



Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



**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. Total number of books and chapters in edited volumes/books published and papers in national/ international conference proceedings year wise during last five years


Year	2022	2021	2020	2019	2018
Number	NIL	1	4	4	1

**Academic year 2021:**

**3.2.2.1 total number of books and chapters in edited volumes/ books published and papers in national / international conference proceedings year wise during last five years.**

Sr. No.	Title of the book	Name of the author	Department	Name of publisher	Year of publication	Isbn/issn no.
1.	"Computer Aided Drug Design"	Mr. C.P. Suryawan shi	Pharmaceutic al Chemistry	P.V. Publications	2021	9781543343069



  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



**Mr. Chandrakant P. Suryawanshi**

Dr. Md. Rageeb Md. Usman

Dr. Rajendra D. Wagh

Dr. Bhushankumar S. Sathe

Dr. Gulam J. Khan

*A Text Book of*

# COMPUTER AIDED DRUG DESIGN

*Strictly As Per Syllabus Prescribed for B. Pharmacy,  
Semester-VIII by Pharmacy Council of India, New Delhi*

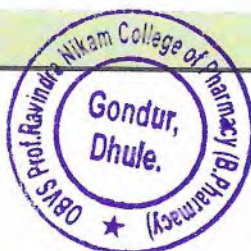


3391

Pee Vee (Regd.)

Computer Aided Drug Design

PRNCOP, Gondur



*Principal*  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



*A Text Book of*

# COMPUTER AIDED DRUG DESIGN

*Strictly As Per Syllabus Prescribed for B. Pharmacy,  
Semester-VIII by Pharmacy Council of India, New Delhi*

**Mr. Chandrakant P. Suryawanshi**  
M. Pharm.  
Assist. Professor  
Department of Pharmaceutical Chemistry  
Professor Ravindra Nikam  
College of Pharmacy Gondur, Dhule

**Dr. Md. Rageeb Md. Usman**  
M. Pharm., Ph.D., FAPP, FICPHS,  
FSRHCP, FRSH, FSPER  
Associated Professor  
Department of Pharmacognosy  
Smt. S. S. Patil College of Pharmacy,  
Chopda, Maharashtra &  
Joint Secretaries  
SPER Central Branch &  
President  
IPA/APP/RSH/SRHCP  
Maharashtra State Branch

**Dr. Rajendra D. Wagh**  
M. Pharm., Ph.D.  
Principal  
Annasaheb Ramesh Ajmera  
College of Pharmacy,  
Nagaon, Dhule

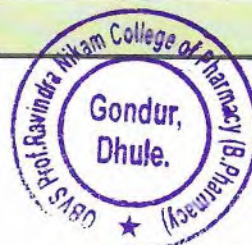
**Dr. Bhushankumar S. Sathe**  
M. Pharm., Ph.D.  
Principal  
Institute of Pharmaceutical  
Education and Research (IPER)  
Borgaon Meghe, Wardha (MS)

**Dr. Gulam J. Khan**  
M. Pharm., Ph.D.  
Principal  
J.I.I.U.'s Ali-Allana College of Pharmacy,  
Akkalkuwa, Maharashtra, India

**S. VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

Computer Aided Drug Design

PRNCOP, Gondur



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

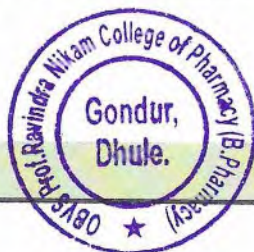
**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



## CONTENTS

<b>Chapter 1</b>	<b>Introduction of Drug Discovery and Development</b>	<b>1-9</b>
	1.0 Introduction 1, 1.1 Steps in modern drug discovery 2, 1.2 In this respect, several points should be kept in mind 3	
<b>Chapter 2</b>	<b>Lead Discovery and Analogue Based Drug Design</b>	<b>10-20</b>
	2.1 Introduction 10, 2.2 Rational drug design 10, 2.3 Lead discovery without lead 12, 2.4 Lead discovery with lead 15, 2.5 Random screening 16, 2.6 Nonrandom screening 16, 2.7 Drug metabolism studies 16, 2.8 Clinical observations 17	
<b>Chapter 3</b>	<b>Analogue Based Drug Design</b>	<b>21-43</b>
	3.1 Introduction 21, 3.2 History: development of the isosterism concept 21, 3.3 Grimm's hydride displacement law 22, 3.4 Classification of bioisosterism 24, 3.5 Analysis of the modifications resulting from isosterism 38, 3.6 Minor metalloids toxic isosters 40	
<b>Chapter 4</b>	<b>Quantitative Structure Activity Relationship (QSAR)</b>	<b>44-78</b>
	4.1 Introduction 44, 4.2 History of quantitative structure-activity relationships 44, 4.3 Physicochemical and biological descriptors 48, 4.4 QSAR methods 63, 4.5 The topliss tree 67, 4.6 Craig plot 71, 4.7 3D-QSAR 73	
<b>Chapter 5</b>	<b>Molecular Modeling and Virtual Screening Techniques</b>	<b>79-95</b>
	5.1 Introduction 79, 5.2 Virtual screening techniques 80, 5.3 Overview of the process 81, 5.4 Strategies of in silico design 82, 5.5 Molecular docking 87, 5.6 De novo drug design 93	
<b>Chapter 6</b>	<b>Informatics and Methods in Drug Design</b>	<b>96-114</b>
	6.1. Introduction 96, 6.2. Bioinformatics 97, 6.3. Cheminformatics 103, 6.4. Material informatics 107, 6.5. Role of bio and cheminformatics in drug discovery 108, 6.6. Admet database 109	
<b>Chapter 7</b>	<b>Molecular Modeling</b>	<b>115-129</b>
	7.1 Introduction 115, 7.2. 3D structure: three-dimensional structure 116, 7.3 Energy minimization methods 122, 7.4 Energy minimization tolerances 125, 7.5 Conformational analysis 127	
	<b>Bibliography</b>	<b>131</b>
	<b>Index</b>	<b>(i)-(iii)</b>

Computer Aided Drug Design



PRNCOP, Gondur

**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's  
**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



An Imprint of

**S.VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

ADMIN : ND-106, BIKRAMPURA, JALANDHAR CITY-144 006 (PUNJAB), INDIA  
SALES : ND-227, TANDA ROAD, JALANDHAR CITY-144 006 (PUNJAB), INDIA  
PRODUCTION : ND-226, TANDA ROAD, JALANDHAR CITY-144 006 (PUNJAB), INDIA  
PHONE : 0181-5054758, 5092796, 094786-64645  
CUSTOMER CARE : For any queries, please contact - 094786-14146  
EMAIL : pv\_books@yahoo.com  
Online Shop : www.pvbooks.in

©Copyrights Reserved

All rights reserved. No part of this publication may be reproduced or used in any form or by any means-photographic, electronic or mechanical including photocopying, recording, taping or information storage and retrieval systems-without the written permission of the publishers

ISBN 9781543343069

TradeMark No. 1350444

**Edition 2019**

PRICE : ₹ **195/-**

Illustrators : Aakriti Jain  
Printed and bound in India  
**By Rahul Art & Press**

Exclusively marketed and distributed by PV books  
For sale only in India, Nepal, Bangladesh, Sri Lanka and U.A.E.

The publishers make no representation, express or implied with regard to the accuracy of the information contained in this book and cannot accept legal responsibility for any errors or omissions.

Computer Aided Drug Design

PRNCOP, Gondur



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule



Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



**Academic year 2020:**

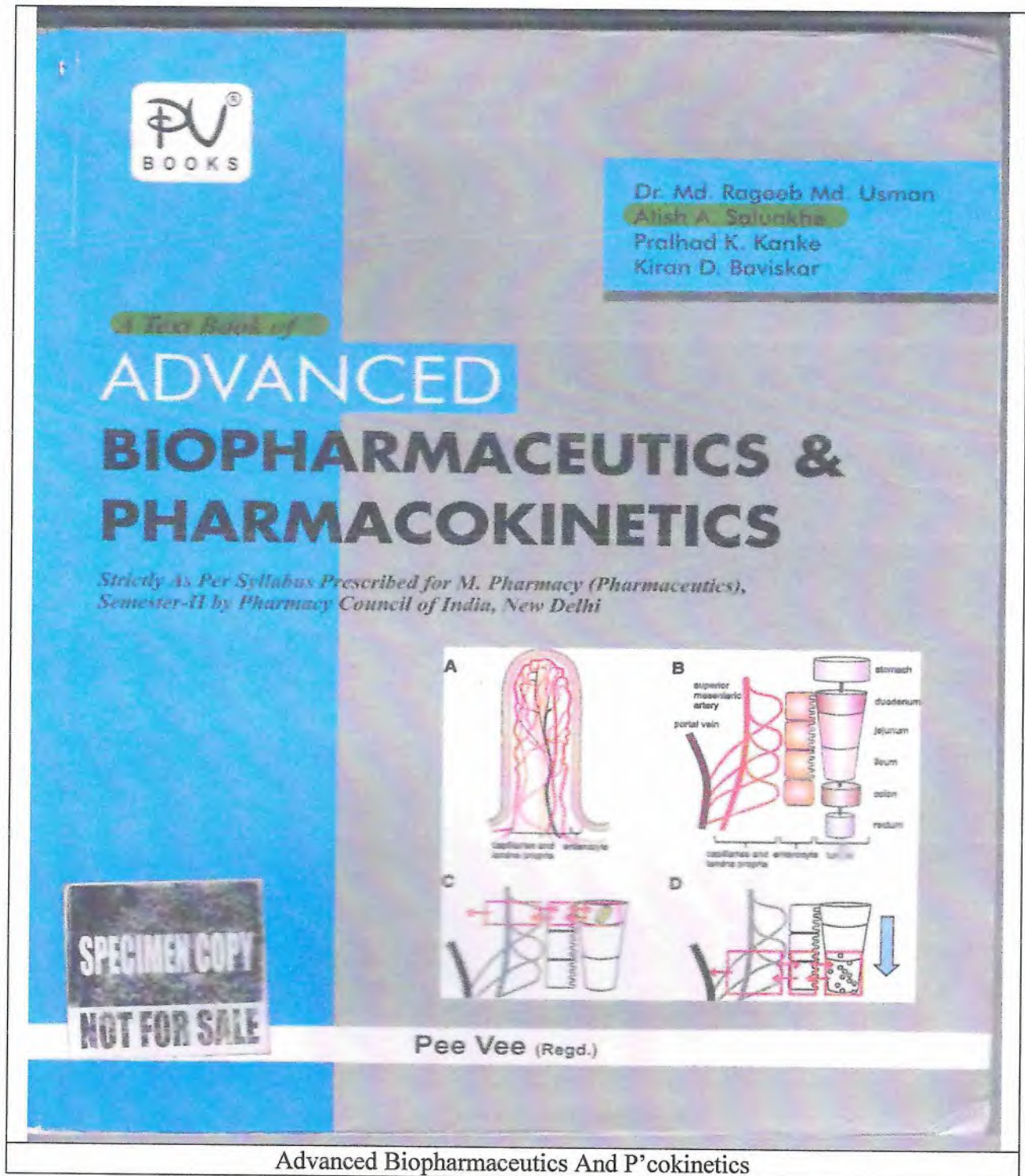
**3.2.2.1 Total number of books and chapters in edited volumes/ books published and papers in national / international conference proceedings year wise during last five years.**

Sr. No.	Title of the book	Name of the author	Department	Name of publisher	Year of publication	Isbn/issn no.
1.	Advanced Biopharmaceutics And Pharmacokinetics	Mr. A. A. Salunkhe	Pharmaceutics	PV publication	2020	9781-43344-54-7
2.	A Text Book Of Phytochemistry	Mrs. N.R. Jadhav	Pharmacognosy	Pee Vee publication.	2020	97815-43344-44-8
3.	A Text Book Of Indian System Of Medicine	Mrs. N.R. Jadhav	Pharmacognosy	Pee VeePublication	2020	97815-43344-54-7
4.	Concise Course In Industrial Pharmacy- II	Dr. R. A. Ahirrao	Pharmaceutics	Pee Vee publication	2020	97815-43344-20-2



