College of Pharmacy
Nashik-422 003

Unit...1

GENERAL INTRODCUTION

All laboratory work involves some form of measurement. Various types of volumetric glassware are available for measuring lab reagents. Before starting any analytical experiment, one must familiarize him/herself with the types of volumetric glassware and should learn to use the apparatus accurately to eliminate the errors resulting from careless handling of the apparatus.



1.1 VOLUMETRIC GLASSWARE

1.1.1 Pipettes

These are used to transfer a known volume of liquid from one container to another. They are designed either to contain (TC) a specific volume of liquid or to deliver (TD) a specified volume. [To contain and To deliver (TC & TD): Manufacturer stamp TC or TD near the top of the pipette. TC pipette holds or contains a particular volume but does not dispense that exact volume, whereas TD pipette will dispense the exact volume indicated].

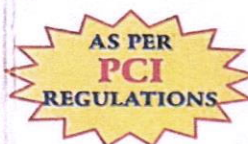
Table 1.1 : Pipette Classification

- | |
|--------------------|
| I. Design |
| A. To contain (TC) |
| B. To deliver (TD) |

(1.1)



PRINCIPAL
K K Wagh College of Pharmacy
Nashik-422 003



FIRST YEAR B. PHARM | SEMESTER-I

PHARMACEUTICAL ANALYSIS

Ms. D. K. KADAM

Dr. K. S. JAIN

Mrs. K. P. BAVISKAR



KKWCOP NASHIK
615.19/JAI



B3890

NIRALI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE



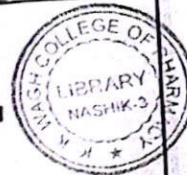
PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

3424

A Text Book Of **PHARMACEUTICAL ANALYSIS**

3890



As per PCI Regulations

**First Year B. Pharm.
Semester - I [BP102T]**

Dr. K. S. Jain

M. Pharm., Ph.D., FIC
Principal & Professor

Deptt. of Pharmaceutical Chemistry
K. K. Wagh Education Society's
K. K. Wagh College of Pharmacy

Hirabai Haridas Vidyanagari, Amrut Dham, Panchavati
Nashik 422003

Ms. D. K. Kadam

M. Pharm.

Asst. Professor

Deptt. of Pharmaceutical Chemistry
K. K. Wagh College of Pharmacy
Nashik 422003

Mrs. K. P. Baviskar

M. Pharm.

Asst. Professor

Deptt. of Pharmaceutical Chemistry
K. K. Wagh College of Pharmacy
Nashik 422003

615.19

JAI



3890

K.K. Wagh College of Pharmacy
Nashik-422 003

Price ₹ 230.00

 **NIRALITM
PRAKASHAN**
ADVANCEMENT OF KNOWLEDGE

N3917





PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

ISBN 978-93-90506-60-6

Pharmaceutical Analysis

First Edition : December 2020

© : Authors

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the authors or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

Published By:

NIRALI PRAKASHAN

Abhyudaya Pragati, 1312, Shivaji Nagar

Off J.M. Road, Pune - 411005

Tel - (020) 25512336/37/39, Fax - (020) 25511379

Email : niralipune@pragationline.com

Polyplate

Printed By:

SHIVANI PRINTERS

Shop No. 7, 8, 9 Kinara Sahakari Gruh Sanstha

1311, Kasbapeth, Pune - 411011

Phone (020) 24577245

> DISTRIBUTION CENTRES**PUNE****Nirali Prakashan** : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra

(For orders within Pune)

Tel : (020) 2445 2044; Mobile : 9657703145

Email : niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhayari, Near Asian College Pune 411041

(For orders outside Pune)

Tel : (020) 24690204; Mobile : 9657703143

Email : bookorder@pragationline.com

MUMBAI**Nirali Prakashan** : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,

Girgaum, Mumbai 400004, Maharashtra; Mobile : 9320129587

Tel : (022) 2385 6339 / 2386 9976

Email : niralimumbai@pragationline.com

> DISTRIBUTION BRANCHES**JALGAON****Nirali Prakashan** : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001, Maharashtra,

Tel : (0257) 222 0395, Mob : 94234 91860; Email : niralijalgaon@pragationline.com

KOLHAPUR**Nirali Prakashan** : New Mahadwar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank, Kolhapur 416 012

Maharashtra. Mob : 9850046155; Email : niralikolhapur@pragationline.com

NAGPUR**Nirali Prakashan** : Above Maratha Mandir, Shop No. 3, First Floor,

Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra

Tel : (0712) 254 7129; Email : niralinagpur@pragationline.com

DELHI**Nirali Prakashan** : 4593/15, Basement, Agarwal Lane, Ansari Road, Daryaganj

Near Times of India Building, New Delhi 110002 Mob : 08505972553

Email : niralidelhi@pragationline.com

BENGALURU**Nirali Prakashan** : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,

Malleswaram, Bengaluru 560003, Karnataka; Mob : 9449043034

Email : niralibangalore@pragationline.com

Other Branches : Hyderabad, Chennai

Note : Every possible effort has been made to avoid errors or omissions in this book. In spite this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on  www.facebook.com/niralibooks
PRINCIPALK K Wagh College of Pharmacy
Nashik-422 003

Contents

Unit I : Introduction to Pharmaceutical Analysis

1. Pharmaceutical Analysis	1.1 - 1.18
1.1 Introduction: Definition & Scope of Pharmaceutical Analysis	1.1
1.2 Different Techniques of Analysis	1.2
1.3 Methods of Expressing Concentration	1.4
1.4 Primary and Secondary Standards	1.6
1.4.1 Primary Standards	1.6
1.4.2 Secondary Standards	1.8
1.5 Preparation and Standardization of Various Molar and Normal Solutions:	
Oxalic Acid, Sodium Hydroxide, Hydrochloric Acid, Sodium Thiosulphate, Sulphuric Acid, Potassium Permanganate and Ceric Ammonium Sulphate	1.9
1.5.1 Preparation of Standard Solutions	1.9
1.5.1.1 Preparation of N/10 H_2SO_4	1.11
1.5.1.2 Preparation of N/10 Na_2CO_3 Solution	1.11
1.5.1.3 Preparation of N/10 NaOH Solution	1.12
1.5.1.4 Preparation of N/10 Oxalic Acid	1.12
1.5.1.5 Preparation of N/10 $KMnO_4$ Solution	1.12
1.5.1.6 Preparation of 0.1 N Hydrochloric Acid	1.13
1.5.1.7 Sodium Thiosulfate, (0.1 N) $Na_2S_2O_3 \cdot 5H_2O$ (248.19)	1.14
1.5.1.8 Ceric Ammonium Sulfate, (0.1 M) $(NH_4)_4Ce(SO_4)_4 \cdot 2H_2O$	1.15
• Question Bank	1.16
2. Errors in Chemical Analysis	2.1 - 2.10
2.1 Introduction	2.1
2.2 Precision	2.2
2.3 Accuracy	2.3
2.4 Significant Figures	2.3
2.5 Sources of Errors in Experimental Chemical Analysis	2.4
2.6 Types of Errors	2.4
2.7 Methods of Minimizing Errors	2.7
2.8 Methods to Minimize and Detect Determinate Errors	2.7
• Question Bank	2.8
3. Pharmacopoeia, Sources of Impurities, Limit Tests	3.1 - 3.40
3.1 Pharmacopoeia	3.1
3.1.1 Indian Pharmacopoeia	3.1
3.1.2 British Pharmacopoeia	3.4
3.1.3 European Pharmacopoeia	3.6



[Signature]

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

3.1.4	United States Pharmacopoeia (USP)	3.7
3.1.5	Pharmacopoeia International (International Pharmacopoeia)	3.8
3.1.6	Extrapharmacopoeia (Martindale)	3.9
3.2	Sources of Impurities in Pharmaceuticals	3.10
3.2.1	Sources and Effects of Impurities in Pharmacopoeial Substances	3.10
3.2.2	Effects of Impurities on Pharmaceuticals	3.13
3.3	Limit Tests	3.13
3.3.1	Importance of Limit Tests	3.13
3.3.2	Principle and Procedure of Limit Test for Chloride	3.15
3.3.2.1	Principle and Procedure of Modified Limit Test for Chloride	3.16
3.3.2.2	Principle and Procedure of Limit Test for Sulphate	3.17
3.3.2.3	Principle and Procedure of Limit Test for Sulphate	3.19
3.3.2.4	Principle and Procedure of Limit Test for Iron	3.20
3.3.2.5	Principle and Procedure of Limit Test for Lead	3.22
3.3.2.6	Principle and Procedure of Limit Test for Arsenic	3.27
3.3.2.7	Principle and Modified Procedure of Limit Test for Arsenic for Different Compounds	3.30
3.3.2.8	Principle and Procedure of Limit Test for Heavy Metals	3.33
•	Question Bank	3.37

Unit II

4. Acid Base Titrations	4.1 – 4.20
4.1 Concepts of Acid and Base	4.1
4.1.1 Arrhenius Theory	4.1
4.1.2 Lowry and Bronsted's Theory	4.1
4.1.3 Lewis's Theory	4.3
4.1.4 Usanovich Theory	4.3
4.1.5 Lux-Flood Concept	4.4
4.2 Theories of Acid-Base Indicators	4.4
4.2.1 Indicator Range	4.5
4.2.2 Ostwald's Theory	4.5
4.2.3 Quinonoid Theory	4.7
4.3 Theory Involved in Titrations of Strong, Weak and Very Weak Acids and Bases	4.8
4.4 Buffer Equations and Buffer Capacity	4.8
4.5 Neutralization Curves	4.11
4.5.1 Neutralization Curve for Strong Acid and Strong Base Titration	4.11
4.5.2 Neutralization Curve for Weak Acid and Strong Base Titration	4.13
4.5.3 Titration Curve between Weak Base and Strong Acid Titration	4.15
4.5.4 Titration Curve between Weak Acid and Weak Base	4.17
• Question Bank	4.19





PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

5. Non-Aqueous Titrations

5.1	Introduction	5.1
5.2	Advantages of Non-aqueous Titrations	5.1
5.3	Solvents used in Non-aqueous Titration	5.2
5.3.1	Properties of Non-aqueous Solvent	5.2
5.3.2	Different Types of Solvents	5.2
5.4	Levelling Effect, Leveling and Differentiating Solvents	5.4
5.5	Methodology for Non-aqueous Titrations	5.4
5.5.1	Preparation of 0.1 N Perchloric Acid	5.4
5.5.2	Standardization of 0.1 N Perchloric Acid	5.5
5.5.3	Choice of Indicators	5.6
5.5.4	Effect of Temperature on Assays	5.6
5.6	Assays by Non-aqueous Titrations	5.7
5.6.1	Acidimetry in Non-aqueous Titrations	5.7
5.6.1.1	Titration of Primary, Secondary and Tertiary Amines	5.7
5.6.1.2	Titration of Halogen Acid Salts of Bases	5.8
5.6.1.2.1	Amitriptyline Hydrochloride	5.8
5.6.2	Alkalimetry in Non-Aqueous Titrations	5.8
5.6.2.1	Preparation of 0.1 N Potassium Methoxide in Toluene-Methanol	5.9
5.6.2.2	Preparation of 0.1 N Sodium Methoxide	5.9
5.6.2.3	Preparation of 0.1 N Lithium Methoxide	5.9
5.6.2.4	Standardization of 0.1 N Methoxide Solution	5.9
5.7	Estimation of Sodium Benzoate and Ephedrine HCl	5.10
5.8	Applications of Non-aqueous Titration	5.11
•	Question Bank	5.12

Unit III

6. Precipitation Titrations

6.1	Introduction	6.1
6.2	Solution Process	6.1
6.3	Factors Affecting Solubility	6.2
6.4	Detection of End Point	6.5
6.4.1	Mohr's Method	6.5
6.4.2	Volhard's Method	6.6
6.4.3	Fajan's Method	6.7
6.5	Estimation of Sodium Chloride	6.9
6.6	Classification of Methods in Precipitation Titration	6.9
6.7	Applications of Precipitation Titrations	6.10
•	Question Bank	6.10



