

### Key Indicator 3.3- Research Publication

**METRIC NO.:- 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*

### **ACADEMIC YEAR 2018-19**

### **Consolidated list of books / papers published**

Sr. No.	Name of Teacher	Title of books published and papers published in national/ international conference proceedings per teacher during 2018-19	ISBN No.	Department	Page No.
1	Dr. Mrs. A. J. Asnani	UV- Spectrophotometric methods for Estimation of antimalerial drugs	978-620-0-24736-0	Pharmaceutical Chemistry	1-6
2	Mr. Kumar Pratyush			Pharmaceutical Chemistry	
3	Dr. Mrs. A. J. Asnani	Pharmaceutical Organic Chemistry II	978-93-87037-17-5	Pharmaceutical Chemistry	7-15
4	Dr. D. R. Chaple			Pharmaceutical Chemistry	
5	Dr. D. P. Kawade			Pharmaceutical Chemistry	
6	Dr. Mrs. K. P. Upadhye	Textbook of Pharmaceutical Biotechnology	978-93-87037-31-1	Pharmaceutics	16-23
7	Dr. R. H. Kasliwal			Pharmaceutics	
8	Mr. A. R. Thakre			Pharmaceutics	
9	Dr. Mrs. K. P. Upadhye	Textbook of Pharmaceutics – I	978-93-87037-14-4	Pharmaceutics	24-31
10	Dr. S. S Bakhle			Pharmaceutics	
11	Dr. Mrs. G. R. Dixit			Pharmaceutics	
12	Dr. Mrs. K. P. Upadhye	Textbook of Physical Pharmaceutics – I	978-93-87037-18-2	Pharmaceutics	32-38
13	Dr, S.S Bakhle			Pharmaceutics	
14	Dr. Mrs. G. R. Dixit			Pharmaceutics	
15	Dr. Mrs. K. P. Upadhye	Textbook of Pharmaceutical Engineering	978-93-87037-20-5	Pharmaceutics	39-50
16	Dr Mrs. S .S Bakhle			Pharmaceutics	
17	Dr. Mrs. G. R. Dixit			Pharmaceutics	
18	Dr. R .H. Kasliwal	Textbook of Industrial Pharmacy – I Part I & II	978-93-87037-22-9	Pharmaceutics	51-60
19	Dr. D. R. Chaple			Pharmaceutics	
20	Mr. Y. N. Gholve			Pharmaceutics	

**Sign of Principal**

# ***PROOFS OF 2018-19***

*Priyadarshini J. I. College of Pharmacy, Nagpur, Maharashtra, India  
Certified Document from page No.1 to 60*

This book aims to educate the undergraduates and postgraduates about development and validation of analytical methods for estimation of medicinal agents in combinations. The book contribute to students who might be considering future career in pharmaceutical industries. This book will provide complete and comprehensive coverage of method development and validation of antimalarial agents as per official guidelines. The book includes two UV-Spectrophotometric methods as simultaneous estimation method and multicomponent analysis method along with comparative studies.



Alpana Asnani  
Kumar Pratyush



Dr. (Mrs.) Alpana J. Asnani Professor at Priyadarshini J. L. College of Pharmacy, Nagpur, Maharashtra, India. A Pharma professional having industrial and academic experience of 26 years. She has published 35 research articles at national and international platforms. She has two books on her name and 108 presentations/ participation at conferences.

## UV-Spectrophotometric Methods for Estimation of Antimalarial Drugs



978-620-0-24736-0

 **LAMBERT**  
Academic Publishing

## **UV-SPECTROPHOTOMETRIC METHODS FOR ESTIMATION OF ANTIMALARIAL**

### **DRUGS**

#### **Author's:-**

- **Dr. (Mrs.) Alpana J. Asnani,**

M. Pharm, Ph.D

Professor, HOD (Pharmaceutical Chemistry)

Priyadarshini J. L. College of Pharmacy,

Electronic Building, Electronic Zone, MIDC, Hingna Road. Nagpur – 440016.  
(M.S.)