*Principal*  
Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule



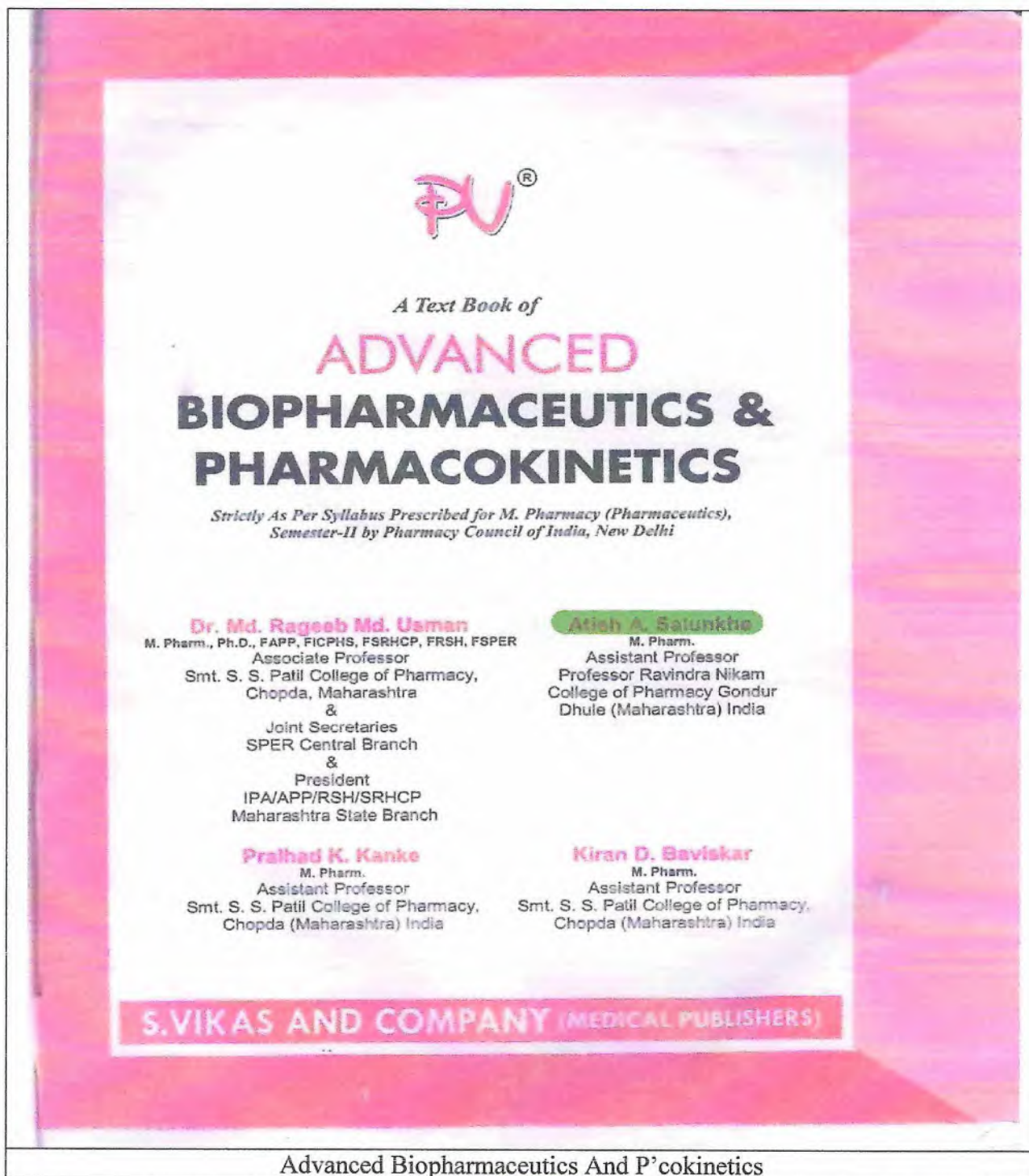






Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



Advanced Biopharmaceutics And P'cokinetics

PRNCOP, Gondur



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



An Imprint of

**S.VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

ADMIN : ND-106, BIKRAMPURA, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
SALES : ND-227, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PRODUCTION : ND-226, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PHONE : 0181-5054798, 5052798, 094786-64648  
CUSTOMER CARE : For any queries, please contact - 094786-18148  
EMAIL : pv\_books@yahoo.com  
Online Shop : www.pvbooks.in

© Copyrights Reserved

All rights reserved. No part of this publication may be reproduced or used in any form or by any means-photographic, electronic or mechanical including photocopying, recording, taping or information storage and retrieval systems-without the written permission of the publishers

ISBN 97815-43344-45-5

TradeMark No. 1350444

**Edition 2020**

PRICE : ₹ 295/-

Illustrators : Aakriti Jain  
Printed and bound in India

**By Rational Art & Press**

Exclusively marketed and distributed by PV books  
For sale only in India, Nepal, Bangladesh, Sri Lanka  
and U.A.E.

The publishers make no representation, express or implied with regard to the accuracy of the information contained in this book and cannot accept legal responsibility for any errors or omissions.

**Advanced Biopharmaceutics And P'cokinetics**

PRNCOP, Gondur



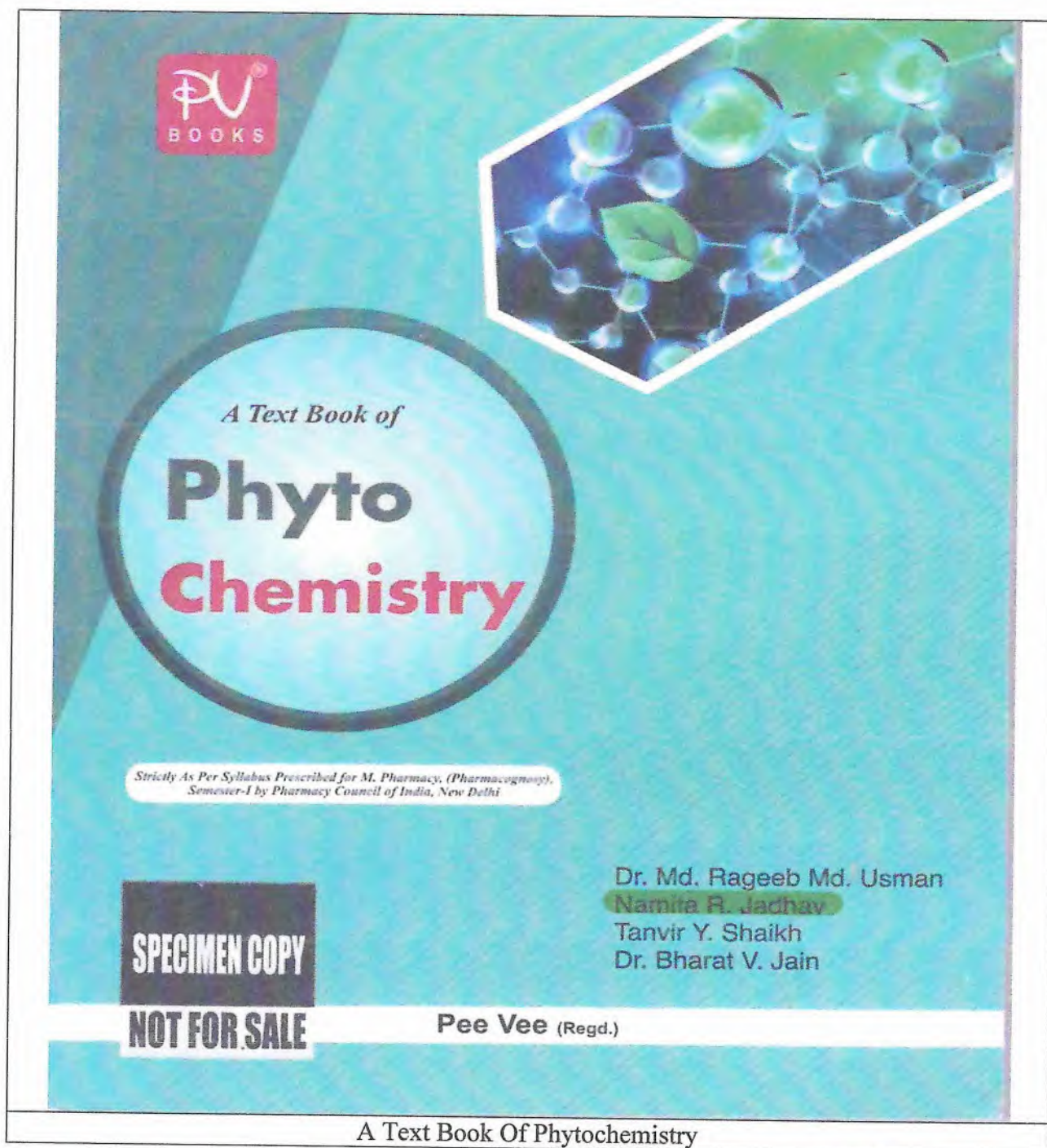
Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



PRNCOP, Gondur



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002

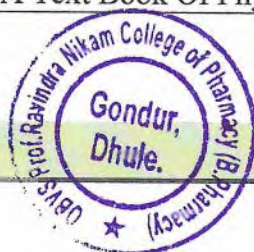


## CONTENTS

<b>Chapter 1</b>	<b>Biosynthetic Pathways and Radio Tracing Techniques</b>	<b>1-74</b>
	1.1 Introduction <b>1</b> , 1.2 Radio tracer <b>2</b> , 1.3 Alkaloids <b>7</b> , 1.4 Glycosides <b>54</b> , 1.5 Steroids <b>66</b> , 1.6 Coumarins <b>70</b> , 1.7 Terpenoids <b>73</b>	
<b>Chapter 2</b>	<b>Drug Discovery and Development</b>	<b>75-83</b>
	2.1 Drug discovery and development <b>75</b> , 2.2 The lead structure selection process <b>76</b> , 2.3 Structure development <b>77</b> , 2.4 Product discovery and drug registration <b>78</b> , 2.5 Selection and optimization of the lead compound <b>79</b> , 2.6 Phases of clinical trials <b>81</b>	
<b>Chapter 3</b>	<b>Extraction and Phytochemical Studies</b>	<b>84-92</b>
	3.1 Recent advances in extraction <b>84</b> , 3.2 Choice of solvent for extraction <b>87</b> , 3.3 Method of fractionation <b>88</b>	
<b>Chapter 4</b>	<b>Phytochemical Finger Printing</b>	<b>93-125</b>
	4.1 Introduction <b>93</b> , 4.2 Standardization <b>95</b> , 4.3 Chromatographic fingerprinting and marker compound analysis <b>101</b> , 4.4 Advanced techniques for herbal standardization <b>104</b> , 4.5 Quality evaluation of the crude drugs <b>113</b> , 4.6 Protocol used for drug analysis <b>116</b> , 4.7 Validation of analytical method <b>118</b> , 4.8 HPTLC studies of various Indian herbal formulations <b>121</b>	
	<b>Bibliography</b>	<b>126-127</b>
	<b>index</b>	<b>(i)</b>