[Signature]

PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

7. Complexometric Titrations	7.1 - 7.16
7.1 Introduction and Definition	7.1
7.2 Ligands (Complexing Agent)	7.2
7.2.1 Classification of Ligands	7.2
7.2.2 Chelating Agents	7.2
7.2.3 EDTA	7.3
7.3 Stability Constant	7.4
7.3.1 Factors Affecting Stability Constant	7.5
7.3.1.1 Effect of pH	7.5
7.3.1.2 Thermodynamic/Chelon Effect	7.6
7.3.1.3 Macrocyclic Effect	7.6
7.3.1.4 Effect of Temperature	7.6
7.3.1.5 Addition of Electrolytes	7.6
7.4 Detection of End Point	7.7
7.4.1 Visual Indicators	7.7
7.4.1.1 Metallochromic Indicators	7.7
7.4.1.2 pH Indicators	7.10
7.4.2 Instrumental Methods	7.10
7.4.2.1 Potentiometric Method	7.10
7.4.2.2 Spectrophotometric Method	7.10
7.4.2.3 Amperometric Method	7.10
7.5 Types of Titration	7.10
7.5.1 Direct Titrations	7.10
7.5.2 Back Titration	7.11
7.5.3 Replacement Titration/ Displacement Titration	7.11
7.5.4 Indirect Titration	7.11
7.5.5 Alkalimetric Titration	7.12
7.6 Titration of Mixtures	7.12
7.7 Applications of Complexometric Titrations	7.13
7.8 Estimation of Magnesium Sulphate	7.14
7.9 Estimation of Calcium Gluconate	7.14
• Question Bank	7.15
8. Gravimetry	8.1 - 8.18
8.1 Introduction	8.1
8.2 Types of Precipitates	8.2
8.2.1 Crystalline Precipitates	8.2
8.2.2 Colloidal Precipitates	8.3
8.2.2.1 Types of Colloidal Precipitates	8.4
8.2.2.2 Peptization of Colloids	8.4
8.2.3 Gelatinous Precipitates	8.5



[Signature]

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

8.3	Precipitation Process and Particle Size	8.5
8.4	Digestion of Precipitates (Ostwald Ripening)	8.6
8.5	Purity of Precipitates	8.6
8.5.1	Co-precipitation	8.6
8.5.1.1	Surface Adsorption	8.7
8.5.1.2	Mixed Crystal Formation	8.7
8.5.1.3	Occlusion and Mechanical Entrapment	8.7
8.5.2	Post Precipitation	8.8
8.6	Precipitation from Homogenous Solution	8.8
8.7	Precipitating Agents	8.9
8.7.1	Inorganic Precipitants	8.9
8.7.2	Reducing Agents	8.9
8.7.3	Organic Precipitants	8.9
8.7.3.1	Advantages of Organic Precipitants	8.11
8.7.3.2	Disadvantages of Organic Precipitants	8.11
8.8	Advantages of Gravimetric Methods	8.11
8.9	Unit Operations in Gravimetric Analysis	8.11
8.10	Estimation of Barium Sulphate	8.15
8.10.1	Principle	8.15
8.10.2	Procedure	8.15
	• Question Bank	8.16
9.	Diazotization Titration (Sodium Nitrite Titration)	9.1 - 9.6
9.1	Introduction	9.1
9.2	Theory	9.1
9.3	Condition for Diazotization	9.2
9.3.1	Rate of Titration	9.2
9.3.2	Temperature	9.2
9.4	Principle	9.2
9.5	Types of Diazotization Titrations	9.3
9.5.1	Direct Titrations	9.3
9.5.2	Reverse Method	9.3
9.5.3	Special Method	9.3
9.6	Preparation and Standardization of 1 M Sodium Nitrate	9.3
9.6.1	Preparation of 1M Sodium Nitrate	9.3
9.6.2	Standardization of 1M Sodium Nitrate with Sulphanilamide	9.3
9.7	Assay of Calcium Aminosaliclate	9.4
9.8	Applications of Diazotization Titration	9.5
	• Question Bank	9.5



[Signature]

PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

Unit IV

10. Redox Titrations

10.1 - 10.16

10.1	Introduction	10.1
10.2	Concepts of Oxidation and Reduction	10.1
10.3	Balancing of Half Reactions	10.2
10.4	Equivalent Weights	10.4
10.5	Redox Potential	10.4
10.6	Detection of End Point in Redox Titrations	10.5
10.6.1	Internal Indicators	10.5
10.6.2	Self Indicators	10.6
10.6.3	External Indicators	10.6
10.6.4	Specific Indicators	10.6
10.6.5	Potentiometric Method	10.6
10.7	Redox Titrations	10.7
10.7.1	Titration using Potassium Permanganate	10.7
10.7.2	Cerimetry	10.8
10.7.3	Iodine Titrations	10.9
10.7.4	Bromatometry	10.13
10.7.5	Dichrometry	10.14
10.7.6	Titration with Potassium Iodate	10.15
	• Question Bank	10.15

Unit V : Electrochemical Methods of Analysis

11. Conductometry

11.1 - 11.13

11.1	Introduction	11.1
11.2	Measurement of Conductivity	11.4
11.3	Conductometric Titrations	11.7
11.3.1	Acid-Base Titrations	11.7
11.3.1.1	Strong Acid with a Strong Base	11.8
11.3.1.2	Strong Acid with Weak Base	11.8
11.3.1.3	Weak Acid with a Strong Base	11.9
11.3.1.4	Weak Acid with Weak Base	11.9
11.3.2	Precipitation Titrations	11.10
11.3.3	Redox Titrations	11.10
11.3.4	Complexometric Titrations	11.11
11.3.5	Non-aqueous Titrations	11.11
11.4	Applications	11.12
	• Question Bank	11.12



(Signature)

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

12. Potentiometry

12.1 Introduction

12.2 Electrode Potential

12.3 Cell

12.3.1 Galvanic Cell

12.4 Electrodes

12.4.1 Reference Electrodes

12.4.1.1 The Standard Hydrogen Electrode (SHE)

12.4.1.2 Calomel Electrode

12.4.1.3 Silver Chloride Electrode

12.4.2 Indicator Electrodes

12.4.2.1 Metal Electrode

12.4.2.2 Glass Electrode

12.5 Methods to Determine End Points

12.6 Types of Potentiometric Titrations

12.7 Applications of Potentiometric Titrations

- Question Bank

13. Polarography

13.1 Introduction

13.2 Principle

13.3 Theory of Polarography

13.3.1 Polarization of Electrodes

13.4 Construction and Working of Dropping Mercury Electrode and Rotating Platinum Electrode

13.4.1 Dropping Mercury Electrode

13.4.2 Rotating Platinum Electrode

13.4.3 Polarographic Modes

13.5 Applications

- Question Bank

Index

Bibliography

12.1 - 12.14

12.1

12.1

12.2

12.2

12.4

12.4

12.4

12.6

12.7

12.8

12.8

12.8

12.10

12.11

12.12

12.13

13.1 - 13.14

13.1

13.1

13.2

13.2

13.3

13.3

13.3

13.8

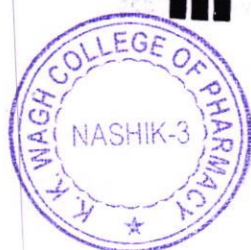
13.9

13.11

13.13

I.1 - I.2

B.1 - B.1



[Signature]

PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

Unit I : Introduction to Pharmaceutical Analysis

Chapter 1

PHARMACEUTICAL ANALYSIS

♦ LEARNING OBJECTIVES ♦

After completing this chapter, student should be able to understand:

- Definition and scope of Pharmaceutical analysis.
- Various analytical techniques.
- Methods of expressing concentration.
- Standard solutions used in analysis.
- Preparation of solutions of various concentrations.

1.1 INTRODUCTION: DEFINITION & SCOPE OF PHARMACEUTICAL ANALYSIS

Definition:

Pharmaceutical analysis is a branch of practical chemistry that involves a series of processes for identification, determination, quantification and purification of a substance, separation of the components of a solution or mixture, or determination of structure of chemical compounds. The substance may be a single compound or a mixture of compounds and it may be isolated or in any of the dosage forms. The substances used as pharmaceuticals are from various synthetic or natural (animal, plant, marine, microbial or mineral) sources.

Scope:

The process of analysis can be broadly categorized as; a) qualitative (identification) and b) quantitative (estimation). The sample to be analysed is called as **analyte** and on the basis of size of analyte, quantitative analysis can be termed as; macro (0.1 gm or more), semi-micro (0.01 gm to 0.1 gm), micro (0.001 gm to 0.01 gm), sub-micro (0.0001 gm to 0.001 gm), ultra-micro (below 10^{-4} gm) and trace analysis (100 to 10000 ppm).

1. **Qualitative analysis** is performed to establish composition of natural/synthetic substances. These tests are performed to indicate whether the substance or compound is present in the sample or not. Various qualitative tests involve; detection of evolved gas, formation of precipitates, limit tests, colour change reactions, determination of melting point and boiling point etc.
2. **Quantitative analysis** is mainly used to quantify any compound or substance in the sample. These techniques are based on (a) the quantitative performance of suitable chemical reaction and either measuring the amount of reagent added to complete

(1.1)



PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

AS PER PCI REGULATIONS
FIRST & SECOND YEAR B. PHARM. | SEMESTER-II & III

A PRACTICAL BOOK OF
**PHARMACEUTICAL
ORGANIC CHEMISTRY**

Dr. K. S. JAIN

Dr. P. B. MINİYAR

Dr. L. V. G. NARGUND



KKWCOP NASHIK
615.19/JAI



B3728

NIRALI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

3728

A Practical Book Of PHARMACEUTICAL ORGANIC CHEMISTRY

As Per PCI Regulations

First and Second Year B. Pharm.
(Semester II & III)



Dr. K. S. Jain

M. Pharm., Ph.D., FIC

Principal & Professor, (Pharmaceutical Chemistry)

K.K. Wagh Education Society's

K.K. Wagh College of Pharmacy

Hirabai Haridas Vidyanagari, Amrut Dham, Panchavati,

Nashik 422003

Dr. P. B. Miniyar

M. Pharm., Ph.D., FAGE

Professor and Head

Sinhgad Technical Education Society's

Sinhgad Institute of Pharmacy, Narhe

Pune 411 041

Dr. L. V. G. Nargund

M. Pharm., Ph.D., FIC

Principal & Professor,

Deptt. of Pharmaceutical Chemistry

Nargund College of Pharmacy

Dattatreyanagar, Banashankari, III Stage

Bangalore 560085

Price ₹ 120.00

615.19 JAI



3728

K.K. Wagh College of Pharmacy,
Nashik-422 003

BOOKS HANDLE WITH CARE

LI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

N3943



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

PHARMACEUTICAL ORGANIC CHEMISTRY (PRACTICAL)

ISBN 978-93-87686-05-2

Third Edition : April 2019
Authors

© The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the authors or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

Polyplate

Printed By :

YOGIRAJ PRINTERS AND BINDERS

Survey No. 10/1A, Ghule Industrial Estate

Nanded Gaon Road

Nanded, Pune - 411041

Mobile No. 9404233041/9850046517

Published By :

NIRALI PRAKASHAN

Abhyudaya Pragati, 1312, Shivaji Nagar

Off J.M. Road, Pune - 411005

Tel - (020) 25512336/37/39, Fax - (020) 25511379

Email : niralipune@pragationline.com

> DISTRIBUTION CENTRES

PUNE

Nirali Prakashan : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra
(For orders within Pune) Tel : (020) 2445 2044, 66022708, Fax : (020) 2445 1538; Mobile : 9657703145
Email : niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhayari, Near Asian College Pune 411041
(For orders outside Pune) Tel : (020) 24690204 Fax : (020) 24690316; Mobile : 9657703143
Email : bookorder@pragationline.com