Mb. No. – 09823048952

Email id: [ajasnani7@gmail.com](mailto:ajasnani7@gmail.com)

- **Mr. Kumar Pratyush**

M. Pharm,

Assistant Professor

Priyadarshini J. L. College of Pharmacy,

Electronic Building, Electronic Zone, MIDC, Hingna Road. Nagpur – 440016.  
(M.S.)

Mb. No. – 07709714926

Email id: [kumar.pratyush29@gmail.com](mailto:kumar.pratyush29@gmail.com)

## **INDEX**

<b>S no.</b>	<b>Contents</b>	<b>Page number</b>
<b>1</b>	<b>INTRODUCTION</b> 1.1. Spectroscopy 1.2. Method Validation 1.3. Aim And Objective 1.4. Plan Of Work 1.5. Drug Profile 1.6. Literature Survey	<b>1</b> <b>2</b> <b>10</b> <b>15</b> <b>16</b> <b>17</b> <b>19</b>
<b>2</b>	<b>EXPERIMENTAL WORK AND RESULTS</b> 2.1. Materials And Methods 2.2. Development of UV Spectrophotometric Method For Simultaneous Estimation of ART And MEF in Combined Dosage Form Using Simultaneous Equation Method 2.3. Development of UV Spectrophotometric Method For Simultaneous Estimation of ART And MEF in Combined Dosage Form Using Multicomponent Method	<b>24</b> 24 25 35
<b>3</b>	<b>SUMMARY</b>	45
<b>4</b>	<b>DISCUSSION AND CONCLUSION</b>	49
<b>5</b>	<b>REFERENCES</b>	51

## List of Tables

Table 1:- Range of Radiation in EMR Spectrum.....	3
Table 2:- Details of marketed tablet formulation.....	24
Table 3:- Data of absorbance additivity study .....	28
Table 4:- Absorptivity coefficient of drugs .....	28
Table 5:- Data of analysis of laboratory mixture .....	29
Table 6:- Assay of tablet formulation by proposed method .....	30
Table 7:-Data of recovery Study.....	32
Table 8:- Data of specificity study.....	34
Table 9:- Data of ruggedness study .....	35
Table 10:- Concentration of ART and MEF mixture.....	36
Table 11:- Data of analysis of laboratory mixture .....	38
Table 12:- Assay of tablet formulation by proposed method .....	39
Table 13:- Data of recovery Study.....	41
Table 14:- Data of specificity study.....	43
Table 15:- Data of ruggedness study .....	44
Table 16:- Summary of statistical result for simultaneous equation method.....	46
Table 17:- Summary of statistical result for multicomponent method .....	47
Table 18:- Summary of statistical result of all the analytical developed methods .....	48

## List of Figures

Figure 1 :- Electronic Energy Levels and Transitions .....	4
Figure 2 :- Schematic diagram of UV Double Beam Spectrophotometer.....	4
Figure 3:- Hypothetical Overlain Spectra of Substances X and Y.....	6
Figure 4:- The Steps of Validation of method .....	11
Figure 5:- Overlain spectrum of ART and MEF (10 µg/mL) .....	26
Figure 6:- Plot of Beer Lambert's law for ART (a), MEF (b) and (c) Laboratory Mixture.....	27
Figure 7:- Spectra of mixtures containing ART and MEF in 2:4 ratio in multicomponent mode of spectrophotometer.....	37
Figure 8:- Linearity graph of mixture at three selected wavelength (205 and 225 nm).....	38

This book aims to educate the undergraduates and postgraduates about development and validation of analytical methods for estimation of medicinal agents in combinations. The book contribute to students who might be considering future career in pharmaceutical industries. This book will provide complete and comprehensive coverage of method development and validation of antimalarial agents as per official guidelines. The book includes two UV-Spectrophotometric methods as simultaneous estimation method and multicomponent analysis method along with comparative studies.



Alpana Asnani  
Kumar Pratyush



Dr. (Mrs.) Alpana J. Asnani Professor at Priyadarshini J. L. College of Pharmacy, Nagpur, Maharashtra, India. A Pharma professional having industrial and academic experience of 26 years. She has published 35 research articles at national and international platforms. She has two books on her name and 108 presentations/ participation at conferences.