A Text Book Of Phytochemistry

PRNCOP, Gondur



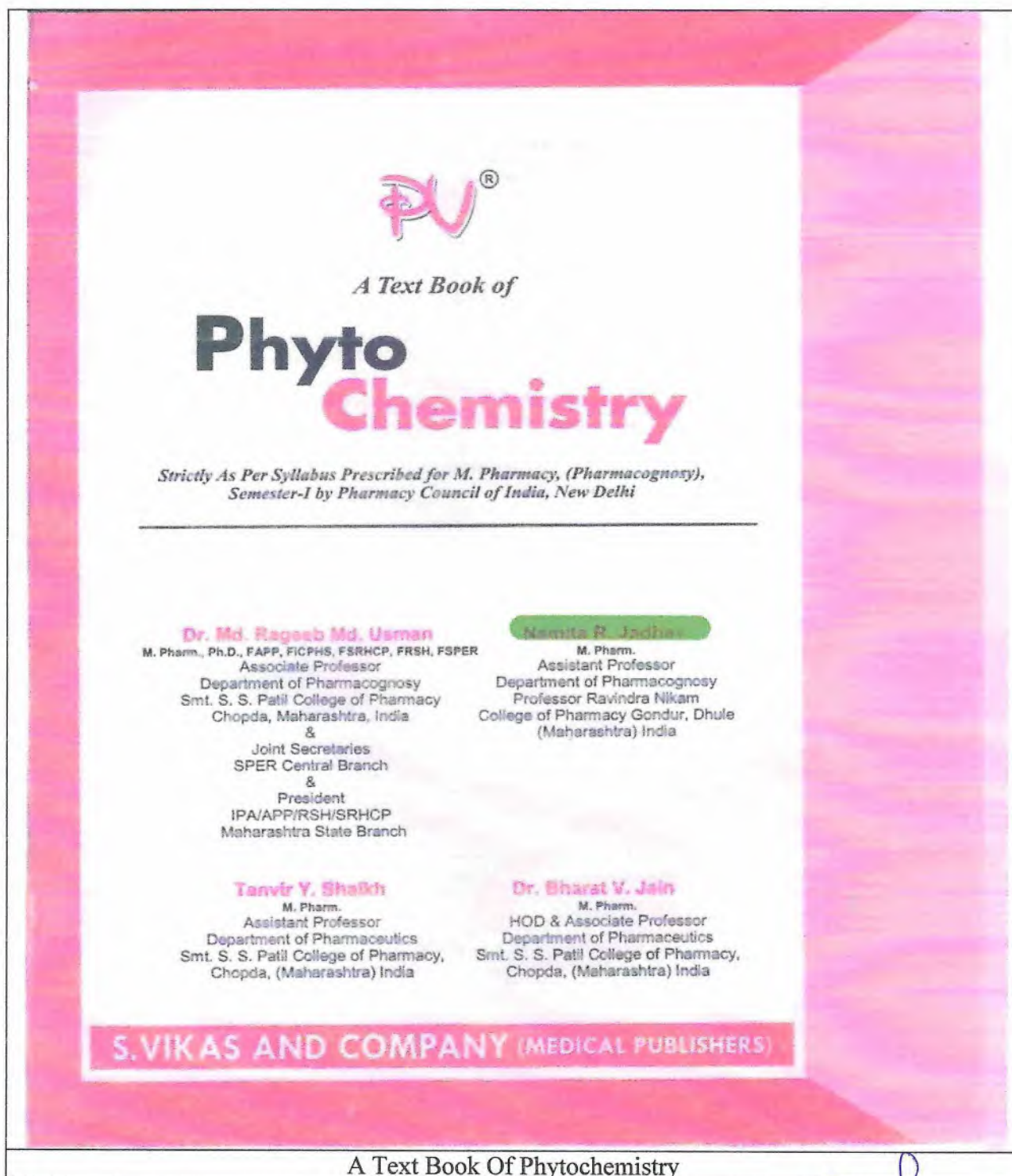
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



A Text Book Of Phytochemistry

PRNCOP, Gondur



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's  
**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



An Imprint of

**S.VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

ADMIN : ND-106, BIKRAMPURA, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
SALES : ND-227, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PRODUCTION : ND-226, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PHONE : 0181-5064798, 5092798, 094786-64645  
CUSTOMER CARE : For any queries, please contact - 094788-14148  
EMAIL : pv\_books@yahoo.com  
Online Shop : www.pvbooks.in

© Copyrights Reserved

All rights reserved. No part of this publication may be reproduced or used in any form or by any means-photographic, electronic or mechanical including photocopying, recording, taping or information storage and retrieval systems-without the written permission of the publishers

ISBN 97815-43344-54-7

TradeMark No. 1350444

**Edition 2021**

PRICE : ₹ 225/-

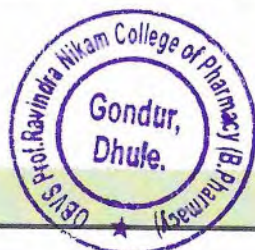
Illustrators : Aakriti Jain  
Printed and bound in India

**By Rahul Art & Press**

Exclusively marketed and distributed by PV books  
For sale only in India, Nepal, Bangladesh, Sri Lanka  
and U.A.E.

The publishers make no representation, express or implied with regard to the accuracy of the information contained in this book and cannot accept legal responsibility for any errors or omissions.

A Text Book Of Phytochemistry



*Principal*  
Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

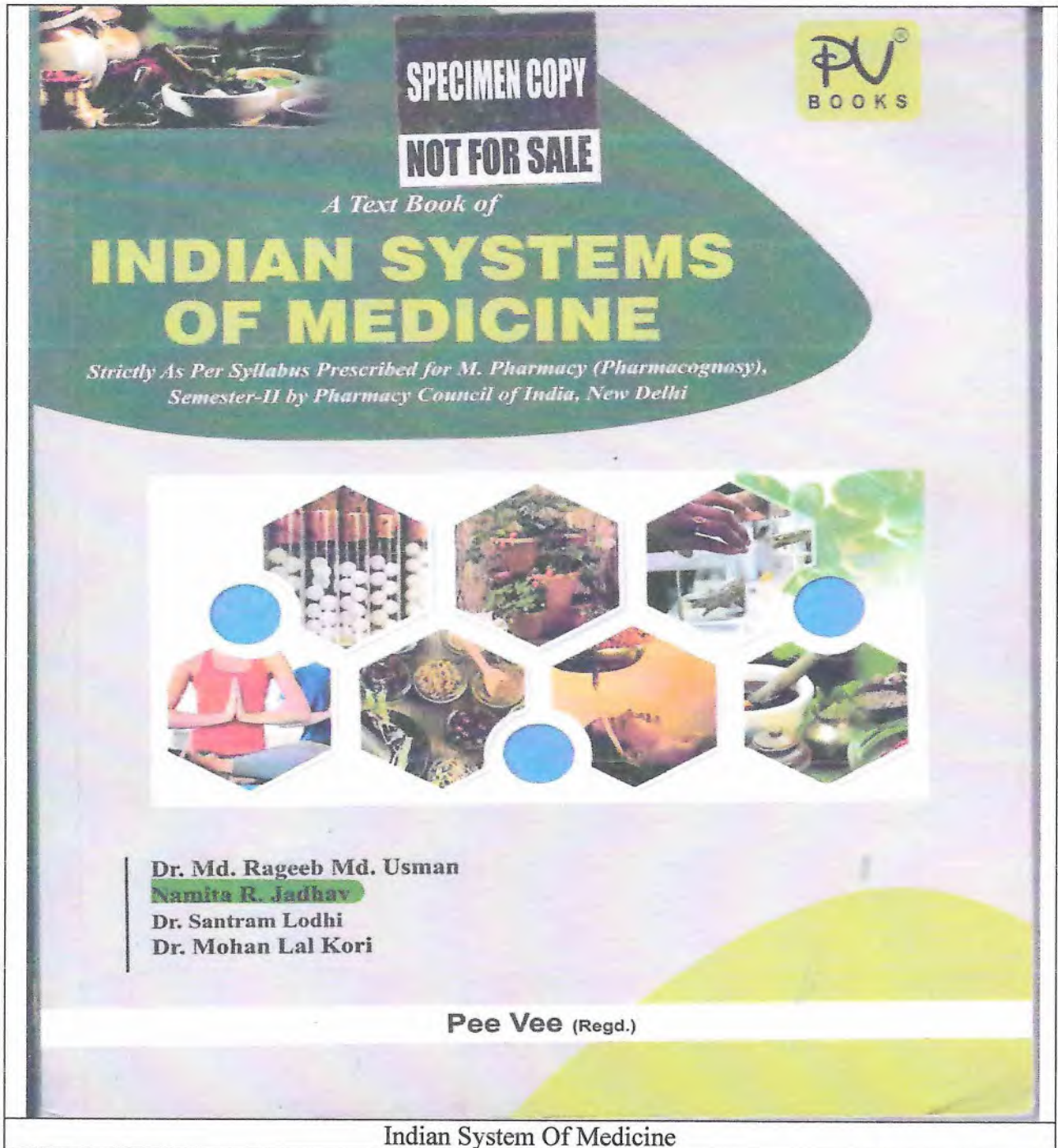
PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



Indian System Of Medicine



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



An Imprint of

**S.VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

ADMIN : ND-106, BIKRAMPURA, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
SALES : ND-227, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PRODUCTION : ND-226, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PHONE : 0181-5054798, 5092798, 094786-64645  
CUSTOMER CARE : For any queries, please contact - 094786-14148  
EMAIL : pv\_books@yahoo.com  
Online Shop : www.pvbooks.in

© Copyrights Reserved

All rights reserved. No part of this publication may be reproduced or used in any form or by any means-photographic, electronic or mechanical including photocopying, recording, taping or information storage and retrieval systems-without the written permission of the publishers

ISBN 97815-43344-44-8

TradeMark No. 1350444

**Edition 2020**

PRICE : ₹ ~~299/-~~

Illustrators : Aakriti Jain  
Printed and bound in India

**By Rahul Art & Press**

Exclusively marketed and distributed by PV books  
For sale only in India, Nepal, Bangladesh, Sri Lanka and U.A.E.

The publishers make no representation, express or implied with regard to the accuracy of the information contained in this book and cannot accept legal responsibility for any errors or omissions.

Indian System Of Medicine



  
**Principal**

Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



*A Text Book of*

# INDIAN SYSTEMS OF MEDICINE

*Strictly As Per Syllabus Prescribed for M. Pharmacy (Pharmacognosy),  
Semester-II by Pharmacy Council of India, New Delhi*

**Dr. Md. Rageeb Md. Usman**

M. Pharm., Ph.D., FAPP, FICPHS, FSRHCP, FRSH, FSPER  
Associate Professor  
Department of Pharmacognosy  
Smt. S. S. Patil College of Pharmacy,  
Chopda, Maharashtra &  
Joint Secretaries  
SPER Central Branch &  
President  
IPA/APP/RSH/SRHCP  
Maharashtra State Branch

**Namita R. Jadhav**

M. Pharm.  
Assistant Professor  
Department of Pharmacognosy  
Professor Ravindra Nikam  
College of Pharmacy, Gondur  
Dhule (Maharashtra) India

**Dr. Santram Lodhi**

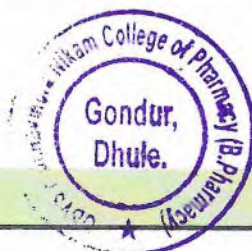
M. Pharm., Ph.D.  
Professor  
Sri SathyaSai Institute of Pharmaceutical Sciences  
Bhopal, (M.P.) India