MUMBAI

Nirali Prakashan : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,
Girgaum, Mumbai 400004, Maharashtra; Mobile : 9320129587
Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976
Email : niralimumbai@pragationline.com

> DISTRIBUTION BRANCHES

JALGAON

Nirali Prakashan : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001, Maharashtra,
Tel : (0257) 222 0395, Mob : 94234 91860; Email : niralijalgaon@pragationline.com

KOLHAPUR

Nirali Prakashan : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank, Kolhapur 416 012
Maharashtra. Mob : 9850046155; Email : niralikolhapur@pragationline.com

NAGPUR

Nirali Prakashan : Above Maratha Mandir, Shop No. 3, First Floor,
Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra
Tel : (0712) 254 7129; Email : niralinagpur@pragationline.com

DELHI

Nirali Prakashan : 4593/15, Basement, Agarwal Lane, Ansari Road, Daryaganj
Near Times of India Building, New Delhi 110002 Mob : 08505972553
Email : niralidelhi@pragationline.com

BENGALURU

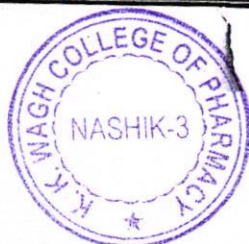
Nirali Prakashan : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,
Malleswaram, Bengaluru 560003, Karnataka; Mob : 9449043034
Email : niralibangalore@pragationline.com

Other Branches : Hyderabad, Chennai

Note : Every possible effort has been made to avoid errors or omissions in this book. In spite this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on : f. www.facebook.com/niralibooks



Signature

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

Contents

1. Systematic Qualitative Analysis of Unknown Organic Compounds	1.1 – 1.82
1. Preliminary Tests	1.6
2. Elemental Analysis or Lassaigne's Test	1.17
3. Compounds: Elements wise and Functional groupwise	1.21
4. Preparation of Derivatives	1.54
5. Physical Constants and Derivatives	1.67
6. Separation of Binary Mixture	1.78
2. Building Molecular Models of Simple Covalent Molecules	2.1 – 2.8
3. Laboratory Techniques	3.1 – 3.11
4. Analysis of Oils	4.1 – 4.7
Experiment 1 : Determination of Acid Value	4.2
Experiment 2 : Determination of Saponification Value	4.3
Experiment 3 : Determination of Ester Value	4.4
Experiment 4 : Determination of Peroxide Value	4.4
Experiment 5 : Determination of Iodine Value	4.5
5. Preparation of Compounds	5.1 – 5.30
Experiment 1 : Synthesis of Benzanilide from Aniline	5.1
Experiment 2 : Synthesis of 2 Naphthyl Benzoate from β -Naphthol	5.2
Experiment 3 : Synthesis of Phenyl Benzoate from Phenol	5.4
Experiment 4 : Synthesis of Acetanilide from Aniline	5.6
Experiment 5 : Synthesis of p-nitroacetanilide from Acetanilide	5.8
Experiment 6 : Synthesis of 2, 4, 6-tribromoaniline from Aniline	5.11
Experiment 7 : Synthesis of p-bromoacetanilide from Acetanilide	5.13
Experiment 8 : Synthesis of m-dinitrobenzene from Nitrobenzene	5.16
Experiment 9 : Synthesis of Nitrobenzene by Nitration Reaction	5.18
Experiment 10 : Synthesis of Benzoic acid from Benzyl chloride by Oxidation Reaction	5.20
Experiment 11 : Synthesis of Benzoic Acid from ethyl Benzoate by base Hydrolysis	5.20
Experiment 12 : Synthesis of Salicylic Acid from Alkyl Salicylate by Hydrolysis Reactions	5.22
Experiment 13 : Synthesis of Benzil from Benzoin	5.24
Experiment 14 : Synthesis of Phenylazo-2-naphthol from Aniline by Diazotisation Coupling reaction	5.25
Experiment 15 : Synthesis of Dibenzalacetone from Benzaldehyde	5.26
Experiment 16 : Synthesis of Cinnamic Acid from Benzaldehyde	5.28

■■■



(Signature)

PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

Chapter 1 ...

Systematic Qualitative Analysis of Unknown Organic Compounds

Qualitative organic analysis is the systematic identification and confirmation of an unknown organic compound.

Qualitative organic analysis forms an important part of the practical training of the budding organic chemist. It gives a balance between structured systemic approach and the intuition, which the student acquires with experience.

Proper application of knowledge of organic chemistry and significant observations can help draw meaningful conclusions leading to pinpoint identification.

The systematic steps of qualitative analysis:

Following essential and integral steps for the systematic identification of an unknown organic compound, should be followed meticulously and religiously, skipping none of it.

1. **Preliminary tests:** It can tell the state, nature and type in a broad manner.
2. **Detection of elements/elemental analysis (Lassaigne's test):** It can throw light on which of the elements N, [O], S, halogens are present.
3. **Detection of functional group:** Which is the main organic functional group in the compound.
4. **Derivative preparation:** This is preparable and can help to confirm the unknown compound.
5. **Determination of physical constants:** B.P. or M.P. are an important characteristic physical property.
6. **Separation of binary mixture:** In case of mixture of two unknown compounds, which need to be separated prior to their analysis.

This helps in error free identification of an unknown organic compound. The tests are given in sequence one after the other, to reach the end results and to confirm the identity of the given, unknown organic compound, correctly and student is required to follow the same sequence.

Main class of organic compounds encountered in the systematic qualitative analysis:

(a) **Carbohydrates:** (e.g., glucose, fructose, sucrose, lactose, maltose, starch, dextrin, etc.)

Tests:

1. **Molisch test:** General test for carbohydrates.
2. **Barfoed's test:** For distinction between mono and disaccharides.
3. **Fehling's and Benedict's tests:** For differentiating between a reducing and a non-reducing saccharides.
4. **Selvinoff's test:** Test for ketoses.

(1.1)



PRINCIPAL
K. K. Wagh College of Pharmacy
Nashik-422 003

AS PER PCI REGULATIONS
FIRST YEAR B. PHARM. | SEMESTER-II

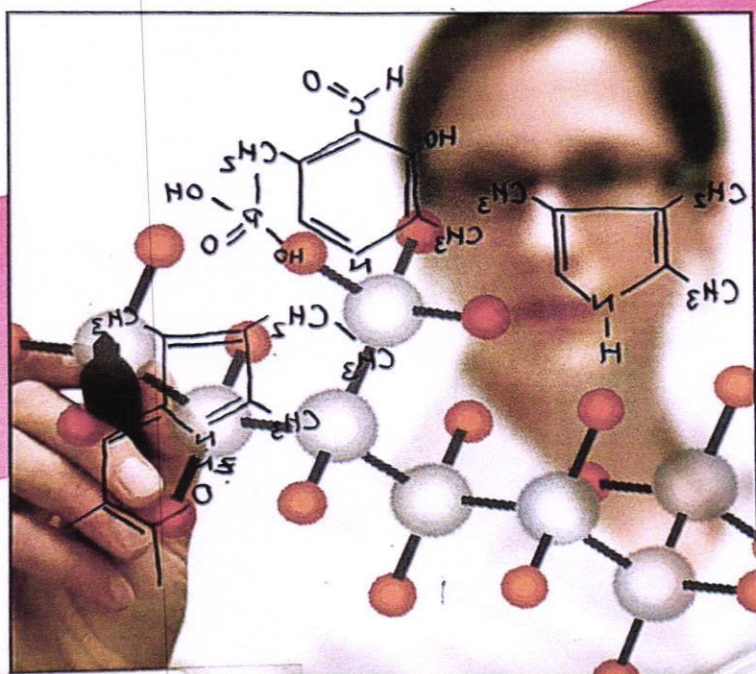
PHARMACEUTICAL ORGANIC CHEMISTRY-I

Simplified

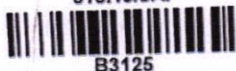
Dr. K. S. JAIN

Dr. P. B. MINIYAR

Dr. L. V. G. NARGUND



KKWCOP NASHIK
615.19/JAI



B3125

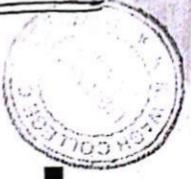
NIRALI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

3125



A Text Book Of
PHARMACEUTICAL
ORGANIC CHEMISTRY - I

As Per PCI Regulations

First Year B. Pharm.
Semester II

Dr. K. S. Jain

M. Pharm., Ph.D., FIC
Principal & Professor, Deptt. of Pharmaceutical Chemistry
K.K. Wagh Education Society's
K.K. Wagh College of Pharmacy
Hirabai Haridas Vidyanagari,
Amrut Dham, Panchavati, Nashik 422003

Dr. P. B. Miniyar

M. Pharm., Ph.D., FAGE
Professor and Vice-Principal
Sinhgad Technical Education Society's
Sinhgad Institute of Pharmacy, Narhe
Pune 411 041

Dr. L. V. G. Nargund

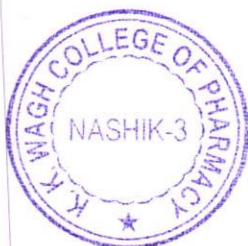
M. Pharm., Ph.D., FIC
Principal and Professor
Deptt. of Pharmaceutical Chemistry
Nargund College of Pharmacy
Dattatreyanagar, Banashankari, III Stage
Bangalore 560085


Price ₹ 150.00

 **NIRALI[®]**
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

N3948

BOOKS HANDLE WITH CARE




PRINCIPAL
K.K. Wagh College of Pharmacy
Nashik-422 003

Third Edition : February 2019

Authors

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopying, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the authors or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

Polyplate

Published By :

NIRALI PRAKASHAN

Abhyudaya Pragati, 1312, Shivaji Nagar

Off J.M. Road, Pune - 411005

Tel - (020) 25512336/37/39, Fax - (020) 25511379

Email : niralipune@pragationline.com

Printed By :
YOGIRAJ PRINTERS AND BINDERS

Survey No. 10/1A, Ghule Industrial Estate

Nanded Gaon Road

Nanded, Pune - 411041

Mobile No. 9404233041/9850046517

> DISTRIBUTION CENTRES

PUNE

Nirali Prakashan : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra
(For orders within Pune) Tel : (020) 2445 2044, 66022708, Fax : (020) 2445 1538; Mobile : 9657703145
Email : niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhayari, Near Asian College Pune 411041
(For orders outside Pune) Tel : (020) 24690204 Fax : (020) 24690316; Mobile : 9657703143
Email : bookorder@pragationline.com

MUMBAI

Nirali Prakashan : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,
Girgaum, Mumbai 400004, Maharashtra; Mobile : 9320129587
Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976
Email : niralimumbai@pragationline.com

> DISTRIBUTION BRANCHES

JALGAON

Nirali Prakashan : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001, Maharashtra,
Tel : (0257) 222 0395, Mob : 94234 91860; Email : niralijalgaon@pragationline.com

KOLHAPUR

Nirali Prakashan : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank, Kolhapur 416 012
Maharashtra. Mob : 9850046155; Email : niralikolhapur@pragationline.com

NAGPUR

Nirali Prakashan : Above Maratha Mandir, Shop No. 3, First Floor,
Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra
Tel : (0712) 254 7129; Email : niralinagpur@pragationline.com

DELHI

Nirali Prakashan : 4593/15, Basement, Agarwal Lane, Ansari Road, Daryaganj
Near Times of India Building, New Delhi 110002 Mob : 08505972553
Email : niralidelhi@pragationline.com

BENGALURU

Nirali Prakashan : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,
Malleswaram, Bengaluru 560003, Karnataka; Mob : 9449043034
Email : niralibangalore@pragationline.com

Other Branches : Hyderabad, Chennai

Note : Every possible effort has been made to avoid errors or omissions in this book. In spite of this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on f www.facebook.com/niralibooks



(Signature)