## UV-Spectrophotometric Methods for Estimation of Antimalarial Drugs



978-620-0-24736-0

LAP LAMBERT  
Academic Publishing



*TPS* "Textbook"

**Technical Pharmacy Series**

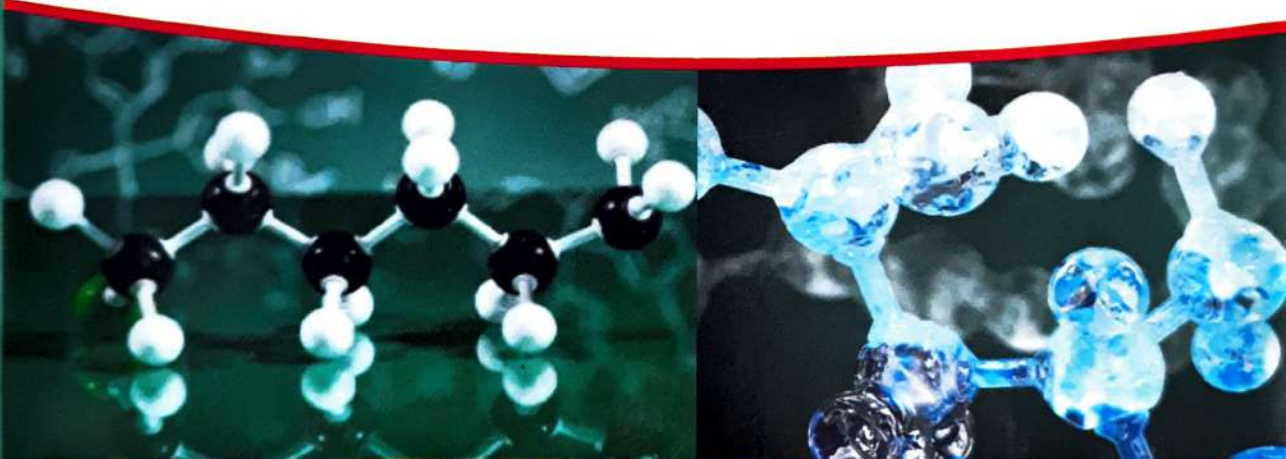
*Strictly Based On PCI Syllabus*



# PHARMACEUTICAL ORGANIC CHEMISTRY - II

**WITH  
VIVA-VOCE**

**THIRD SEM. B. PHARM**



For On-line Purchases, Please Visit

[vbdpublications.com](http://vbdpublications.com) OR [amazon.in](http://amazon.in)

▶ **Dr. Dinesh P. Kawade**

▶ **Dr. A. J. Asnani**

▶ **Dr. D. R. Chaple**

## About the Book

This textbook is based on the syllabus prescribed by the Pharmacy Council of India. The salient features of this book are:

- Full coverage of PCI syllabus.
- Easy to understand language.
- Points to Remember & Exercises.
- Viva-voce for practical examination.

## About the Authors



**Dr. Dinesh P. Kawade**, The author has completed B. Pharm. (2002) and M. Pharm. Pharmaceutical Chemistry (2006) and Ph.D. (2014) from Sharad Pawar College of Pharmacy, Nagpur. He is registered with Pharmacy Council of India and is a life member of APTI and MAPAI. He has published over 21 research papers /communications including 05 national journals and 16 international journals. The author also attended over 27 national and international conference and workshop. He also guided 10 students for UG research project and 06 students for PG research work. Author also delivered 01 guest lectures. He is approved Ph.D. supervisor and examiner of different universities at UG and PG levels. Presently he is working as a Assistant Professor in Department of

Pharmaceutical Chemistry, Priyadarshini J. L. College of Pharmacy, Nagpur since from 2006.