**Dr. Mohan Lal Kori**

Dean and Professor  
Faculty of Pharmacy  
RKDF University  
Bhopal (M.P.) India

**S.VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

Indian System Of Medicine



**Principal**

Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



## CONTENTS

<b>Chapter 1</b>	<b>Fundamental Concept of Ayurveda, Siddha, Unani and Homeopathy System of Medicine</b>	<b>1-65</b>
	1.1 Introduction 1, 1.2 Fundamental Concept of Ayurveda, Siddha, Unani and Homeopathy System of Medicine 4, The Pancha mahabhutas 5, 1.2.2 Unani 13, 1.2.3 Siddha 18, 1.2.4 Homeopathy 19, 1.3 Different dosage forms of the ISM 22, 1.3.1 Ayurvedic dosage forms, classification and definitions 22, 1.4 Ayurveda 24, 1.4.1 Ayurvedic pharmacopoeia 24, 1.4.2 Analysis of formulations and bio drugs with references to identify and quality 28, 1.4.3 Analytical evaluation 30, 1.4.4 Bio drugs: identify, purity and quality 42, 1.5 Siddha drugs 59	
<b>Chapter 2</b>	<b>Naturopathy, Yoga and Aromatherapy Practices</b>	<b>66-116</b>
	2.1 Introduction 66, 2.2 Principles of naturopathy 70, 2.3 Response of naturopathy treatment modalities 72, 2.4 Streams of yoga, asana, pranayama, meditations and techniques 74, 2.4.1 Four streams of yoga 76, 2.4.2 Asana 84, 2.4.3 Pranayama 90, 2.4.4 Relaxation and meditation technique 99, 2.4.5 Relaxation technique 102, 2.5 Aromatherapy 104, 2.5.1 Carrier oils 109	
<b>Chapter 3</b>	<b>Formulation Development of Various Systems of Medicine</b>	<b>117-146</b>
	3.1 Introduction 117, 3.1 Standardization of raw drugs 118, 3.2 Stability testing of herbal products 130, 3.2.1 Analytical methods for herbal products 130, 3.2.2 Shelf-life 136, 3.2.3 Challenges in stability testing of herbal medicinal product 137, 3.2.4 Mechanisms involved in change product 137, 3.2.5 Stress testing 137, 3.2.6 Predictable changes in herbal medicinal product 138, 3.3 Shelf life of ayurvedic formulations 139, 3.4 Stability studies of ism formulations 143	
<b>Chapter 4</b>	<b>Schedule T: GMP of ISM</b>	<b>147-166</b>
	4.1 Introduction 147, 4.1.1 Drugs objectives to ensure 148, 4.1.2 Components of G.M.P 149, 4.1.3 General requirements to establish G.M.P in ayurvedic pharma industries 149, 4.1.4 Working space 151, 4.1.5 Health, clothing, sanitation and hygiene of workers 151, 4.1.6 Machinery and equipments 152, 4.1.7 Distribution records 153, 4.1.8	

Indian System Of Medicine



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



Quality control **153**, 4.2 Quality control/assurance for ASU drug industry **154**, 4.2.1 Production process & quality control: relevance for pharmaceutical industry **155**, 4.2.2 Customers general quality perspectives **156**, 4.2.3 Why QC/QA needed **156**, 4.2.4 Instruments used in QC/QA process **160**, 4.2.5 Documentation required for QC/QA **160**, 4.3 Challenges in monitoring the safety herbal medicines **161**, 4.3.1 Objectives **161**, 4.3.2 Challenges in monitoring the safety of herbal medicines **164**, 4.3.3 Quality assurance and control **165**, 4.3.4 National/regional pharmacopoeias **165**

**Chapter 5 TKDL Geographical Indication & Government Bills in Ayush, ISM, CCRAS, CCRS, CCRH, CCRU** **167-186**

5.1 Traditional knowledge digital library (TKDL) **167**, 5.2 Geographical indication bill **169**, 5.2.1 Geographical indication registry **170**, 5.2.2 Prohibition of geographical indication registration **170**, 5.2.3 Right of application **170**, 5.2.4 Registration of homonymous geographical indications **170**, 5.2.5 Registration of foreign geographical indications **171**, 5.2.6 Use of geographical indication **171**, 5.2.7 Revocation of registered geographical indication **172**, 5.2.8 Update of register **172**, 5.2.9 Scope of protection **172**, 5.2.10 Interaction between trademark and geographical indication **172**, 5.2.11 Offences, penalties and procedures **172**, 5.3 A bill for an act to provide for the protection of geographical indications and related matters **173**, 5.4. Government bills in AYUSH, ISM, CCRAS, CCRS, CCRH, and CCRU **181**

**Bibliography** **187-197**

**Index** **(i)-(ii)**

Indian System Of Medicine



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



Concise Course In Industrial Pharmacy- II



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



*Concise Course in*

## **INDUSTRIAL PHARMACY-II**

*Strictly As Per Syllabus Prescribed for B.Pharmacy  
Semester-VII by Pharmacy Council of India, New Delhi*

**V. H. Jain**

M. Pharm.

Asst. Professor

P.S.G.V.P. Mandal's College of Pharmacy,  
Shahada, Dist- Nandurbar, Maharashtra

**Dr. R. A. Ahirrao**

M. Pharm. Ph.D.

Principal

Onkar Bahu Uddeshiya Vikas Sanstha's,  
Prof. Ravindra Nikam College of Pharmacy,  
Gondur, Dist- Dhule, Maharashtra

**A. R. Dhankani**

M. Pharm.

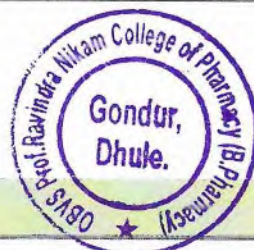
Asst. Professor

P.S.G.V.P. Mandal's College of Pharmacy,  
Shahada, Dist- Nandurbar, Maharashtra



**S. VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

Concise Course In Industrial Pharmacy- II



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's  
**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



An imprint of

**S.VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

ADMIN : ND-106, BIKRAMPURA, JALANDHAR CITY-144 002 (PUNJAB), INDIA  
SALES : ND-227, TANDA ROAD, JALANDHAR CITY-144 002 (PUNJAB), INDIA  
PRODUCTION : ND-226, TANDA ROAD, JALANDHAR CITY-144 002 (PUNJAB), INDIA  
PHONES : 094786-64645, 0181-5014275, 0181-5011125  
CUSTOMER CARE : For any queries, please contact - 094786-64645  
EMAIL : [pv\\_books@yahoo.com](mailto:pv_books@yahoo.com)  
Online Shop : [www.pvbooks.in](http://www.pvbooks.in)  
Also Buy at [www.amazon.in](http://www.amazon.in)

© Copyrights Reserved

All rights reserved. No part of this publication may be reproduced or used in any form or by any means-photographic, electronic or mechanical including photocopying, recording, taping or information storage and retrieval systems-without the written permission of the publishers

ISBN 97815-43344-20-2

TradeMark No. 1350444

**EDITION 2020**

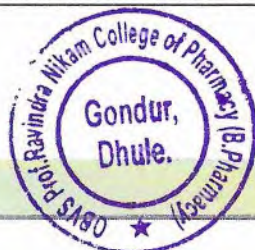
PRICE : ₹ 255/-

Illustrators : Aakriti Jain  
Printed and bound in India  
**By Rahul Art & Press**

Exclusively marketed and distributed by PV books  
For sale only in India, Nepal, Bangladesh, Sri Lanka  
and U.A.E.

The publishers make no representation, express or implied with regard to the accuracy of the information contained in this book and cannot accept legal responsibility for any errors or omissions.

Concise Course In Industrial Pharmacy- II



*Principal*  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur



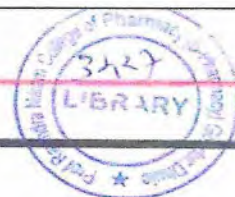


Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



## Contents



<b>Unit-I Pilot Plant Scale Up Techniques</b>	<b>1-31</b>
1.1. Introduction to pilot plant scale-up techniques	1
1.2. General considerations for scale up techniques	6
1.3. Pilot plant scale-up consideration for solids (tablets)	11
1.4. Pilot plant scale-up consideration for oral liquids	17
1.5. Pilot plant scale-up consideration for semi solids	19
1.6. Supac guidelines	24
1.7. Introduction to platform technology	26
<b>Unit-II Technology Development and Transfer</b>	<b>32-64</b>
2.1. Introduction to technology transfer (TT)	32
2.2. Who guidelines for technology transfer	35
2.3. Terminologies related to process of technology transfer	37
2.4. Technology transfer protocol	40
2.5. Quality risk management (QRM)	41
2.6. Transfer from R & D to production	46
2.7. Granularity of TT process	48
2.8. Documentation	51
2.9. Premises & equipments	54
2.10. Quality control: analytical method transfer	55
2.11. TT (technology transfer) agencies in India	57
2.12. TT related documents	60
<b>Unit-III Regulatory Affairs</b>	<b>65-106</b>
3.1. Introduction	65
3.2. Historical overview of regulatory affairs	68
3.3. Regulatory authorities working in different countries of world	69
3.4. Role of regulatory affairs department	70
3.5. Responsibilities of regulatory affairs professionals	71
3.6. drug development teams	73
3.7. Non-clinical drug development process	74
3.8. Pharmacology study in non-clinical drug development	77
3.9. Pharmacokinetics (drug metabolism) study in non-clinical drug development process	77
3.10. Toxicology study in non-clinical drug development	78
3.11. General considerations of IND (investigational new drug) application	79
3.12. General considerations of IB (investigator's brochure)	86
3.13. General considerations of NDA (new drug application)	87
3.14. Clinical research	90
3.15. Bioequivalence studies (be studies)	93
3.16. Clinical research protocols	95
3.17. Biostatistics in pharmaceutical product development	97
3.18. Data presentation for FDA submission	99
3.19. Management of clinical studies	103

### Concise Course In Industrial Pharmacy- II



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



**Unit-IV Quality Management System 107-140**

- 4.1. Introduction to quality management system (QMS) and certification system 107, 4.2. Concept of quality 109, 4.3. Concept of TQM (total quality management) 113, 4.4. Concept of QBD (quality by design) 116, 4.5. Concept of six sigma 120, 4.6. Concept of out of specification (OOS) 124, 4.7. Concept of change control 128, 4.8. Introduction to ISO 9000 & ISO 14000 131, 4.9. Nabl accreditation 133, 4.10. Good laboratory practices (GLP) 136

**Unit-V Indian Regulatory Requirements 141-162**

- 5.1. Introduction to Indian regulatory system 141, 5.2. Drug regulatory authority of India 143, 5.3. Central drug standard control organization (CDSCO) 145, 5.4. State licensing authority 148, 5.5 drug controller general of India (DCGI) 150, 5.6. Certificate of pharmaceutical product (COPP / CPP) 151, 5.7. Regulatory requirements and approval procedure for new drugs in India 153, 5.8. National pharmaceutical pricing authority (NPPA) 157, 5.9. Deficiencies & limitations of drug regulatory system 159

**Index (i)-(ii)**

Concise Course In Industrial Pharmacy- II



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



**Academic year 2019:**

**3.2.2.1 total number of books and chapters in edited volumes/ books published and papers in national / international conference proceedings year wise during last five years.**

Sr. No.	Title of the book	Name of author	Department	Name of publisher	Year of publication	Isbn/issn no.
1.	Textbook Of Pharmaceutical Engineering	Mr. A. A. Salunkhe	Pharmaceuti cs	Nirali Prakashan	2019	978938819 4136
2.	Physical Pharmaceutic s – I	Mr. A. A. Salunkhe	Pharmaceuti cs	Nirali Prakashan	2019	978938768 6878
3.	Industrial Pharmacy-I	Mr. A. A. Salunkhe	Pharmaceuti cs	PV publication	2019	97815- 43343-08-3
4.	Pharmaceutic al Inorganic Chemistry-I”	Mr. C. P. Suryawans hi	Pharmaceuti cal chemistry	PV Publication s	2019	