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

Contents

Unit I

1. Classification, Nomenclature and Isomerism	1.1 – 1.37
1.1 Classification of Organic Compounds	1.1
1.2 Common names of Organic Compounds	1.4
1.2.1 Compounds containing Carbon and Hydrogen Only	1.4
1.2.2 Compounds containing Carbon, Hydrogen and Oxygen	1.6
1.2.3 Compounds containing Carbon, Hydrogen and Nitrogen only	1.9
1.2.4 Compounds containing Carbon, Hydrogen, Oxygen and Halogens only	1.10
1.2.5 Compounds containing Carbon, Hydrogen, Oxygen, Nitrogen and Halogens only	1.11
1.2.6 Compounds containing Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur and/or Halogens	1.13
1.3 IUPAC Nomenclature System for Organic Compounds: General Rules	1.15
1.4 Isomerism	1.27
1.4.1 Constitutional or Structural Isomerism	1.27
1.4.2 Stereoisomerism	1.32
• Questions	1.34

Unit II

2. Alkanes	2.1 – 2.8
2.1 Introduction	2.1
2.2 Hybridization of Atomic Orbitals	2.3
2.3 Halogenation of Alkanes	2.5
2.4 Uses of Paraffins (alkanes)	2.7
• Questions	2.8
3. Alkenes	3.1 – 3.18
3.1 Introduction: Properties of Alkenes	3.1
3.2 Elimination Reactions-Type	3.4
3.2.1 The Mechanisms of Elimination Reaction (β -Elimination)	3.5
3.2.2 Orientation of Elimination	3.7
3.2.3 Comparison of E_1 , E_2 and E_{1cB} Reactions	3.12
3.2.4 Ozonolysis	3.13
3.3 Addition Reactions of Alkenes: Electrophilic Additions	3.14
3.4 The Markovnikoff's Orientation in Electrophilic Addition	3.17
• Questions	3.18
4. Conjugated Dienes	4.1 – 4.9
4.1 Introduction	4.1
4.2 Stability of Conjugated Dienes	4.2
4.3 Diel's-Alder Reaction	4.4
4.4 Electrophilic Addition Reaction	4.5
4.5 Free Radical Addition Reactions	4.7
4.6 Allylic Rearrangement	4.8
• Questions	4.9



AKP

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

Unit III

5. Alkyl Halides

5.1 – 5.24

- 5.1 Introduction 5.1
- 5.2 General Reactions of Alkyl Halides 5.4
- 5.3 Factors affecting SN_1 and SN_2 Reaction Mechanisms 5.11
- 5.4 Substitution Vs Elimination 5.14
- 5.5 Structures and Uses of Some Alkyl halide derivatives 5.17
 - Questions 5.23

6. Alcohols

6.1 – 6.10

- 6.1 Introduction 6.1
- 6.2 Nomenclature 6.2
- 6.3 Physical Properties 6.3
- 6.4 Qualitative Tests 6.4
- 6.5 Structure and Uses of some Alcohols 6.6
 - Questions 6.10

Unit IV

7. Carbonyl Compounds

7.1 – 7.28

- 7.1 Nucleophilic Addition 7.1
 - 7.1.1 Mechanism of Nucleophilic Addition and Condensation Reactions 7.1
 - 7.1.2 Examples of Nucleophilic Addition to Carbonyl Groups 7.2
 - 7.1.3 Acetal-Preparation and Uses / Addition of Alcohols to $C=O$ 7.4
 - 7.1.4 Additions of Derivatives of Ammonia 7.6
- 7.2 Electromeric Effect 7.12
- 7.3 Some Reactions of Carbonyl Compounds 7.13
 - 7.3.1 Aldol Condensation 7.13
 - 7.3.2 Crossed Aldol Condensation 7.14
 - 7.3.3 Cannizaro Reaction 7.14
 - 7.3.4 Crossed Cannizaro Reaction 7.15
 - 7.3.5 Benzoin Condensation 7.15
 - 7.3.6 Perkin Reaction 7.16
- 7.4 Qualitative tests for Aldehydes and Ketones 7.17
 - 7.4.1 2, 4-DNP Test for Aldehydes and Ketones 7.17
 - 7.4.2 Tollen's Test for Aldehydes 7.17
 - 7.4.3 Jones (Chromic Acid) Oxidation Test for Aldehydes 7.18
 - 7.4.4 Iodoform Test for Methyl Ketones 7.19
- 7.5 Structures and Uses of some Carbonyl Compounds 7.19
 - Questions 7.28



(Signature)

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

Unit V

8. Carboxylic Acids (Aromatic and Aliphatic)

8

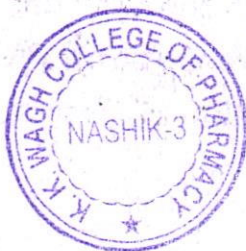
- 8.1 Introduction
- 8.2 Acidity of Carboxylic Acids
- 8.3 Effect of Substituents on Acidity
- 8.4 Inductive Effect
- 8.5 Qualitative Test for Carboxylic Acid ($R-/Ar-COOH$)
- 8.6 Structures and Uses of some Carboxylic Acids and Derivatives
 - Questions

9. Aliphatic Amines

9

- 9.1 Introduction
- 9.2 Basicity of Amines
- 9.3 Effects of Substituents on Basicity of Amines
- 9.4 Qualitative Tests for Amines
- 9.5 Structure and Uses of some Amines
 - Questions

Index



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

Chapter ... 1

CLASSIFICATION, NOMENCLATURE AND ISOMERISM

♦ LEARNING OBJECTIVES ♦

- To know different types of Classes and Organic Compounds.
- To understand the IUPAC Rules for Nomenclature of Organic Compounds.
- To draw the Structure from given name.
- To give the name for given Structure.
- To understand types of Isomerism of the Organic Compound.

1.1 CLASSIFICATION OF ORGANIC COMPOUNDS

Classification of organic compounds on the basis of functional group and elemental composition:

1. Compounds containing carbon and hydrogen atoms only: Hydrocarbons (Alkanes, Alkenes, Alkynes, Aromatic Hydrocarbons, Arylalkyl Hydrocarbons, Alicyclic Hydrocarbons).
2. Compounds containing carbon, hydrogen and oxygen atoms only: Alcohols, Phenols, Ethers, Epoxides, Carbonyl compounds, Aldehydes and Ketones, Carboxylic acids, Esters, Anhydrides.
3. Compounds containing Carbon, Hydrogen and Nitrogen atoms only: Amines and Imines, Nitriles, Hydrazines.
4. Compounds containing Carbon, Hydrogen, Halogens with or without Oxygen: Alkyl Halides, Aryl Halides, Acyl Halides.
5. Compounds containing Carbon, Hydrogen, Oxygen and Nitrogen atoms only: Amides, Imides, Aldoximes, Ketoximes, Nitro compounds.
6. Compounds containing Carbon, Hydrogen and Sulphur with/without Nitrogen, Oxygen and Halogen: Sulphonic acids, Sulphonylhalides, Sulphonamides.
7. IUPAC nomenclature of all classes of compounds; Nomenclature of Mono-substituted and Poly-substituted compounds. (Recent rules of IUPAC referred).

Chp 1 | 1.1



(Signature)

PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

AS PER
PCI
REGULATIONS

FIRST YEAR B. PHARM | SEMESTER-I

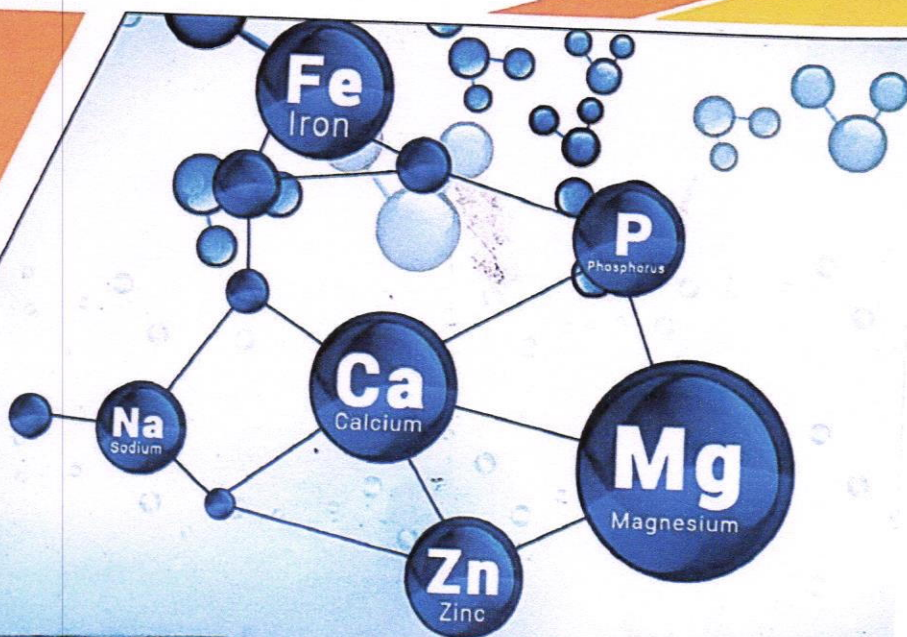
PRACTICAL PHARMACEUTICAL INORGANIC CHEMISTRY

SIMPLIFIED

Dr. K. S. JAIN

J. N. KADAM

M. G. SHINDE



KKWCOP NASHIK

615.19/JAI.



B3167

NIRALI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

3167

A Practical Book Of **PHARMACEUTICAL INORGANIC CHEMISTRY**

Simplified

As Per PCI Regulations

First Year B. Pharm.

Semester - I

Dr. K. S. Jain

M. Pharm., Ph.D., FIC

Principal & Professor, (Pharmaceutical Chemistry)

K.K. Wagh Education Society's

K.K. Wagh College of Pharmacy

Panchwati, Nashik - 422 003

J. N. Kadam

M. Pharm.

Asst. Professor of Pharm. Chem.

Siddhant College of Pharmacy

Sudumbare, Pune 412109

M. G. Shinde

M. Pharm.

Asst. Professor of Pharm. Chem.

K. K. Wagh Education Society's

K. K. Wagh College of Pharmacy

Panchwati, Nashik - 422 003

Price ₹ 70.00

 **NIRALI[®]**
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

N4013

BOOKS HANDLE WITH CARE



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

Second Edition : January 2019

© : Authors

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the authors or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

Published By :

NIRALI PRAKASHAN

Abhyudaya Pragati, 1312, Shivaji Nagar

Off J.M. Road, Pune - 411005

Tel - (020) 25512336/37/39, Fax - (020) 25511379

Email : niralipune@pragationline.com

Polyplate

Printed By :

YOGIRAJ PRINTERS AND BINDERS

Survey No. 10/1A, Ghule Industrial Estate

Nanded Gaon Road

Nanded, Pune - 411041

Mobile No. 9404233041/9850046517

➤ **DISTRIBUTION CENTRES****PUNE****Nirali Prakashan** : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra

Tel : (020) 2445 2044, 66022708

Email : bookorder@pragationline.com, niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhyari, Near Pari Company, Pune 411041

Tel : (020) 24690204 Fax : (020) 24690316

Email : dhyari@pragationline.com, bookorder@pragationline.com

MUMBAI**Nirali Prakashan** : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,

Girgaum, Mumbai 400004, Maharashtra

Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976

Email : niralimumbai@pragationline.com

➤ **DISTRIBUTION BRANCHES****JALGAON****Nirali Prakashan** : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001,

Maharashtra, Tel : (0257) 222 0395, Mob : 94234 91860

Email : niralijalgaon@pragationline.com

KOLHAPUR**Nirali Prakashan** : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank

Kolhapur 416 012, Maharashtra, Mob : 9850046155

Email : niralikolhapur@pragationline.com

NAGPUR**Pratibha Book Distributors** : Above Maratha Mandir, Shop No. 3, First Floor,

Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra

Tel : (0712) 254 7129

DELHI**Nirali Prakashan** : 4593/15, Basement, Agarwal Lane, Ansari Road, Daryaganj