**Dr. Alpana J. Asnani**, She has completed B. Pharm. (1992) and M. Pharm. (1993) and Ph.D (2011) from RTM Nagpur University, Nagpur. She is registered with the Pharmacy Council of India and is a life member of IPA and MAPAI. She has published over 23 research papers/communications including 12 national journals and 11 research papers/communications in international journals. The author also attended over 40 national and international conference and workshop. She also guided 10 students for UG research project and 24 students for PG research work and 01 research scholar is registered for Ph.D. Author also delivered 08 guest lectures. Presently she is working as a Professor and HOD (Pharmaceutical Chemistry) in Priyadarshini J. L. College of Pharmacy,

Nagpur since from 2015. She is approved supervisor and examiner of different universities at UG and PG levels.



**Dr. Dinesh R. Chaple**, has been working as Principal at Priyadarshini J. L. College of Pharmacy, Nagpur since 2010. He has completed B. Pharm. (1988) and M. Pharm. (1990). Later on in 2010 he has completed his Ph. D. (Pharmaceutical Chemistry) from RTMNU, Nagpur. He possesses about 29 years of experience in academics. He is registered with the Pharmacy Council of India and is a life member of The Indian Pharmaceutical Association, Indian Society for Technical Education, Association of Pharmaceutical Teachers in India. He has published over 28 research papers/ communications in national journals and 13 research papers/communications in international journals. The author also attended more than 25 national and international

conference and workshop. He has authored a book entitled "Spectrophotometric Estimation of Fluroquinolones antibacterial agent: Ion-Pair with acid dyes". He also guided 9 students for UG research project, 31 students for PG research work and 01 students of Ph.D. He is approved Ph.D. supervisor and examiner of different universities at UG and PG levels.

## OUR HIGHLY RECOMMENDED TEXTBOOKS FOR B. PHARM III SEM.

Subjects	Author Name
Pharmaceutical Organic Chemistry-II	Dr. D. P. Kawade, Dr. A. J. Asnani, Dr. D. R. Chaple
Physical Pharmaceutics-I	Dr. K. P. Upadhye, Dr. G. R. Dixit, Dr. S. S. Bakhle
Pharmaceutical Microbiology	Vijay R. Tahilyani
Pharmaceutical Engineering	Dr. S. S. Bakhle, Dr. K. P. Upadhye, Dr. G. R. Dixit

**For On-line Purchases, Please Visit**

**vbdpublications.com OR amazon.in**

Published By :

**ABD PUBLISHERS & PRINTERS (P) LTD.**

Distributed By : **VBD PUBLICATIONS (P) LTD.**

Plot No. 236, Near Ram Coolers, Besides Ganesh Temple, Singada Market,  
Navi Shukrawari, Mahal, Nagpur-18 Ph. : 0712-2722235/36, 7620266004

ISBN : 978-93-87037-17-5



**Distributed by :**

**VBD Publications Pvt. Ltd.**

**477, Golchha Marg, Sadar, Nagpur - 440001.**

**Sales Office :**

**Plot No. 236, Near Ram Coolers,**

**Besides Ganesh Temple,**

**Singada Market, Navi Shukrawari,**

**Mahal, Nagpur - 32**

**☎: 0712-2722235, 7620266004, Fax : 0712-2722236**

**Website : [www.vbdpublications.com](http://www.vbdpublications.com)**

**E-mail : [vbdbooks@gmail.com](mailto:vbdbooks@gmail.com)**

**© Publishers**

**ISBN : 978-93-87037-17-5**

**Price : Rs. 190/-**

**Edition : 2019**

फोटोकॉपी (रेप्रक्स) करने से पैटर बहुत छोटा हो जाता है और इसे पढ़ने से आपकी आँखें कमजोर होती हैं।  
As per Indian Copyright Act 1957, photocopying of a book is punishable under law.

**Books Available At ALL LEADING BOOK SELLERS  
OR CONTACT:  
VIJAY BOOK DEPOT,  
GOLCHHA MARG, SADAR, NAGPUR  
Ph. No. 0712 - 2520496**

**For online purchases, please visit [WWW.VBDPUBLICATIONS.COM](http://WWW.VBDPUBLICATIONS.COM)**

*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 without the prior written permission of the publisher.*

Note: While every care and precautions have been taken regarding the contents and data of this book, the publisher does not hold responsibility for any error or omissions. Please refer prescribed text books. Any dispute will be subject to Nagpur Jurisdiction only.