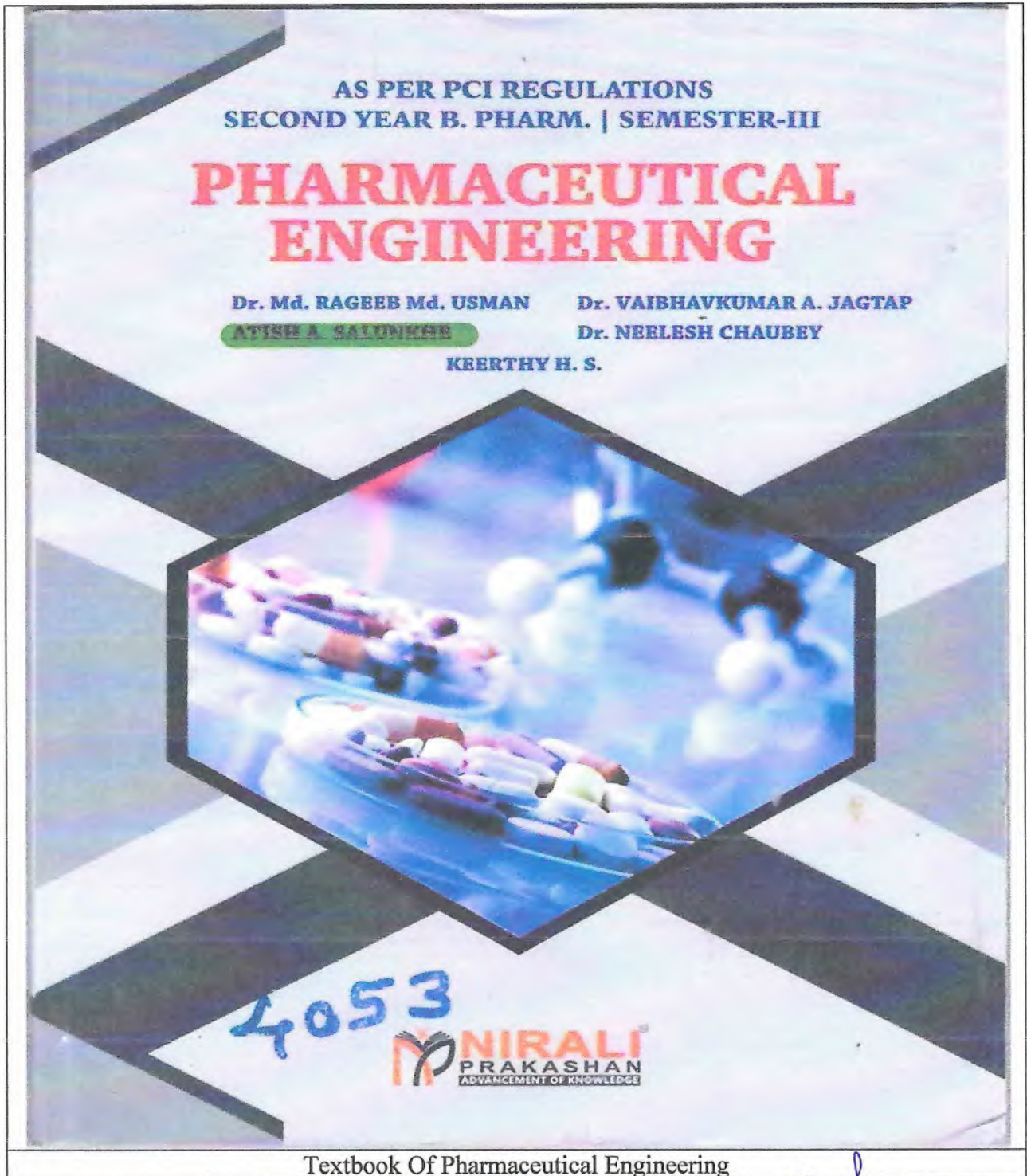
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



Textbook Of Pharmaceutical Engineering

PRNCOP, Gondur



*[Signature]*  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



# A Text Book of **PHARMACEUTICAL ENGINEERING**

As Per PCI Regulations  
**SECOND YEAR B. PHARM.**  
Semester III

**Dr. Md. Rageeb Md. Usman**

M. Pharm., Ph.D., FAPP, FICPHS, FSRHCP, FRSH, FSPER  
Associate Professor,  
Smt. S. S. Patil College of Pharmacy,  
Chopda, Maharashtra and Joint Secretaries  
SPER Central Branch and President  
IPA/APP/RSR/SRHCP  
Maharashtra State Branch

**Dr. Vaibhavkumar A. Jagtap**

M. Pharm., Ph.D.  
Associate Professor  
DCS's A.R.A. College of Pharmacy,  
Nagaon,  
Dhule.

**Mr. Atish A. Salunkhe**

M. Pharm.  
Assistant Professor,  
Professor Ravindra Nikam  
College of Pharmacy (B. Pharmacy)  
Gondur, Dhule.

**Dr. Neelesh Chaubey**

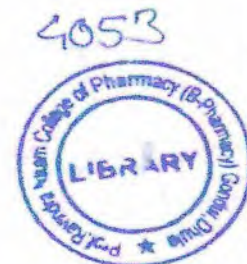
M. Pharm., Ph.D.  
Professor,  
School of Pharmacy,  
Sri Satya Sai University of Technology  
and Medical Science, Sehore, M.P.  
India.

**Keerthy H.S.**

M. Pharm.  
Professor, Department of Pharmaceutics  
Mailige College of Pharmacy,  
Bangalore

Price ₹ 200.00

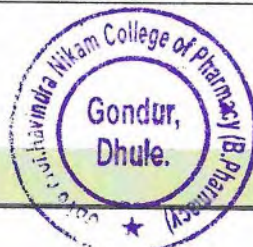
 **NIRALI**  
PRAKASHAN  
ADVANCEMENT OF KNOWLEDGE




N4349

Textbook Of Pharmaceutical Engineering

PRNCOP, Gondur



  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



## Contents

Unit I	
<b>1. Flow of Fluids</b>	<b>1.1 - 1.20</b>
1.1 Introduction	1.1
1.2 Manometers	1.2
1.2.1 Classification of Manometer	1.3
1.3 Bernoulli's Theorem	1.7
1.4 Reynolds Number	1.9
1.5 Energy Losses during Fluid Flow	1.10
1.5.1 Major Energy Losses	1.10
1.5.2 Minor Energy Losses	1.10
1.6 Measurement of Rate of Flow of Fluids	1.12
1.6.1 Pitot Tube	1.12
1.6.2 Venturi Meter	1.14
1.6.3 Orifice Meter	1.16
1.6.4 Rotameter	1.18
• Multiple Choice Questions	1.19
• Short Type Questions	1.20
• Long Type Questions	1.20
<b>2. Size Reduction</b>	<b>2.1 - 2.12</b>
2.1 Introduction	2.1
2.2 Objectives of Size Reduction	2.1
2.3 Mechanism of Size Reduction	2.1
2.4 Laws Governing Size Reduction	2.2
2.5 Factor Affecting Size Reduction	2.3
2.6 Equipments used in Size Reduction	2.4
2.6.1 Hammer Mill	2.4
2.6.2 Ball Mill	2.6
2.6.3 Fluid Energy Mill	2.8
2.6.4 Edge Runner Mill	2.9
2.6.5 End Runner Mill	2.10
• Multiple Choice Questions	2.11
• Short Type Questions	2.12
• Long Type Questions	2.12
<b>3. Size Separation</b>	<b>3.1 - 3.12</b>
3.1 Introduction	3.1
3.2 Official Standards for Powder Size	3.1
3.3 Objectives of Size Reduction	3.2
3.4 Applications of Size Reduction	3.2

Textbook Of Pharmaceutical Engineering



Principal

Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



5.4	Factors Influencing the Rate of Evaporation	5.2
5.5	Differences between Evaporation and other Heat Processes	5.3
5.5.1	Difference between Evaporation and Distillation	5.3
5.5.2	Difference between Evaporation and Sublimation	5.3
5.5.3	Difference between Evaporation and Boiling	5.4
5.5.4	Difference between Evaporation and Drying	5.4
5.5.5	Difference between Evaporation and Crystallization	5.4
5.6	Equipments used for Evaporation	5.4
5.6.1	Steam Jacketed Kettle (Evaporating Pan)	5.5
5.6.2	Horizontal Tube Evaporator	5.7
5.6.3	Climbing Film Evaporator	5.8
5.6.4	Forced Circulation Evaporator	5.10
5.6.5	Multiple Effect Evaporator	5.11
•	Multiple Choice Questions	5.15
•	Short Type Questions	5.16
•	Long Type Questions	5.16
<b>6.</b>	<b>Distillation</b>	<b>6.1 - 6.14</b>
6.1	Introduction	6.1
6.2	Applications	6.2
6.3	Different Methods of Distillation	6.2
6.3.1	Simple Distillation	6.2
6.3.2	Flash Distillation	6.4
6.3.3	Fractional Distillation	6.6
6.3.4	Distillation under Reduced Pressure	6.7
6.3.5	Steam Distillation	6.9
6.3.6	Molecular Distillation	6.11
•	Multiple Choice Questions	6.13
•	Short Type Questions	6.14
•	Long Type Questions	6.14
	<b>Unit III</b>	
<b>7.</b>	<b>Drying</b>	<b>7.1 - 7.22</b>
7.1	Introduction	7.1
7.2	Objectives of Drying	7.1
7.3	Applications of Drying	7.2
7.4	Mechanisms of Drying	7.2
7.4.1	Diffusion Theory	7.2
7.4.2	Capillarity Theory	7.3
7.4.3	Pressure Gradient Theory	7.3
7.5	Methods of Drying	7.3
7.6	Equilibrium Moisture Content	7.4

Textbook Of Pharmaceutical Engineering



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

## Prof. Ravindra Nikam College of Pharmacy

Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



7.7 Drying Equipments	7.6
7.7.1 Tray Dryer	7.6
7.7.2 Drum Dryer	7.8
7.7.3 Spray Dryer	7.10
7.7.5 Fluidized Bed Dryer	7.13
7.7.6 Vacuum Dryer	7.15
7.7.7 Freeze Drying	7.17
• Multiple Choice Questions	7.21
• Short Type Questions	7.22
• Long Type Questions	7.22

### 8. Mixing

8.1 - 8.18

8.1 Introduction	8.1
8.2 Objectives of Mixing	8.1
8.3 Applications	8.1
8.4 Factors Affecting Mixing	8.2
8.5 Difference in Between Solid and Liquid Mixing	8.2
8.6 Mechanism of Mixing	8.3
8.6.1 Solid Mixing	8.3
8.6.2 Liquid Mixing	8.4
8.7 Equipments used in Mixing	8.5
8.7.1 Double Cone Blender	8.5
8.7.2 Twin Shell Blender	8.6
8.7.3 Ribbon Blender	8.7
8.7.4 Propeller	8.9
8.7.5 Sigma Blade Mixer	8.10
8.7.6 Planetary Mixer	8.11
8.7.7 Turbines	8.13
8.7.8 Paddles	8.14
8.7.9 Silverson Emulsifier	8.15
• Multiple Choice Questions	8.16
• Short Type Questions	8.17
• Long Type Questions	8.17

### Unit IV

### 9. Filtration

9.1 - 9.24

9.1 Introduction	9.1
9.2 Objectives	9.1
9.3 Applications	9.2
9.4 Mechanisms of Filtration	9.2

Textbook Of Pharmaceutical Engineering

PRNCOP, Gondur



Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



10.7	Classification of Industrial Centrifuges	10.8
10.7.1	Perforated Basket Centrifuge	10.8
10.7.2	Semi-continuous Centrifuge	10.11
10.7.3	Non-perforated Basket Centrifuge	10.12
10.7.4	Super Centrifuge	10.13
•	Multiple Choice Questions	10.13
•	Short Type Questions	10.14
•	Long Type Questions	10.14