Near Times of India Building, New Delhi 110002 Mob : 08505972553

Email : niralidelhi@pragationline.com

BANGALURU**Nirali Prakashan** : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,


Malleswaram, Bangaluru 560 003, Karnataka

Mob : +91 9449043034

Email : niralibangalore@pragationline.com

Note : Every possible effort has been made to avoid errors or omissions in this book. In spite this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on  www.facebook.com/niralibooks

PRINCIPAL✓ K K Wagh College of Pharmacy
Nashik-422 003

Contents

1. Limit Tests for Various Ions - Introduction	1.1 - 1.26
1. To perform Limit Test for Chloride	1.2
2. To perform modified Limit Test for Chloride.	1.4
3. To perform Limit Test for Sulphate	1.5
4. To perform modified Limit Test for Sulphate	1.7
5. To perform Limit Test for Iron	1.8
6. To perform Limit Test for Lead	1.11
7. To perform Limit Test for Arsenic	1.15
8. To perform modified Limit Test for Arsenic	1.17
9. To perform Limit Test for Heavy metals	1.21
2. Qualitative Analysis of Inorganic Substances	2.1 - 2.41
10. Magnesium Hydroxide	2.22
11. Ferrous Sulphate	2.25
12. Sodium Bicarbonate	2.29
13. Calcium Gluconate	2.33
14. Copper Sulphate	2.36
3. Tests for Purity	3.1 - 3.6
15. To determine the neutralizing capacity of Aluminium Hydroxide Gel	3.1
16. To determine the Swelling Power of Bentonite	3.2
17. To determine Potassium Iodate and Iodine in Potassium Iodide	3.2
4. Preparation of Inorganic Pharmaceuticals	4.1 - 4.4
18. To prepare Boric Acid	4.1
19. To prepare Ferrous Sulphate	4.2
20. To prepare Potash Alum	4.3

■■■



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

Chapter 1 ...

Limit Tests

Limit Tests are quantitative or semi-quantitative tests designed to identify or control small quantities of impurities. These tests should be specific and sensitive.

Limit = A value or amount that is likely to be present in a substance.

Test = To examine or to investigate

Impurity = A foreign matter present in a compound

Definition:

Limit test is defined as a quantitative or semi-quantitative test designed to identify and control small quantities of impurities which are likely to be present in the substance.

Importance of Limit Tests:

1. To find out the harmful amount of impurities
2. To find out avoidable / unavoidable amount of impurities.

Types of Limit Tests:

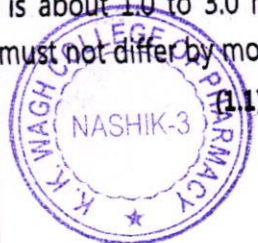
1. Comparison method
2. Quantitative determination
3. Test in which there is no visible reaction

General Principles:

1. If the sample is lighter (in colour/turbidity/opalescence) than the standard solution then it is within the pharmacopoeial limit (accepted).
2. If the sample is darker/heavier than the standard solution then it is above the pharmacopoeial limit (rejected).
3. **Specificity of a Limit Test:** A given limit test for a trace impurity should involve some selective reaction of the reagent with the trace impurity under consideration/detection specifically characteristic only to it.
4. **Sensitivity of a Limit Test:** As most of the limit tests involve dilute solutions and results are based on concentration of the trace impurity, the results may take longer duration to become observable or appreciable. Thus, consideration of duration of test needs to be of prime consideration in designing the limit test.

Nessler's Cylinder (IP appendix VII A127):

It is a clear glass cylinder with normal capacity of 50 ml. However, some Nessler's cylinders are of 100 ml capacity. The overall height is about 15 cm, the external height to the 50 ml mark is 11.0 to 12.4 cm and the thickness of the wall is around 1.0 to 1.5 mm, while, the thickness of the base is about 1.0 to 3.0 mm. The external height to the 50 mark of cylinders used for the test must not differ by more than 1 mm in the given pair.




PRINCIPAL
K K Wagh College of Pharmacy
Nashik-422 003

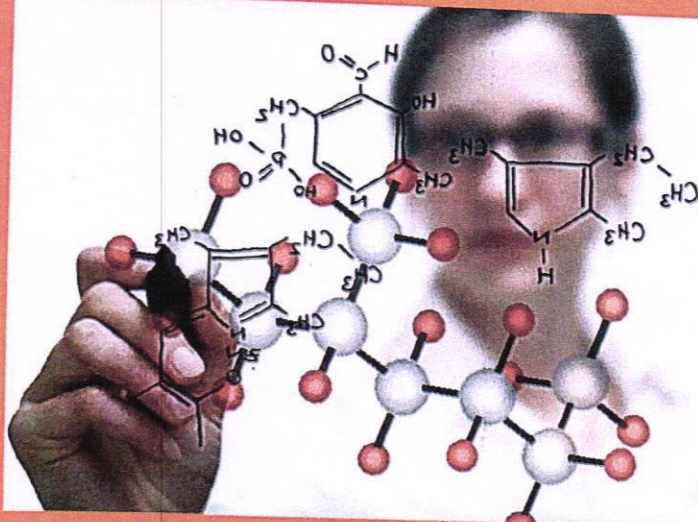
AS PER PCI REGULATIONS
SECOND YEAR B. PHARM. | SEMESTER-IV

PHARMACEUTICAL ORGANIC CHEMISTRY-III

SIMPLIFIED

Dr. K. S. JAIN

Dr. P. B. MINİYAR



NIRALI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE



PRINCIPAL
K. K. Wagh College of Pharmacy
Nashik-422 003

A Text Book of
**PHARMACEUTICAL
ORGANIC CHEMISTRY - III**
SIMPLIFIED

**As Per PCI Regulations
Second Year B. Pharm.
Semester - IV**

Dr. K. S. Jain

M. Pharm., Ph.D., FIC

Principal & Co-ordinator (Pharmacy), Deptt. of Pharmaceutical Chemistry
K.K. Wagh Education Society's, K.K. Wagh College of Pharmacy
Hirabai Haridas Vidyanagari, Amrut Dham, Panchavati, Nashik 422003

&

Member Executive Council

Dr. Babasaheb Ambedkar Technological University, Lonere, Raigad

Dr. P. B. Miniyaar

M. Pharm., Ph.D., FAGE

Professor, Sinhgad Technical Education Society's
Sinhgad Institute of Pharmacy, Narhe
Pune 411 041

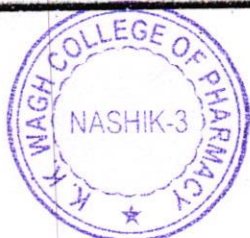
&

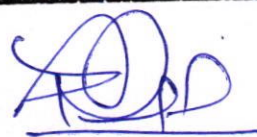
Senate Member, Savitribai Phule Pune University, Ganeshkhind, Pune 411007

Price ₹ 140.00

 **NIRALI[®]
PRAKASHAN**
ADVANCEMENT OF KNOWLEDGE

N4356




PRINCIPAL
K K Wagh College of Pharmacy
Nashik-422 003

ISBN 978-93-880706-58-2

Pharmaceutical Organic Chemistry - Simplified

First Edition : January 2019

© : Authors

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the authors or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

Published By :
NIRALI PRAKASHAN
 Abhyudaya Pragati, 1312, Shivaji Nagar
 Off J.M. Road, Pune - 411005
 Tel - (020) 25512336/37/39, Fax - (020) 25511379
 Email : niralipune@pragationline.com

Polyplate

Printed By :
YOGIRAJ PRINTERS AND BINDERS
 Survey No. 10/1A, Ghule Industrial Estate
 Nanded Gaon Road
 Nanded, Pune - 411041
 Mobile No. 9404233041/9850046517

> DISTRIBUTION CENTRES**PUNE**

Nirali Prakashan : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra
 (For orders within Pune) Tel : (020) 2445 2044, 66022708, Fax : (020) 2445 1538; Mobile : 9657703145
 Email : niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhayari, Near Asian College Pune 411041
 (For orders outside Pune) Tel : (020) 24690204 Fax : (020) 24690316; Mobile : 9657703143
 Email : bookorder@pragationline.com

MUMBAI

Nirali Prakashan : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,
 Girgaum, Mumbai 400004, Maharashtra; Mobile : 9320129587
 Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976
 Email : niralimumbai@pragationline.com

> DISTRIBUTION BRANCHES**JALGAON**

Nirali Prakashan : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001, Maharashtra,
 Tel : (0257) 222 0395, Mob : 94234 91860; Email : niralijalgaon@pragationline.com

KOLHAPUR

Nirali Prakashan : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank, Kolhapur 416 012
 Maharashtra. Mob : 9850046155; Email : niralikolhapur@pragationline.com

NAGPUR

Nirali Prakashan : Above Maratha Mandir, Shop No. 3, First Floor,
 Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra
 Tel : (0712) 254 7129; Email : niralinagpur@pragationline.com

DELHI

Nirali Prakashan : 4593/15, Basement, Agarwal Lane, Ansari Road, Daryaganj
 Near Times of India Building, New Delhi 110002 Mob : 08505972553
 Email : niralidelhi@pragationline.com

BENGALURU

Nirali Prakashan : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,
 Malleswaram, Bengaluru 560003, Karnataka; Mob : 9449043034
 Email : niralibangalore@pragationline.com

Other Branches : Hyderabad, Chennai

Note : Every possible effort has been made to avoid errors or omissions in this book. In spite this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on www.facebook.com/niralibooks

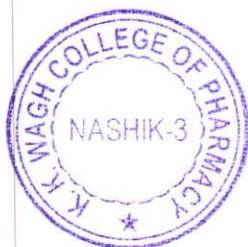


(Signature)
PRINCIPAL

K K Wagh College of Pharmacy
 Nashik-422 003

Contents ...

1. Stereoisomerism	1.1 – 1.34
1.1 Introduction	1.1
1.2 Stereoisomerism	1.3
1.2.1 Configurational Isomerism	1.3
1.2.2 Conformational Isomerism	1.4
1.3 Optical Isomerism	1.4
1.4 Optical Activity	1.5
1.5 Molecular Symmetry and Chirality	1.7
1.6 Optical Isomers	1.9
1.6.1 Enantiomers and Diastereomers	1.9
1.7 DL System of Nomenclature of Optical Isomers	1.13
1.8 RS System of Nomenclature of Optical Isomers	1.15
1.9 Reactions of Chiral Molecules	1.23
1.9.1 The Stereochemistry of SN2 and SN1 Reactions	1.23
1.9.2 The Stereochemistry of E1 and E2 Reactions	1.24
1.10 Racemic Modification and Resolution of Racemic Mixture	1.27
1.11 Asymmetric Synthesis (Stereoselective Synthesis or the Synthesis of Chiral Molecules)	1.30
• Questions	1.32
2. Geometrical Isomerism	2.1 – 2.30
2.1 Introduction	2.1
2.2 Nomenclature of Geometrical Isomers	2.2
2.3 Methods of Determination of Configuration of Geometrical Isomers	2.6
2.3.1 Chemical Methods	2.6
2.3.2 Physical Methods	2.7
2.4 Conformational Isomerism	2.9
2.4.1 Newmann Projections	2.9
2.4.2 Sawhorse Projections	2.10
2.4.3 Conformational Isomerism and Conformational Analysis	2.10
2.4.4 Conformations of Ethane	2.11
2.4.5 Conformations of Butane	2.12
2.4.6 Conformations of Cyclohexane	2.14
2.4.7 Equatorial and Axial Bonds in Chair form of Cyclohexane	2.14
2.4.8 Conformation of Cyclohexane - Conformational Analysis	2.20
2.5 Stereo Isomerism in Biphenyl Compounds (Atropisomerism) and Conditions for Optical Activity	2.22
2.6 Stereoselective and Stereospecific Reactions	2.24
• Questions	2.28