**Published by : ABD Publishers & Printers Pvt. Ltd., Nagpur.**

**PHARM. ORG. CHEM.-II (B.Pharm. III SEM.)**

## CONTENTS

### UNIT - I

1.1	Introduction	1
1.2	Synthesis of benzene	2
1.3	Structure of benzene	3
1.3.1	Analytical evidences	6
1.3.2	Synthetic evidences	7
1.3.3	Other evidences	9
1.3.4	Properties of benzene	11
1.3.5	Uses of benzene	11
1.4	Orbital picture	12
1.5	Resonance in benzene	14
1.6	Aromatic character	16
1.7	Huckel's rule	18
1.8	Reactions of benzene	19
1.8.1	Difference between Friedel-Craft's alkylation and acylation	26
1.9	Substituents	27
1.10	Effect of ring substituents	28
1.11	Effect of substituents towards electrophilic substitution reaction	32
1.12	Effect of substituents on reactivity	33
1.13	Effect of substituents on orientation	35
1.14	Structure and uses of benzene derivatives	37
1.14.1	DDT	38

1.14.2	Saccharin	39
1.14.3	BHC	40
1.14.4	Chloramine	41
1.15	Points to remember	42
1.16	Exercise	43
<b>UNIT - II</b>		
<b>Phenol :</b>		
2.1	General introduction of phenol	51
2.2	Structure and bonding	52
2.3	Properties of phenol	52
2.4	Nomenclature of phenol	54
2.5	Preparation of phenol	56
2.6	Acidity of phenols	59
2.6.1	Effect of substituent groups on acidity of phenols	60
2.7	Reactions of phenols	63
2.8	Qualitative tests	71
2.9	Structure and uses of phenol	73
2.10	Structure and uses of cresols	75
2.11	Structure and uses of resorcinol	76
2.12	Structure and uses of naphthols	77
<b>Aromatic amines :</b>		
2.13	Introduction	81
2.14	Classification of amines	82
2.15	Naming conventions (nomenclature)	83
2.16	Physical properties	86
2.17	Structure of alkyl and aromatic amines	87

<b>2.18</b>	Basicity of amines	88
<b>2.19</b>	Synthesis of amines	94
<b>2.20</b>	Reactions of amines	101
<b>2.21</b>	Applications of amines	108
<b>2.22</b>	Structure and uses of aryl diazonium salts	109
	<b>2.22.1</b> Diazotisation reaction (preparation)	109
	<b>2.22.2</b> Properties	111
	<b>2.22.3</b> Applications	111
<b>Aromatic acids :</b>		
<b>2.23</b>	Introduction	113
<b>2.24</b>	Nomenclature of acids	115
<b>2.25</b>	Physical properties	118
<b>2.26</b>	Acidity of aromatic carboxylic acids	118
<b>2.27</b>	Synthesis of aromatic acids	122
<b>2.28</b>	Reactions of benzoic acid	123
<b>2.29</b>	Applications of benzoic acid	128
<b>2.29</b>	Points to remember	130
<b>2.30</b>	Exercise	134
<b>UNIT - III</b>		
<b>3.1</b>	Introduction	149
<b>3.2</b>	Fats and oils	150
	<b>3.2.1</b> Difference between fats and oils	152
	<b>3.2.2</b> Classification of fatty acids	153
	<b>3.2.3</b> Physical properties	155
<b>3.3</b>	Reactions of fats and oils	157