**Unit V**

**11. Materials of Pharmaceutical Plant Construction, Corrosion and its Prevention**

**11.1 - 11.22**

11.1	Materials of Plant Construction	11.1
11.1.1	Factors Influencing the Selection of Materials of Construction	11.1
11.1.2	Materials used for Plant Construction	11.3
11.2	Corrosion	11.9
11.2.1	Theories of Corrosion	11.9
11.2.2	Types of Corrosion	11.10
11.2.3	Factors influencing Corrosion	11.13
11.2.4	Corrosion Control Methods	11.13
11.3	Material Handling Systems	11.16
11.3.1	Handling of Solids	11.16
11.3.2	Handling of Liquids in Pharmaceutical Industry	11.18
•	Multiple Choice Questions	11.21
•	Short Type Questions	11.22
•	Long Type Questions	11.22

\*\*\*

Textbook Of Pharmaceutical Engineering

PRNCOP, Gondur



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



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

# PHYSICAL PHARMACEUTICS-I

Dr. VAIBHAVKUMAR A. JAGTAP

Prof. Md. RAGEEB Md. USMAN

ATISH A. SALUNKHE

BASAWARAJ BENDEGUMBLE



**NIRALI**  
PRAKASHAN  
ADVANCEMENT OF KNOWLEDGE

Physical Pharmaceutics-I



*Principal*  
Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



# A Text Book of **PHYSICAL PHARMACEUTICS - I**

As Per PCI Regulations  
**SECOND YEAR B. PHARM.**  
Semester III

**Dr. Vaibhavkumar A. Jagtap**

M. Pharm., Ph.D.  
Associate Professor,  
DCS's A.R.A. College of Pharmacy,  
Nagaon,  
Dhule.

**Prof. Md. Rageeb Md. Usman**

M. Pharm., FAPP, FICPHS, FSRHCP, FRSH, FSPER  
Assistant Professor  
Smt. S. S. Patil College of Pharmacy,  
Chopda, Maharashtra.  
Joint Secretaries, SPER Central Branch  
and President, IPA/APP/RSH/SRHCP  
Maharashtra State Branch

**Mr. Atish A. Salunkhe**

M. Pharm.  
Assistant Professor  
Gangamai College of Pharmacy,  
Nagaon, Dhule.

**Basawaraj Bendegumble**

M. Pharm.  
Assistant Professor  
H.K.E.S.'s Matoshree Taradevi Rampure  
Institute of Pharmaceutical Sciences  
Kalaburagi / Gulbarga - Karnataka.

Price ₹ 85.00


 **NIRALI  
PRAKASHAN**  
ADVANCEMENT OF KNOWLEDGE



N4347

Physical Pharmaceutics-I



  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



**Physical Pharmaceutics - I (Theory)** ISBN 978-93-87696-87-8

First Edition : June 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 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.

**Published By :** **NIRALI PRAKASHAN** **Polyplate** **Printed By :** **YOGIRAJ PRINTERS AND BINDERS**  
Abhyudaya Pragati, 1312, Shivaji Nagar. Works: Sr. No. 10\1, Ghule Industrial Estate,  
Off J.M. Road, PUNE - 411005. Nanded Village Road,  
Tel - (020) 25512336/37/39, Fax - (020) 25511379 TAL-HAVELI, DIT-PUNE 411041.  
Email : niralipune@pragationline.com Mobile - 9850046517, 9404225254

**> 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, Dhyan, Near Pari Company, Pune 411041  
Tel : (020) 24690204 Fax : (020) 24690316  
Email : dhyan@pragationline.com, bookorder@pragationline.com

**Nirali Prakashan :** **MUMBAI**  
385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,  
Girgaum, Mumbai 400004, Maharashtra  
Tel : (022) 2385 6339 / 2385 9976, Fax : (022) 2385 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, 1<sup>st</sup> Floor Opp. IDBI Bank  
Kolhapur 416 012, Maharashtra. Mob : 9850046155  
Email : niralikolhapur@pragationline.com

**NAGPUR**  
**Pratibha Book Distributors :** Above Marathe 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 :** Maltri Ground Floor, Jaya Apartments, No. 99, 6<sup>th</sup> Cross, 6<sup>th</sup> Main,  
Mallezwaram, 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 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

Physical Pharmaceutics-I



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002

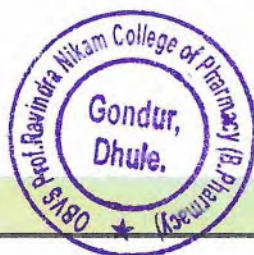


## Contents

Unit 1: Solubility of Drugs	1.1 – 1.24
Unit 2: States of Matter and Drug Molecules	2.1 – 2.24
Unit 3: Surface and Interfacial Phenomenon	3.1 – 3.18
Unit 4: Complexation and Protein Binding	4.1 – 4.12
Unit 5: pH, Buffers and Isotonic Solutions	5.1 – 5.14
• Bibliography	B.1 – B.1

\*\*\*

Physical Pharmaceutics-I



*Principal*  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

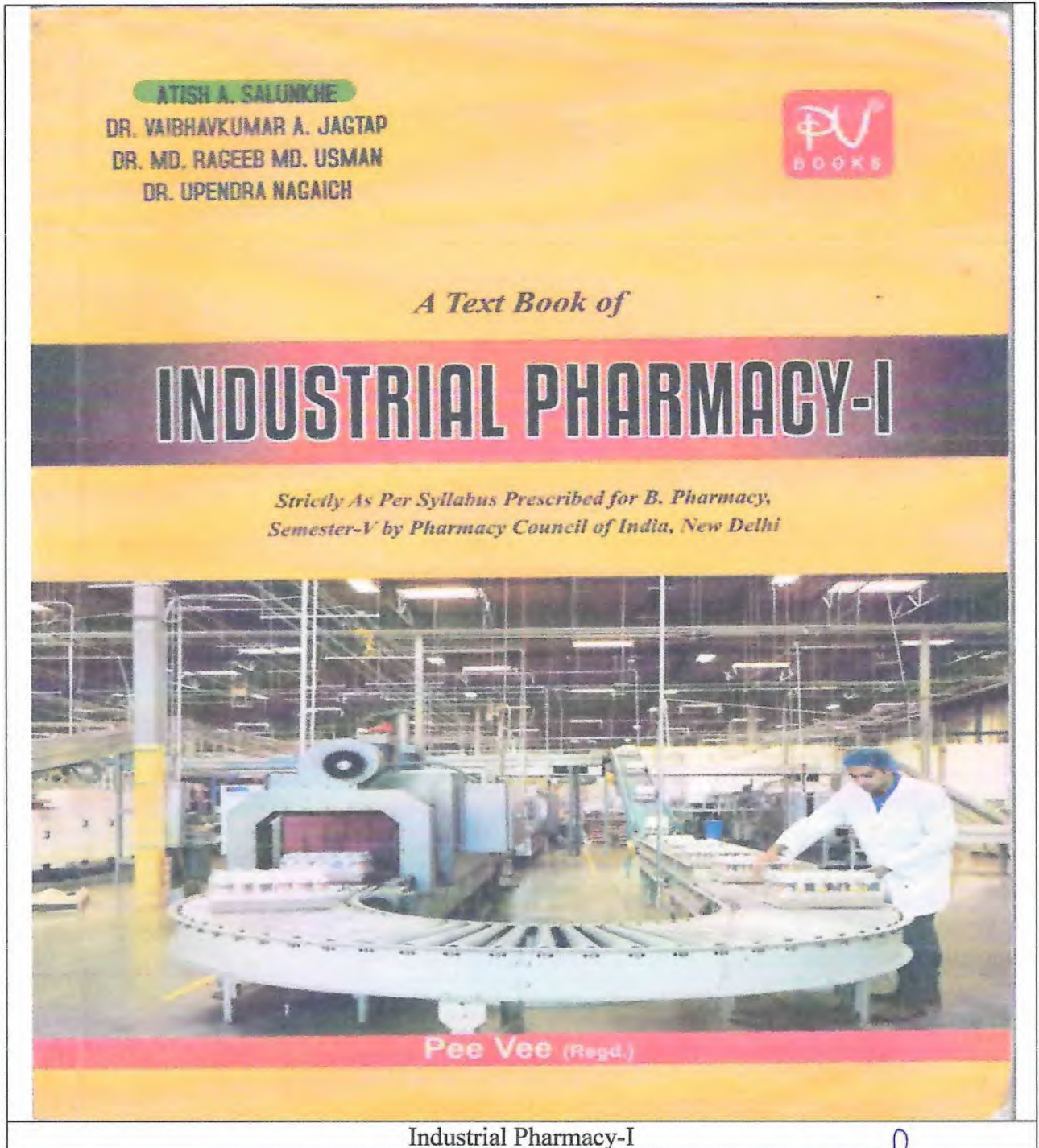
PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



Industrial Pharmacy-I



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

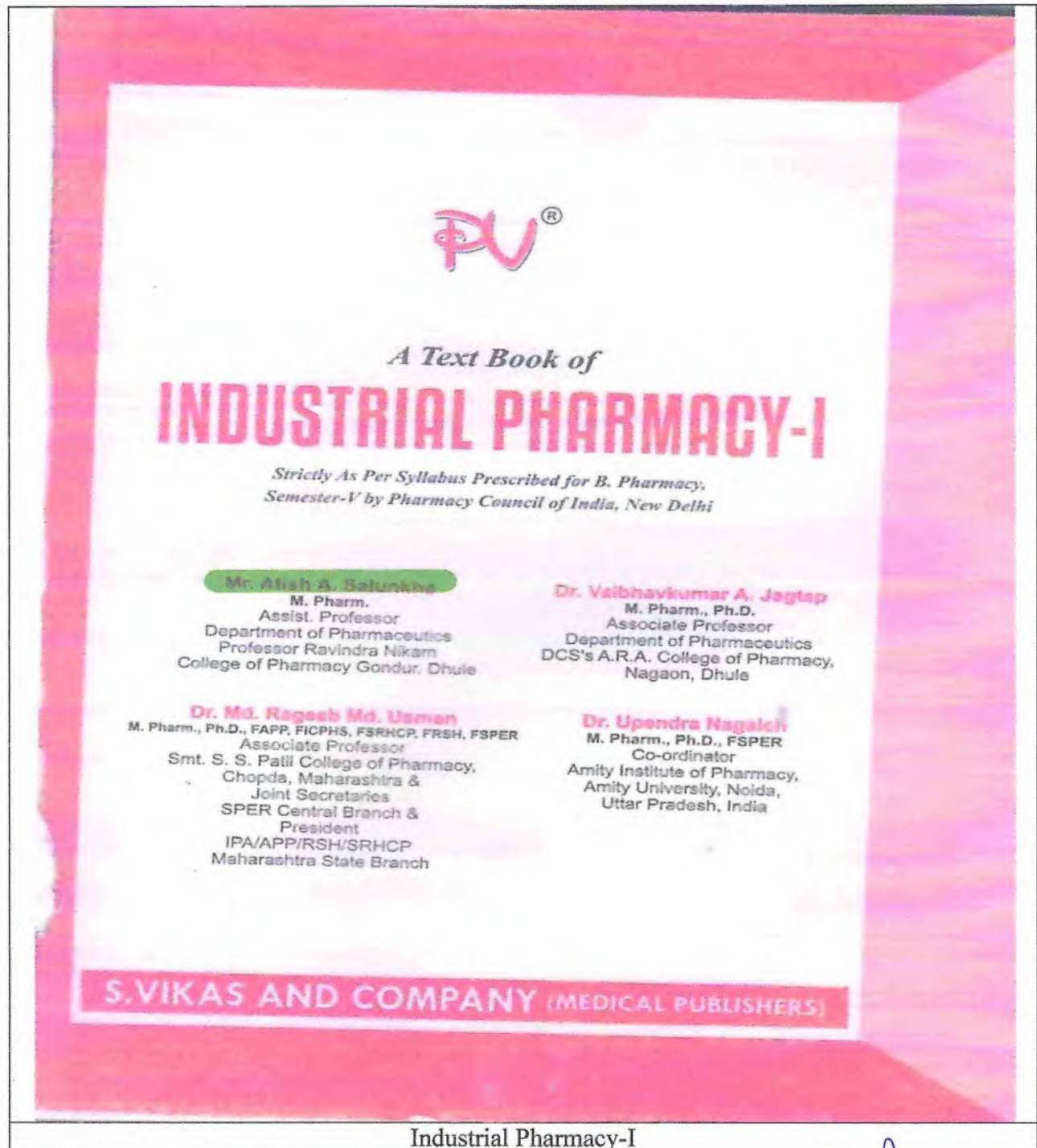
PRNCOP, Gondur



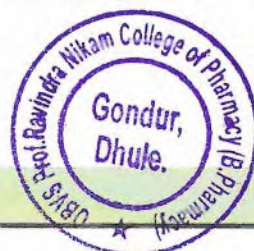


Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



Industrial Pharmacy-I



Principal

Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



An Imprint of

**S.VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

ADMIN : ND-106, BIKRAMPURA, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
SALES : ND-227, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PRODUCTION : ND-226, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PHONE : 0181-5054795, 5052795, 054786-64645  
CUSTOMER CARE : For any queries, please contact - 054786-14148  
EMAIL : pv\_books@yahoo.com  
Online Shop : www.pvbooks.in