PRINCIPAL
K. K. Wagh College of Pharmacy
Nashik-422 003

3. Heterocyclic Compounds - I

3.1 - 3.26

3.1	Introduction	3.1
3.2	Nomenclature of Heterocyclic Compounds	3.2
3.3	Classification of Heterocyclic Compounds	3.3
3.4	Pyrrole	3.8
3.4.1	Structure	3.8
3.4.2	Physical Properties	3.9
3.4.3	Synthesis of Pyrroles	3.9
3.4.4	Chemical Reactions	3.11
3.4.5	Medicinal uses of Pyrrole	3.14
3.5	Furan	3.15
3.5.1	Structure	3.15
3.5.2	Physical Properties	3.15
3.5.3	Synthesis of Furan	3.15
3.5.4	Chemical Reactions	3.16
3.5.5	Medicinal uses of Furan	3.19
3.6	Thiophene	3.20
3.6.1	Structure	3.20
3.6.2	Physical Properties	3.21
3.6.3	Synthesis of Thiophene	3.21
3.6.4	Chemical Reactions	3.21
3.6.5	Medicinal uses of Thiophene	3.22
3.7	Relative Aromaticity and Reactivity of Pyrrole, Furan and Thiophene	3.24
•	Questions	3.25

4. Heterocyclic Compounds - II

4.1 - 4.46

4.1	Pyrazole	4.1
4.1.1	Structure	4.1
4.1.2	Physical Properties	4.1
4.1.3	Synthesis of Pyrazole	4.1
4.1.4	Chemical Reactions	4.2
4.1.5	Medicinal uses of Pyrazole	4.3
4.2	Imidazole	4.4
4.2.1	Structure	4.4
4.2.2	Physical Properties	4.4
4.2.3	Synthesis of Imidazole	4.5
4.2.4	Chemical Reactions	4.6
4.2.5	Medicinal uses of Imidazole	4.11
4.3	Oxazole	4.12
4.3.1	Structure	4.12
4.3.2	Physical Properties	4.12
4.3.3	Synthesis of Oxazole	4.13
4.3.4	Medicinal uses of Oxazole	4.14



PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

4.4	Thiazole	4.15
4.4.1	Structure	4.15
4.4.2	Physical Properties	4.16
4.4.3	Synthesis of Thiazole	4.16
4.4.4	Chemical Reactions	4.16
4.4.5	Medicinal uses of Thiazoles	4.17
4.5	Pyridine	4.18
4.5.1	Structure and Physical Properties	4.18
4.5.2	Electrophilic Attack at Positions 3 and 5	4.18
4.5.3	Synthesis of Pyridine	4.19
4.5.4	Chemical Properties	4.20
4.5.5	Medicinal uses of Pyridine	4.23
4.6	Quinoline	4.24
4.6.1	Structure, Reactivity and Orientation	4.24
4.6.2	Synthesis of Quinoline	4.25
4.6.3	Chemical Properties	4.28
4.6.4	Medicinal uses of Quinoline	4.31
4.7	Isoquinoline	4.31
4.7.1	Structure	4.31
4.7.2	Physical Properties	4.31
4.7.3	Synthesis of Isoquinoline	4.32
4.7.4	Chemical Reactions	4.32
4.7.5	Medicinal uses of Isoquinoline	4.34
4.8	Acridine	4.35
4.8.1	Structure	4.35
4.8.2	Physical Properties	4.35
4.8.3	Synthesis of Acridine	4.35
4.8.4	Chemical Reactions	4.35
4.8.5	Medicinal uses of Acridine	4.36
4.9	Indole	4.36
4.9.1	Structure	4.36
4.9.2	Physical Properties	4.36
4.9.3	Synthesis of Indole	4.37
4.9.4	Chemical Reactions of Indole	4.39
4.9.5	Medicinal uses of Indole	4.41
4.10	Basicity of Pyridine	4.42
4.11	Pyrimidine	4.43
4.11.1	Synthesis of Pyrimidine	4.43
4.11.2	Pyrimidine: Biological Activity	4.44
4.12	Purine	4.44
	• Questions	4.45



5. Reactions of Synthetic Importance

- 5.1 Metal Hydride reduction by Sodium Borohydride (NaBH_4) and Lithium Aluminium Hydride (LiAlH_4)
- 5.2 Clemmensen Reduction
- 5.3 Wolf Kishner Reduction
- 5.4 Birch Reduction
- 5.5 Oppenauer-Oxidation
- 5.6 Dakin Reaction
- 5.7 Claisen-Schmidt Condensation
- 5.8 Schmidt Rearrangement
- 5.9 Beckmann Rearrangement
- Questions

5.1
5.4
5.6
5.7
5.8
5.10
5.11
5.13
5.14
5.15



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

Unit ... 1

STEREISOMERISM

♦ LEARNING OBJECTIVES ♦

After completing this chapter, reader should be able to understand:

- Optical isomerism – Optical Activity
- Enantiomerism
- Diastereoisomerism
- Meso Compounds
- Elements of Symmetry
- Chiral and Achiral Molecules
- DL System of Nomenclature of Optical Isomers, Sequence Rules
- RS System of Nomenclature of Optical Isomers
- Reactions of Chiral Molecules
- Racemic Modification and Resolution of Racemic Mixture
- Asymmetric Synthesis: Partial and Absolute

1.1 INTRODUCTION

Stereochemistry is a branch of organic chemistry which deals with structure of compounds in three dimensions and hence can be termed as chemistry or study of compounds with respect to the arrangements and movements of different atoms or group of atoms in space. The word is derived from Greek word (Stereos = "three"-dimensionality).

Stereochemistry also deals with stereo-isomerism and stereo-chemical reactions of organic compounds.

Founders of Stereochemistry:

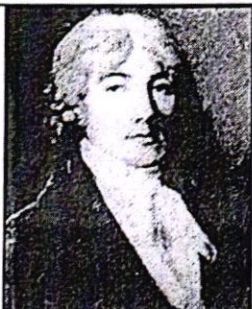


		
Biot realized in 1815 that the solutions of many naturally occurring compounds rotate the plane of polarization of plane polarized light.	Pasteur recognized in 1850 that the optical activity was caused by an asymmetric arrangement of atoms in a molecule.	van't Hoff with Le Bel described in 1874 how the atoms of a molecule are actually arranged in space.

Fig. 1.1: Founders of Stereochemistry

(1.1)



PRINCIPAL
K K Wagh College of Pharmacy
Nashik-422 003



FIRST YEAR B. PHARM | SEMESTER-I

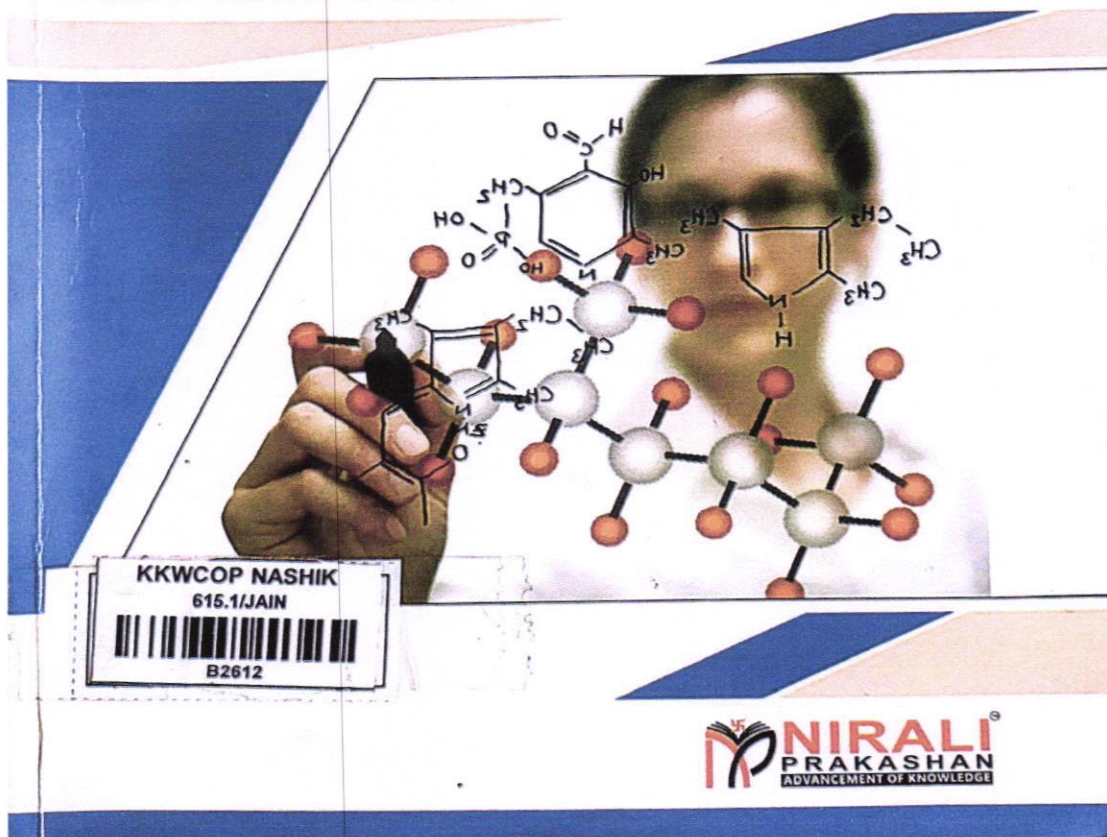
PHARMACEUTICAL INORGANIC CHEMISTRY

SIMPLIFIED

Dr. K. S. JAIN

Dr. P. B. MINIYAR

Dr. K. ILANGO



KKWCOP NASHIK

615.1/JAIN



B2612

NIRALI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

A Textbook Of

2612



PHARMACEUTICAL INORGANIC CHEMISTRY

SIMPLIFIED

F. Y. B.Pharm [Semester - I]

As Per PCI Syllabus

Dr. K. S. Jain

M. Pharm., Ph.D., FIC

Principal and Professor of Pharm. Chem.

K. K. Wagh Education Society's

K. K. Wagh College of Pharmacy

Panchwati, Nashik - 422 003

Dr. P. B. Miniyar

M. Pharm., Ph.D., FAGE

Prof. (Pharm. Chem.) and Senate Member (SPPU, Pune)

Sinhgad Technical Education Society's

Sinhgad Institute of Pharmacy, Narhe, Pune - 411 041

Dr. K. Ilango

M. Pharm., Ph.D., FIC

Professor, Department of Pharmaceutical Chemistry,

SRM College of Pharmacy, SRM University

Chennai - 603 203 (Tamil Nadu)

Price ₹ 110.00

BOOKS HANDLE WITH CARE

 **NIRALI**
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

N3925




PRINCIPAL
K. K. Wagh College of Pharmacy
Nashik-422 003

Pharmaceutical Inorganic Chemistry

ISBN 978-93-88194-55-6

First Edition : July 2018

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the authors or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

Published By :

NIRALI PRAKASHAN

Abhyudaya Pragati, 1312, Shivaji Nagar,
Off J.M. Road, PUNE - 411005
Tel - (020) 25512336/37/39, Fax - (020) 25511379
Email : niralipune@pragationline.com

Printed By :

YOGIRAJ PRINTERS AND BINDERS

Works: Sr. No. 10/1, Ghule Industrial Estate,
Nanded Village Road
TAL-HAVELI, DIT-PUNE 411041
Mobile - 9850046517, 9404225254

DISTRIBUTION CENTRES

PUNE

Nirali Prakashan : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra
Tel : (020) 2445 2044, 66022708, Fax : (020) 2445 1538

Email : bookorder@pragationline.com, niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhyari, Near Pari Company, Pune 411041

Tel : (020) 24690204 Fax : (020) 24690316

Email : dhyari@pragationline.com, bookorder@pragationline.com

MUMBAI

Nirali Prakashan : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,

Girgaum, Mumbai 400004, Maharashtra

Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976

Email : niralimumbai@pragationline.com

DISTRIBUTION BRANCHES

JALGAON

Nirali Prakashan : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001,
Maharashtra, Tel : (0257) 222 0395, Mob : 94234 91860

KOLHAPUR

Nirali Prakashan : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank
Kolhapur 416 012, Maharashtra. Mob : 9850046155

NAGPUR

Pratibha Book Distributors : Above Maratha Mandir, Shop No. 3, First Floor,
Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra
Tel : (0712) 254 7129

DELHI

Nirali Prakashan : 4593/21, Basement, Aggarwal Lane 15, Ansari Road, Daryaganj
Near Times of India Building, New Delhi 110002
Mob : 08505972553


BENGALURU

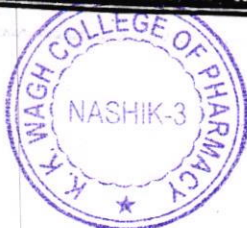
Nirali Prakashan : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,
Malleswaram, Bangalore 560 003, Karnataka
Mob : +91 9449043034

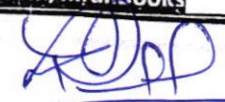
Email : niralibangalore@pragationline.com

Note : Every possible effort has been made to avoid errors or omissions in this book. In spite this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on  www.facebook.com/niralibooks




PRINCIPAL
K. K. Wagh College of Pharmacy
Nashik-422 003

Contents ...

1. Introduction to Pharmaceutical Substances	1.1 - 1.32
2. Acids Bases and Buffers	2.1 - 2.12
3. Major Extra and Intracellular Electrolytes	3.1 - 3.20
4. Dental Products	4.1 - 4.10
5. Gastrointestinal Agents	5.1 - 5.4
6. Antacids	6.1 - 6.14
7. Cathartics	7.1 - 7.6
8. Antimicrobials	8.1 - 8.10
9. Miscellaneous Agents	9.1 - 9.14
10. Radiopharmaceuticals	10.1 - 10.14



PRINCIPAL
K K Wagh College of Pharmacy
Nashik-422 003

Chapter 1 ...

Impurities in Pharmaceutical Substances

Contents ...

- 1.1 Inorganic Chemistry
 - 1.1.1 Importance of Inorganic Pharmaceuticals
- 1.2 Pharmacopoeia
 - 1.2.1 History of Pharmacopoeia
 - 1.2.2 Indian Pharmacopoeia
 - 1.2.3 Indian Pharmacopoeia 2010
 - 1.2.4 Indian Pharmacopoeia 2014
 - 1.2.5 Indian Pharmacopoeia 2018
 - 1.2.6 British Pharmacopoeia
 - 1.2.7 European Pharmacopoeia
 - 1.2.8 Pharmacopoeia International (International Pharmacopoeia)
 - 1.2.9 United States Pharmacopoeia (USP)
- 1.3 Official Monograph
- 1.4 New Inclusion / Exclusion of Monograph
- 1.5 Sources of Impurities
- 1.6 Limit Tests
 - 1.6.1 Limit Test for Chlorides
 - 1.6.2 Limit Test for Sulphates
 - 1.6.3 Limit Test for Iron
 - 1.6.4 Limit Test for Lead
 - 1.6.5 Limit Test for Heavy Metals
 - 1.6.6 Limit Test for Arsenic
 - 1.6.7 Limits of Insoluble and Soluble Matter
- 1.7 Qualitative Tests for Alkali and Alkaline Earth Metals
- 1.8 Modified Limit Tests for Chlorides and Sulfates
- Question Bank



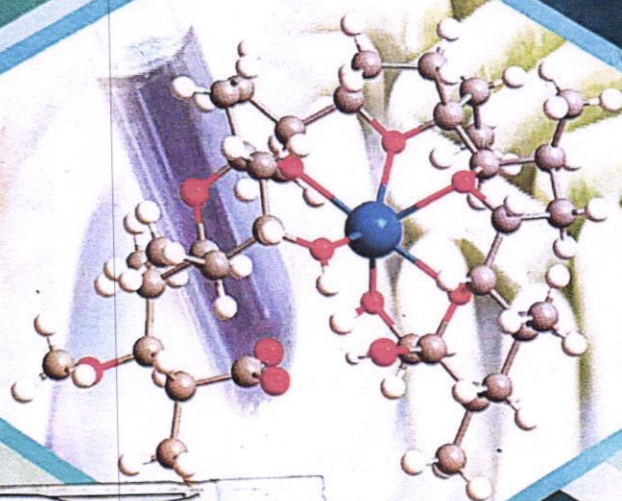
AS PER PCI REGULATIONS
SECOND YEAR B. PHARM. | SEMESTER-III

PHARMACEUTICAL ORGANIC CHEMISTRY-II

Dr. K. S. JAIN

Dr. P. B. MINİYAR

Dr. L. V. G. NARGUND



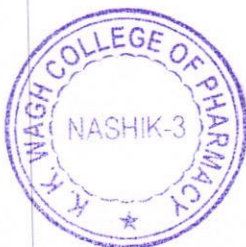
KKWCOP NASHIK

615.1/JAIN



B2425

NIRALI
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE



PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

2425 /

A Text Book Of
**PHARMACEUTICAL
ORGANIC CHEMISTRY - II**

As Per PCI Regulations

Second Year B. Pharm.
Semester III

Dr. K. S. Jain

M. Pharm., Ph.D., FIC
Principal & Professor
Deptt. of Pharmaceutical Chemistry
K.K. Wagh Education Society's
K.K. Wagh College of Pharmacy
Hirabai Haridas Vidyarnagari, Amrut Dham, Panchavati,
Nashik 422003

Dr. P. B. Miniyar

M. Pharm., Ph.D., FAGE
Professor and Senate Member (SSPU)
Sinhgad Technical Education Society's
Sinhgad Institute of Pharmacy, Narhe
Pune 411 041

Dr. L. V. G. Nargund

M. Pharm., Ph.D., FIC
Principal and Professor
Deptt. of Pharmaceutical Chemistry
Nargund College of Pharmacy
Dattatreyanagar, Banashankari, III Stage
Bangalore 560085

Price ₹ 85.00

615.19

JAI



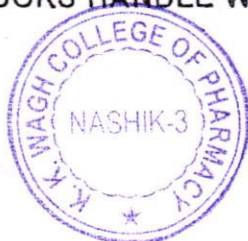
2425

K.K. Wagh College of Pharmacy,
Nashik-422 003

 **NIRALI[®]**
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

N4346

BOOKS HANDLE WITH CARE





PRINCIPAL

K.K. Wagh College of Pharmacy
Nashik-422 003

First Edition : July 2018

© : Authors

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the authors or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

**Published By :
NIRALI PRAKASHAN**

Abhyudaya Pragati, 1312, Shivaji Nagar
Off J.M. Road, Pune - 411005
Tel - (020) 25512336/37/39, Fax - (020) 25511379
Email : niralipune@pragationline.com

Polyplate

**Printed By :
YOGIRAJ PRINTERS AND BINDERS**

Survey No. 10/1A, Ghule Industrial Estate
Nanded Gaon Road
Nanded, Pune - 411041
Mobile No. 9404233041/9850046517

> DISTRIBUTION CENTRES

PUNE

Nirali Prakashan : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra

Tel : (020) 2445 2044, 66022708

Email : bookorder@pragationline.com, niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhyari, Near Pari Company, Pune 411041

Tel : (020) 24690204 Fax : (020) 24690316

Email : dhyari@pragationline.com, bookorder@pragationline.com

MUMBAI

Nirali Prakashan : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,

Girgaum, Mumbai 400004, Maharashtra

Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976

Email : niralimumbai@pragationline.com

> DISTRIBUTION BRANCHES

JALGAON

Nirali Prakashan : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001,

Maharashtra, Tel : (0257) 222 0395, Mob : 94234 91860

Email : niralijalgaon@pragationline.com

KOLHAPUR

Nirali Prakashan : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank

Kolhapur 416 012, Maharashtra. Mob : 9850046155

Email : niralikolhapur@pragationline.com

NAGPUR

Pratibha Book Distributors : Above Maratha Mandir, Shop No. 3, First Floor,

Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra

Tel : (0712) 254 7129

DELHI

Nirali Prakashan : 4593/15, Basement, Agarwal Lane, Ansari Road, Daryaganj

Near Times of India Building, New Delhi 110002 Mob : 08505972553

Email : niralidelhi@pragationline.com

BANGALURU

Nirali Prakashan : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,

Malleswaram, Bangalore 560 003, Karnataka

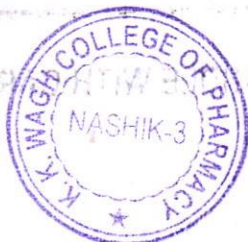
Mob : +91 9449043034

Email : niralibangalore@pragationline.com

Note : Every possible effort has been made to avoid errors or omissions in this book. In spite of this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on www.facebook.com/niralibooks



(Signature)

PRINCIPAL

Wagh College of Pharmacy
Nashik-422 003

Contents

Unit I

1. Benzene and Its Derivatives

1.1 – 1.22

- | | | |
|-----|--|------|
| 1.1 | Structure of Benzene | 1.1 |
| 1.2 | Analytical Evidences | 1.2 |
| 1.3 | Synthetic/Chemical Evidences | 1.2 |
| 1.4 | Orbital Picture of Benzene | 1.3 |
| 1.5 | Resonance and Aromaticity in Benzene | 1.4 |
| 1.6 | Reactions of Benzene | 1.6 |
| 1.7 | Electrophilic Aromatic Substitution | 1.7 |
| 1.8 | Nucleophilic Aromatic Substitution | 1.17 |
| 1.9 | Structure and Uses of some selected Benzene Derivatives,
viz., DDT, Saccharin, BHC and Chloramine | 1.18 |
| | • Questions | 1.22 |

Unit II

2. Phenols

2.1 – 2.13

- | | | |
|-----|------------------------|------|
| 2.1 | Introduction | 2.1 |
| 2.2 | Acidity of Phenols | 2.2 |
| 2.3 | Methods of Preparation | 2.3 |
| 2.4 | Reactions of Phenols | 2.6 |
| | • Questions | 2.13 |

3. Aromatic Amines

3.1 – 3.14

- | | | |
|-------|--|-----|
| 3.1 | Introduction | 3.1 |
| 3.2 | Methods of Preparation | 3.2 |
| 3.3.1 | Reduction of Nitriles | 3.2 |
| 3.2.2 | Reduction of Nitrocompounds | 3.2 |
| 3.2.3 | Selective Reduction by Ammonium Sulphide | 3.3 |
| 3.2.4 | Reductive Amination of Ketone | 3.3 |
| 3.2.5 | Hoffmann Rearrangement | 3.3 |
| 3.2.6 | Ammonolysis of Aryl Chloride | 3.3 |
| 3.3 | Chemical Reactions of Aromatic Amines | 3.3 |
| 3.3.1 | Formation of Amide from Acyl Chloride | 3.3 |
| 3.3.2 | Salt Formation | 3.4 |
| 3.3.3 | Reaction with Nitrous Acid | 3.4 |
| 3.3.4 | Carbylamine Reaction | 3.4 |
| 3.3.5 | Acetylation | 3.5 |
| 3.3.6 | Reaction with Aldehydes (Schiff's Base) | 3.5 |
| 3.3.7 | Oxidation Reactions | 3.5 |



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

3.4	Basicity of Amines	3.5
3.5	Effects of Substituents on Basicity of Amines	3.7
3.6	Factors affecting on Basicity	3.7
3.6.1	Resonance Effect	3.8
3.6.2	Inductive Effect	3.8
3.6.3	Hydrogen Bonding	3.9
3.6.4	Orbital Nature of Electron Pair	3.9
3.6.5	Steric Effect	3.9
3.6.6	Solvation Effect	3.9
3.6.7	Electronegativity of Bonded Atoms	3.10
3.7	Aryl Diazonium Salts	3.10
3.7.1	History of Aryl Diazonium Salts	3.10
3.7.2	Aryl Diazonium Salts	3.10
3.7.3	Preparation of Benzenediazonium Chloride	3.11
3.7.4	Synthetic Applications of Aryl Diazonium Salts	3.12
3.7.5	Importance of Diazonium Salts	3.13
•	Questions	3.14
4.	Aromatic Acids	4.1 – 4.8
4.1	Introduction	4.1
4.2	Acidity: Salt Formation	4.2
4.3	Important Reactions of Benzoic Acid	4.3
4.4	Methods of Preparation of Aryl Carboxylic Acids	4.6
•	Questions	4.8