© Copyrights Reserved

All rights reserved. No part of this publication may be reproduced or used in any form or by any means-photographic, electronic or mechanical including photocopying, recording, taping or information storage and retrieval systems-without the written permission of the publishers

ISBN 97815-43343-08-3

TradeMark No. 1350444

Edition 2019

PRICE : ₹ 375/-

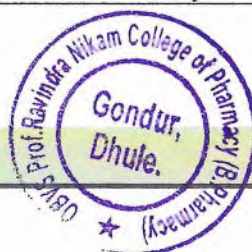
Illustrators : Aakriti Jain  
Printed and bound in India  
By Rahul Art & Press

Exclusively marketed and distributed by PV books  
For sale only in India, Nepal, Bangladesh, Sri Lanka and U.A.E.

The publishers make no representation, express or implied with regard to the accuracy of the information contained in this book and cannot accept legal responsibility for any errors or omissions.

Industrial Pharmacy-I

PRNCOP, Gondur



Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



## CONTENTS

<b>Chapter 1</b>	<b>Preformulation Studies</b>	<b>1-24</b>
	1.1 Introduction <b>1</b> , 1.2 Objectives <b>2</b> , 1.3 Goals <b>2</b> , 1.4 Principal areas of preformulation <b>2</b> , 1.5 Evaluation of physicochemical properties of drugs <b>3</b> , 1.6 BCS classification <b>20</b>	
<b>Chapter 2</b>	<b>Tablets</b>	<b>25-72</b>
	2.1 Introduction <b>25</b> , 2.2 Advantages of Tablets in Pharmaceutical industry <b>26</b> , 2.3 Disadvantages of Tablets <b>26</b> , 2.4 Ideal characteristics of tablets <b>26</b> , 2.5 Classification of tablets <b>26</b> , 2.6 Excipients Used In the Manufacture of Tablets <b>32</b> , 2.7 Granulation method <b>35</b> , 2.8 Manufacturing defects in tablets <b>37</b> , 2.9 Tablet coating <b>41</b> , 2.10 Tablet coating materials <b>50</b> , 2.11 Tablet coating equipments <b>54</b> , 2.12 Defects in tablet coating <b>60</b> , 2.13 Evaluation of tablets <b>62</b>	
<b>Chapter 3</b>	<b>Oral Liquids</b>	<b>73-92</b>
	3.1 Oral liquids <b>73</b> , 3.2 Formulation considerations for oral liquid dosage forms <b>73</b> , 3.3 Manufacturing considerations <b>77</b>	
<b>Chapter 4</b>	<b>Capsules</b>	<b>93-116</b>
	4.1 Introduction <b>93</b> , 4.2 Manufacture of hard gelatin capsules <b>96</b> , 4.3 Properties of empty capsule <b>98</b> , 4.4 Size of capsule <b>98</b> , 4.5 Filling and Finishing of Hard Gelatin Capsules <b>99</b> , 4.6 Capsule filling machines <b>100</b> , 4.7 Defects in capsules <b>102</b> , 4.8 Introduction <b>103</b> , 4.9 Nature of soft gelatin capsule <b>104</b> , 4.10 Content of a soft gelatin capsules <b>105</b> , 4.11 Base Adsorption of solids to be suspended in soft gelatin capsules <b>106</b> , 4.12 Manufacturing process of soft gelatin capsule <b>107</b> , 4.13 Quality control test for capsules <b>111</b> , 4.14 Capsule stability <b>113</b> , 4.15 Packaging and storage of capsules <b>114</b>	
<b>Chapter 5</b>	<b>Pellets</b>	<b>117-129</b>
	5.1 Introduction <b>117</b> , 5.2 Advantages of pelletization <b>117</b> , 5.3 Formulation <b>118</b> , 5.4 Pelletization techniques <b>120</b>	
<b>Chapter 6</b>	<b>Parenteral Dosage Form</b>	<b>130-174</b>
	6.1 Introduction <b>130</b> , 6.2 Advantages <b>131</b> , 6.3 Disadvantages <b>131</b> , 6.4 Types of parenteral products <b>131</b> , 6.5 Preformulation factors <b>133</b> , 6.6 General requirements for Parenteral Dosage Forms <b>135</b> , 6.7 Vehicles <b>136</b> , 6.8 Additives <b>137</b> , 6.9 Isotonicity and its importance <b>138</b> , 6.10 Production of Parenteral products <b>139</b> , 6.11 Production facilities and control <b>142</b> , 6.12 Formulation of injection <b>152</b> , 6.13 Sterile powders <b>152</b> , 6.14 Large Volume Parenteral (LVP) <b>153</b> , 6.15 Lyophilized products <b>156</b> , 6.16 Containers <b>158</b> , 6.17 Filling <b>165</b> , 6.18 Sealing <b>167</b> , 6.19 Evaluation test for parenterals <b>169</b>	

Industrial Pharmacy-I

PRNCOP, Gondur



Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

## Prof. Ravindra Nikam College of Pharmacy

Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



<b>Chapter 7</b>	<b>Ophthalmic Preparation</b>	<b>175-196</b>
	7.1 Introduction <b>175</b> , 7.2 Formulation considerations <b>176</b> , 7.3 Eye Drops <b>179</b> , 7.4 Eye ointment <b>184</b> , 7.5 Eye lotion <b>187</b> , 7.6 Evaluation of ophthalmic products <b>186</b>	
<b>Chapter 8</b>	<b>Cosmetics</b>	<b>197-226</b>
	8.1 Introduction <b>197</b> , 8.2 Cosmetic products <b>198</b> , 8.3 Lipsticks <b>199</b> , 8.4 Shampoos <b>204</b> , 8.5 Cold creams <b>209</b> , 8.6 Vanishing creams <b>210</b> , 8.7 Toothpastes <b>212</b> , 8.8 Hair Dyes <b>216</b> , 8.9 Sunscreens <b>222</b>	
<b>Chapter 9</b>	<b>Pharmaceutical Aerosols</b>	<b>227-246</b>
	9.1 Introduction <b>227</b> , 9.2 Formulation of pharmaceutical aerosols <b>229</b> , 9.3 Containers <b>233</b> , 9.4 Valves <b>235</b> , 9.5 Types of aerosol systems <b>237</b> , 9.6 Manufacture / Filling of aerosols <b>240</b> , 9.7 Evaluation of Aerosols <b>241</b>	
<b>Chapter 10</b>	<b>Pharmaceutical Packaging</b>	<b>247-277</b>
	10.1 Introduction <b>247</b> , 10.2 Ideal Qualities of a Pharmaceutical Package <b>248</b> , 10.3 Types of Package <b>248</b> , 10.4 Components of packaging <b>248</b> , 10.5 Factors affecting selection of packaging material <b>249</b> , 10.6 Materials used for packaging of pharmaceutical product <b>251</b> , 10.7 Closures <b>261</b> , 10.8 Regulatory requirements <b>267</b> , 10.9 Quality control tests <b>272</b>	
	<b>Bibliography</b>	<b>278</b>
	<b>Index</b>	<b>(i)-(ii)</b>

### Industrial Pharmacy-I



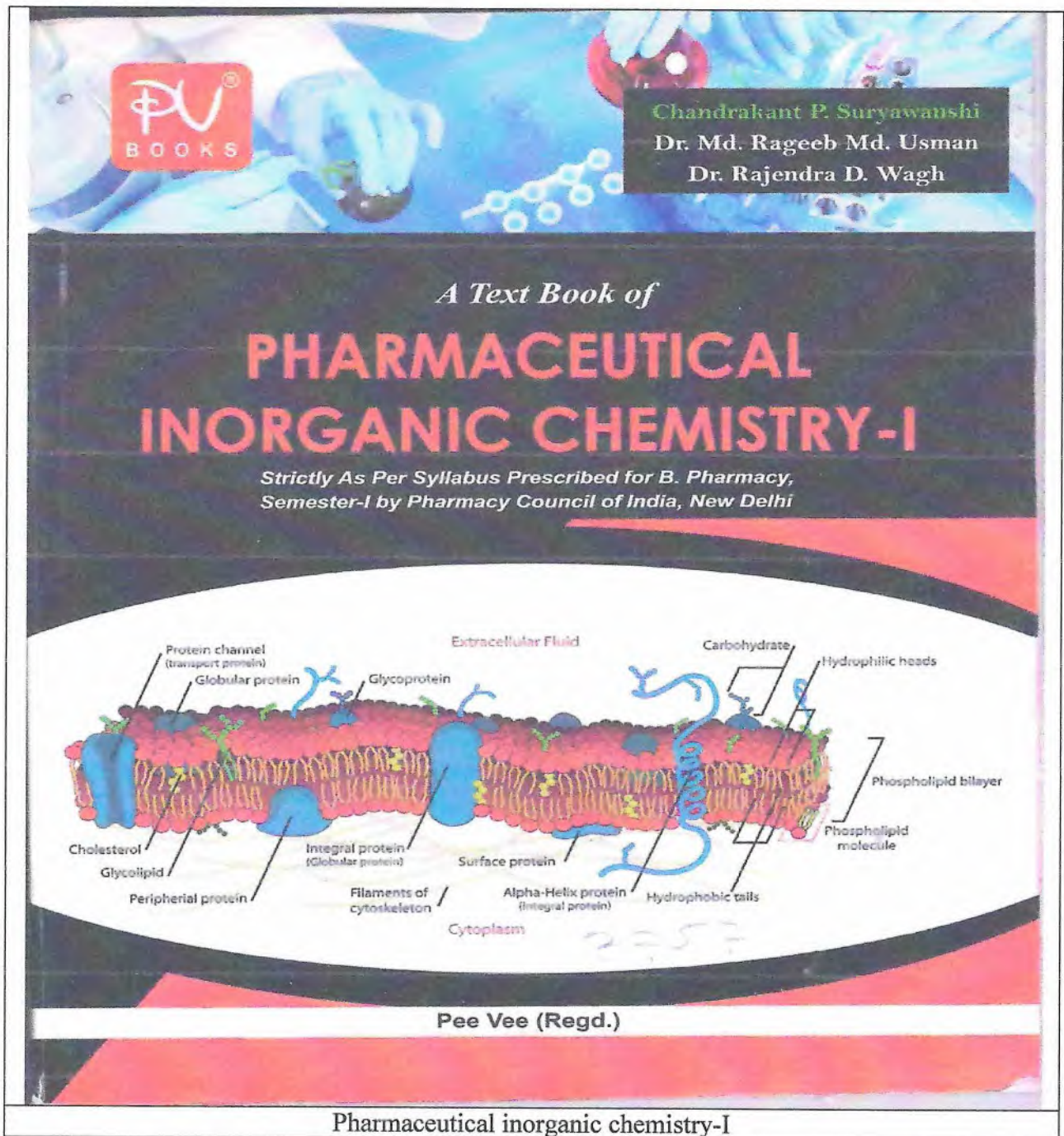
*Principal*  
Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