Unit III

5.	Fats and Oils	5.1 – 5.6
5.1	Introduction	5.1
5.2	Reactions of Fatty Acids	5.2
5.2.1	Hydrolysis	5.2
5.2.2	Hydrogenation	5.2
5.3	Rancidity of Oil (Rancidification)	5.2
5.3.4	Drying Oils	5.3
5.3	Principles and Significance of various Analytical Constants	5.3
5.3.1	Acid Value	5.4
5.3.2	Saponification Value	5.4
5.3.3	Ester Value	5.5
5.3.4	Iodine Value	5.5
5.3.5	Acetyl Value	5.6
5.3.6	Reichert-Meissl (RM) Value	5.6
•	Questions	5.6



(Signature)

PRINCIPAL

K K Wagh College of Pharmacy
Nashik-422 003

Unit IV

6. Polynuclear Hydrocarbons

6.1 – 6.24

- 6.1 Introduction
- 6.2 Naphthalene
 - 6.2.1 Synthesis of Naphthalene
 - 6.2.2 Properties
 - 6.2.3 Chemical Reactions
 - 6.2.4 Uses of Naphthalene and its Derivatives
 - 6.2.5 Structures of Naphthalene Derivatives
- 6.3 Anthracene
 - 6.3.1 Synthesis
 - 6.3.2 Chemical Reactions
 - 6.3.3 Uses of Anthracene and its Derivatives
 - 6.3.4 Structures of Anthracene Derivatives
- 6.4 Phenanthrene
 - 6.4.1 Synthesis
 - 6.4.2 Chemical Reactions
 - 6.4.3 Uses of Phenanthrene and its Derivatives
- 6.5 Diphenylmethane (Benzylbenzene)
- 6.6 Triphenylmethane
 - Questions

6.1
6.1
6.3
6.4
6.6
6.9
6.10
6.10
6.11
6.12
6.14
6.15
6.16
6.16
6.19
6.20
6.21
6.21
6.24

Unit V

7. Cycloalkanes

7.1 – 7.7

- 7.1 Introduction
- 7.2 Classification of Saturated Cycloalkanes
- 7.3 Methods of Preparation of Cycloalkanes
 - 7.3.1 From Dihalides
 - 7.3.2 Dieckmann Reaction
 - 7.3.3 Simmons-Smith Reaction
 - 7.3.4 From Aromatic Hydrocarbon
- 7.4 Stability of Cycloalkanes
 - 7.4.1 Baeyer Strain Theory
 - 7.4.2 Sacke-Mohr's Theory of Strainless Rings
- 7.5 Reactions of Cyclopropane and Cyclobutane
 - 7.5.1 Substitution Reactions
 - 7.5.2 Addition of Cl_2 and Br_2
 - 7.5.3 Addition of HBr and HI
 - 7.5.4 Addition of Hydrogen
 - Questions

7.1
7.1
7.3
7.3
7.3
7.3
7.3
7.4
7.4
7.5
7.6
7.6
7.6
7.6
7.7



[Signature]

PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003

Unit I

Chapter ... 1

BENZENE AND ITS DERIVATIVES

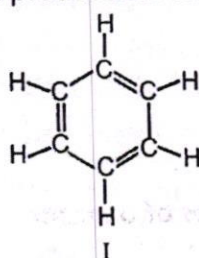
♦ LEARNING OBJECTIVES ♦

After completing this chapter, reader should be able to understand:

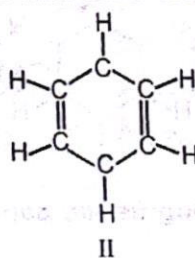
- Introduction to benzene.
- Analytical, Synthetic and other evidences in the derivation of structure of benzene.
- Orbital picture of benzene.
- Resonance in benzene, aromatic characters, Huckel's rules.
- Reactions of benzene - nitration, sulphonation, halogenation-reactivity, Friedel-Crafts alkylation - reactivity, limitations, Friedel-Crafts acylation.
- Substituents, effect of substituents on reactivity and orientation of mono substituted benzene compounds towards electrophilic substitution reaction.
- Structure and uses of DDT, Saccharin, BHC and Chloramine.

1.1 STRUCTURE OF BENZENE

Benzene on which the study of aromatics began was discovered in 1825. However, it was not till 1866 that the Kekule's formula or structure I of benzene was known, till he proposed it. This structure of benzene is most accepted because the satisfactory answers it offers to various substitution products as compared with other four proposed structures II-V (Fig. 1.1).



Kekule formula



Dewar formula

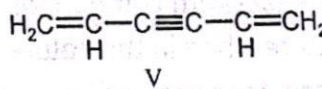
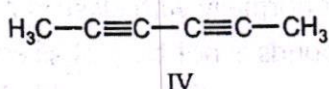
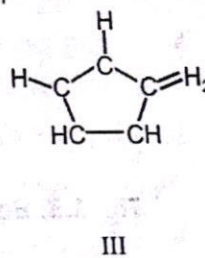
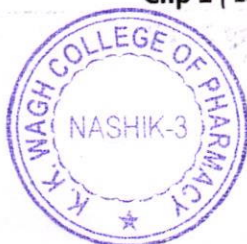


Fig. 1.1: Various structures proposed for benzene in earlier days

Chp 1 | 1.1



PRINCIPAL

K. K. Wagh College of Pharmacy
Nashik-422 003



K. K. WAGH COLLEGE OF PHARMACY

(B. Pharmacy & D. Pharmacy)

Hirabai Haridas Vidyanagari, Amrutdham, Panchavati, Nashik - 422 003. (Maharashtra) India.

☎ : 0253 - 2221121, 2517003, 2510262 Web : www.pharmacy.kkwagh.edu.in

Email: principal-bpharmacy@kkwagh.edu.in, disp-bpharmacy@kkwagh.edu.in

(Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, MSBTE, Mumbai & Approved by PCI)

3.3.2

2. Web links of Books/Chapter



K. K. WAGH COLLEGE OF PHARMACY

(B. Pharmacy & D. Pharmacy)

Hirabai Haridas Vidyanagari, Amrutdham, Panchavati, Nashik - 422 003. (Maharashtra) India.

☎ : 0253 - 2221121, 2517003, 2510262 Web : www.pharmacy.kkwagh.edu.in

Email: principal-bpharmacy@kkwagh.edu.in, disp-bpharmacy@kkwagh.edu.in

(Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, MSBTE, Mumbai & Approved by PCI)

3.3. Research Publications and Awards

3.3.2 Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during last five year

2. Web-link of books.

Sr. No.	Name of the teacher	Title of the book/chapters published	National / International	Year of publication	ISBN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher	Link of chapter/book
1	Dr. Vaibhav G. Bhamre, Mr. Shivraj P. Jadhav	Concepts of Physical Pharmaceutics I	National	2021-2022	9789392867392	K. K. Wagh College of Pharmacy	PharmaCareer Publications	Not Available
2	Bhamare V. G., Amrutkar R. D., Patil V, Upasani C. D.	Growing impact of herbal bioenhancers in pharmaceutical industries	International	2021-2022	9783110746792	K. K. Wagh College of Pharmacy	De-Gruyter	https://www.google.co.in/books/edition/Drug_Delivery_Technology/CyJIEAAAQBAJ?hl=en&gbpv=1&dq=Drug+Delivery+Technology:+Herbal+Bioenhancers+in+Pharmaceutics+ISBN&printsec=frontcover
3	Shamal. D. Dawange	A Laboratory Manual For Pharmacognosy	National	2021-2022	9788195407422	K. K. Wagh College of Pharmacy	Briliant Publication	https://pragationline.com/oin-structure-and-function-pamela-k-levangie-cynthia-c-norkin-michael-d-lewek-jaypee/
4	Dr. K. S. Jain, D. K. Kadam	A Practical of Pharmaceutical Analysis-	National	2020-2021	9789390596898	K. K. Wagh College of Pharmacy	Nirali Prakashan	https://pragationline.com/a-practical-book-of-pharmaceutical-analysis-first-year-bpharm-semester-1-pci/



K. K. WAGH COLLEGE OF PHARMACY

(B. Pharmacy & D. Pharmacy)

Hirabai Haridas Vidyanagari, Amrutdham, Panchavati, Nashik - 422 003. (Maharashtra) India.

☎ : 0253 - 2221121, 2517003, 2510262 Web : www.pharmacy.kkwagh.edu.in

Email: principal-bpharmacy@kkwagh.edu.in, disp-bpharmacy@kkwagh.edu.in

(Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, MSBTE, Mumbai & Approved by PCI)

Sr. No.	Name of the teacher	Title of the book/chapters published	National / International	Year of publication	ISBN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher	Link of chapter/book
5	Dr. K. S. Jain, D. K. Kadam, K. P. Baviskar	Pharmaceutical Analysis I	National	2019-2020	978-93-90506-60-6	K. K. Wagh College of Pharmacy	Nirali Prakashan	https://pragationline.com/pharmaceutical-analysis-jain-kadam-baviskar-first-year-bpharm-semester-1-as-per-pci/
6	Dr. K. S. Jain	A Practical book of Pharmaceutical Organic Chemistry	National	2018-2019	978-93-87686-05-2	K. K. Wagh College of Pharmacy	Nirali Prakashan	https://pragationline.com/a-practical-book-of-pharmaceutical-organic-chemistry-miniyar-nargund-jain/
7.	Dr. K. S. Jain	Pharmaceutical Organic Chemistry– I, Simplified	National	2018-2019	978-93-87397-62-0	K. K. Wagh College of Pharmacy	Nirali Prakashan	https://pragationline.com/pharmaceutical-organic-chemistry-1-simplified-jain-miniyar-nargund/
8	Dr. K. S. Jain, M.G.Shinde	Practical Pharmaceutical Inorganic Chemistry simplified	National	2018-2019	978-93-88293-31-0	K. K. Wagh College of Pharmacy	Nirali Prakashan	https://pragationline.com/practical-pharmaceutical-inorganic-chemistry-simplified-jain-kadam-shinde/
9	Dr. K. S. Jain	A Text Book of Pharmaceutical	National	2018-2019	978-93-880706-58-2	K. K. Wagh College of Pharmacy	Nirali Prakashan	https://pragationline.com/pharmaceutical-organic-chemistry-iii-3-jain-miniyar/



K. K. WAGH COLLEGE OF PHARMACY

(B. Pharmacy & D. Pharmacy)

Hirabai Haridas Vidyanagari, Amrutdham, Panchavati, Nashik - 422 003. (Maharashtra) India.

☎ : 0253 - 2221121, 2517003, 2510262 Web : www.pharmacy.kkwagh.edu.in

Email: principal-bpharmacy@kkwagh.edu.in, disp-bpharmacy@kkwagh.edu.in

(Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, MSBTE, Mumbai & Approved by PCI)

Sr. No.	Name of the teacher	Title of the book/chapters published	National / International	Year of publication	ISBN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher	Link of chapter/book
		Organic Chemistry – III						
10	Dr. K. S. Jain	Pharmaceutical Inorganic Chemistry, Simplified	National	2017-2018	9789388194556	K. K. Wagh College of Pharmacy	Nirali Prakashan	https://pragationline.com/pharmaceutical-inorganic-chemistry-simplified-jain-miniyar-ilango/
11	Dr. K. S. Jain	A textbook of Pharmaceutical Organic Chemistry– II	National	2017-2018	978-93-88194-10-5	K. K. Wagh College of Pharmacy	Nirali Prakashan	https://pragationline.com/pharmaceutical-organic-chemistry-2-nargund-jain-miniyar/