*A Text Book of*

# PHARMACEUTICAL INORGANIC CHEMISTRY-I

Strictly As Per Syllabus Prescribed for B. Pharmacy,  
Semester-I by Pharmacy Council of India, New Delhi

**Chandrakant P. Suryawanshi**

M. Pharm.  
Assistant Professor  
Department of Pharmaceutical Chemistry  
Professor Ravindra Nikam  
College of Pharmacy Gondur, Dhule

**Dr. Md. Rageeb Md. Usman**

M. Pharm., Ph.D., FAPP, FICPHS, FSRHCP, FRSH, FSPER  
Associate Professor  
Department of Pharmacognosy  
Smt. S. S. Patil College of Pharmacy,  
Chopda, Maharashtra  
&  
Joint Secretaries  
SPER Central Branch  
&  
President  
IPA/APP/RSR/SRHCP  
Maharashtra State Branch

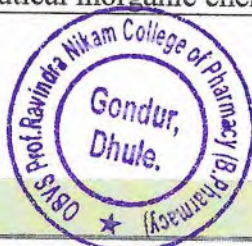
**Dr. Rajendra D. Wagh**

M. Pharm., Ph.D.  
Principal  
Annasaheb Ramesh Ajmera College of Pharmacy,  
Nagaon, Dhule



**S. VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

Pharmaceutical inorganic chemistry-I



Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



An imprint of

**S.VIKAS AND COMPANY (MEDICAL PUBLISHERS)**

ADMIN : ND-186, BIKRAMPURA, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
SALES : ND-227, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PRODUCTION : ND-226, TANDA ROAD, JALANDHAR CITY-144 008 (PUNJAB), INDIA  
PHONE : 0181-5054758, 5052758, 094786-64545  
CUSTOMER CARE : For any queries, please contact - 094786-14148  
EMAIL : pv\_books@yahoo.com  
Online Shop : www.pvbooks.in

© Copyrights Reserved

All rights reserved. No part of this publication may be reproduced or used in any form or by any means-photographic, electronic or mechanical including photocopying, recording, taping or information storage and retrieval systems-without the written permission of the publishers

ISBN 97815-43343-92-2

TradeMark No. 1350444

**Edition 2020**

PRICE : ₹ **255/-**

Illustrators : **Aakriti Jain**  
Printed and bound in India  
**By Rahul Art & Press**

Exclusively marketed and distributed by **PV books**  
For sale only in India, Nepal, Bangladesh, Sri Lanka and U.A.E.

The publishers make no representation, express or implied with regard to the accuracy of the information contained in this book and cannot accept legal responsibility for any errors or omissions.

Pharmaceutical inorganic chemistry-I



**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's


**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002

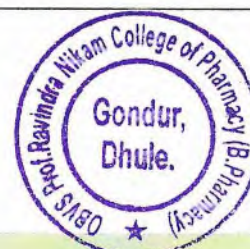


## CONTENTS

<b>Chapter 1</b>	<b>Impurities in Pharmaceutical Substances</b>	<b>1-18</b>
	1. Introduction <b>1</b> , 1.2. Impurities in pharmaceutical substances <b>3</b> , 1.3. Limit test <b>7</b>	
<b>Chapter 2</b>	<b>Acid, Bases and Buffers</b>	<b>19-38</b>
	2. Introduction <b>19</b> , 2.1. Acids and bases <b>19</b> , 2.2. Buffers <b>23</b> , 2.3. Buffer capacity <b>24</b> , 2.4. Isotonic and buffer solutions <b>25</b> , 2.5. Understanding diffusion <b>26</b> , 2.6. Tonicity <b>29</b> , 2.7. Importance of pharmaceutical buffers <b>33</b> , 2.8. Applications of buffers <b>36</b>	
<b>Chapter 3</b>	<b>Major Extra and Intracellular Electrolytes</b>	<b>39-40</b>
	3.1. Introduction <b>39</b> , 3.2. Body fluids <b>39</b> , 3.3. Fluid balance mechanism <b>41</b> , 3.4. Disturbances of acid-base balance <b>48</b> , 3.5. Electrolyte replacement therapy <b>55</b> , 3.6. Electrolyte combination therapy <b>57</b>	
<b>Chapter 4</b>	<b>Dental Products</b>	<b>61-68</b>
	4.1 Introduction <b>61</b> , 4.2 Dental products classification <b>62</b> , 4.3 Cement and fillers <b>67</b>	
<b>Chapter 5</b>	<b>Gastrointestinal Agents</b>	<b>69-98</b>
	5.1. Introduction <b>69</b> , 5.2. Acidifying agents <b>70</b> , 5.3. Antacids <b>72</b> , 5.4. Protectives and adsorbents <b>86</b> , 5.5. Saline cathartics <b>89</b>	
<b>Chapter 6</b>	<b>Miscellaneous Agents</b>	<b>99-112</b>
	6.1. Introduction <b>99</b> , 6.2. Emetics <b>99</b> , 6.3. Expectorants <b>101</b> , 6.4. Anti-dotes <b>103</b> , 6.5. Astringents <b>107</b> , 6.6. Haematinic <b>109</b>	
<b>Chapter 7</b>	<b>Radiopharmaceuticals</b>	<b>113-125</b>
	7.1. Introduction <b>113</b> , 7.2. Radionuclides or radioisotopes <b>113</b> , 7.3. Properties of $\alpha$ , $\beta$ , $\gamma$ radiations <b>115</b> , 7.4. Handling and storage of radiopharmaceuticals <b>116</b> , 7.5. Measurement of radioactivity <b>117</b> , 7.6. Application of radioactive compounds <b>121</b>	
	<b>Bibliography</b>	<b>126</b>
	<b>Index</b>	<b>(i)</b>

Pharmaceutical inorganic chemistry-I

  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule



PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



**Academic year 2018:**

**3.2.2.1 total number of books and chapters in edited volumes/ books published and papers in national / international conference proceedings year wise during last five years.**

Sr. No.	Title of the book	Name of author	Department	Name of publisher	Year of publication	Isbn/issn no.
1.	Human Anatomy and Physiology-II	Mr. A. A. Salunkhe	Pharmacology	Publication	2018	



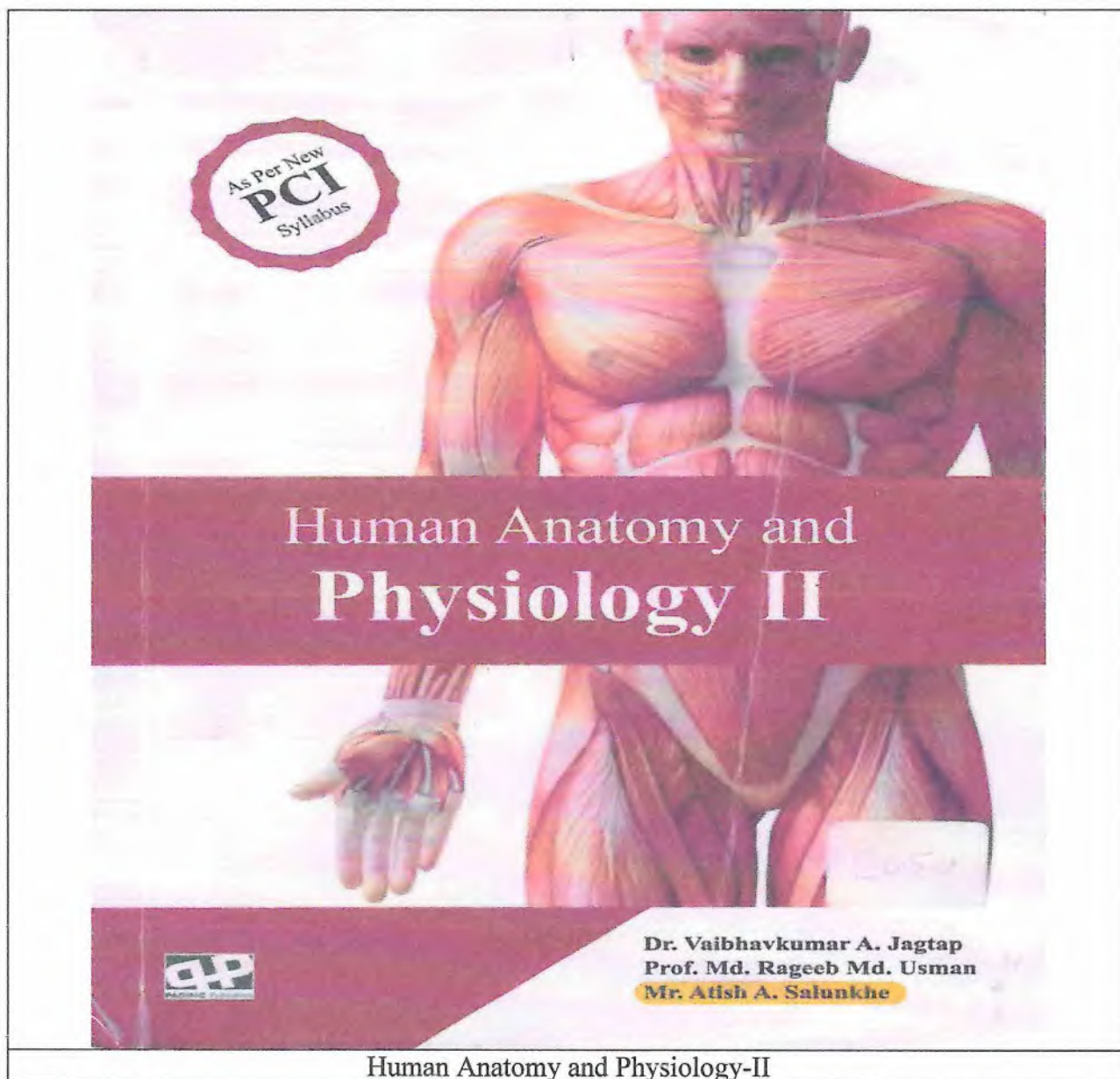
  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



Human Anatomy and Physiology-II



Principal  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur, Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's  
**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



# Human Anatomy & Physiology-II

Dr. Vaibhavkumar A. Jagtap  
Prof. Md. Rageeb Md. Usman  
Mr. Atish A. Salunkhe



Human Anatomy and Physiology-II



*Principal*  
**Principal**  
Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)  
Gondur Dhule

PRNCOP, Gondur





Onkar Bahu-UddeshiyaVikasSanstha's

**Prof. Ravindra Nikam College of Pharmacy**  
Approved by: PCI; Govt. of Maharashtra; DTE; KBC NMU Jalgaon  
Morane-Gondur Bypass Road, Gondur, Dhule- 424002



#### UNIT - IV

- **Endocrine system**

Classification of hormones, mechanism of hormone action, structure and functions of pituitary gland, thyroid gland, parathyroid gland, adrenal gland, pancreas, pineal gland, thymus and their disorders.

#### UNIT - V

- **Reproductive system**

Anatomy of male and female reproductive system, Functions of male and female reproductive system, sex hormones, physiology of menstruation, fertilization, spermatogenesis, oogenesis, pregnancy and parturition.

- **Introduction to genetics**

Chromosomes, genes and DNA, protein synthesis, genetic pattern of inheritance.

Human Anatomy and Physiology-II

PRNCOP, Gondur



*Principal*  
**Prof. Ravindra Nikam College  
of Pharmacy (B-Pharmacy)**  
Gondur, Dhule