	165
3.4 Analysis of oils and fats	178
3.5 Uses of fats and oils	178
3.6 Points to remember	181
3.7 Exercise	
<b>UNIT - IV</b>	
4.1 Introduction	189
4.2 Classification of polynuclear hydrocarbons	192
4.3 Physiochemical properties	194
4.4 Nomenclature of PAHs	195
4.5 Biphenyl	201
4.5.1 Preparation of biphenyl	202
4.5.2 Reactions of biphenyl	203
4.5.3 Uses	203
4.5.4 Biphenyl derivatives	204
4.6 Diphenyl methane	206
4.6.1 Methods of preparation	207
4.6.2 Chemical reactions of diphenyl methane	208
4.6.3 Uses	209
4.6.4 Derivatives of diphenyl methane	210
4.7 Triphenylmethane	211
4.7.1 Methods of preparation	212
4.7.2 Reactions of triphenylmethane	213
4.7.3 Uses	214
4.7.4 Derivatives	214
4.8 Naphthalene	217
4.8.1 Methods of preparation	219

4.8.2 Physical properties	223
4.8.3 Chemical properties /reactions of naphthalene	223
4.8.4 Substituted naphthalene	227
4.8.5 Uses of naphthalene	230
4.8.6 Derivatives of naphthalene	230
4.9 Anthracene	237
4.9.1 Methods of preparation	239
4.9.2 Physical properties	242
4.9.3 Chemical properties/ reactions	242
4.9.4 Uses of anthracene	244
4.9.5 Derivatives of anthracene	244
4.10 Phenanthrene	248
4.10.1 Preparation of phenanthrene	251
4.10.2 Physical properties	253
4.10.3 Reactions of phenanthrene	254
4.10.4 Uses	256
4.10.5 Derivative of phenanthrene	256
4.11 Points to remember	256
4.12 Exercise	259
<b>UNIT - V</b>	
5.1 Introduction	271
5.2 Nomenclature of cycloalkane	271
5.3 Preparation of cycloalkanes	273
5.4 Physical properties of cycloalkanes	274
5.5 Chemical properties of cycloalkanes	275
5.6 Conformations of cycloalkanes	276



5.7	Stability of cycloalkanes (ring strain in cycloalkanes)	284
5.8	Baeyer's strain theory	285
5.8.1	Angle strain in cycloalkane	288
5.8.2	Advantages of Baeyer's strain theory	290
5.8.3	Limitations of Baeyer's strain theory	290
5.9	Coulson and Moffitt's modification	290
5.10	Sachse-Mohr's theory of strainless rings	292
5.11	Reactions of cyclopropane and cyclobutane	293
5.12	Points to remember	297
5.13	Exercise	298
	<b>VIVA-VOCE</b>	305
	<b>Glossary</b>	321
	<b>Index</b>	329

*TPS* "Textbook"

**Technical Pharmacy Series**

*Strictly Based On PCI Syllabus*



# PHARMACEUTICAL BIOTECHNOLOGY

**SIXTH SEM. B. PHARM**



**For On-line Purchases, Please Visit**

**vbdpublications.com OR **

- ▶ **Mr. Anup R. Thakre**
- ▶ **Dr. Rahul H. Kasliwal**
- ▶ **Dr. (Mrs.) Kanchan Upadhye**

## About the Book

This textbook is based on the syllabus prescribed by the Pharmacy Council of India. The salient features of this book are:

- Full coverage of PCI syllabus.
- Points to Remember & Exercises.
- Easy to understand language.
- Clear and Sharp Printing.

## About the Authors



**Mr. Anup R. Thakre** has completed **B. Pharm.** (2007) and **M. Pharm.** (Pharmaceutics) (2012). He is registered as a life member of **APTI** and **ISCA**. He has filed one patent. He has published over **05 research papers/communications** in **national journals** and **11 research papers/communications** in **international journals**. The author also attended over **16 national and international conference and workshop**. He also guided **09 students** for **UG** research project. Author also delivered **03 guest lectures**. Presently he has been working as **Assistant professor** in Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur.



**Dr. Rahul H. Kasliwal**, has completed **D. Pharm.** (1998), **B. Pharm.** (2001) and **M. Pharm.** (2003) from IPER, Wardha. Later on in 2008 he has completed his **Ph.D.** (Pharmaceutics) from RTMNU, Nagpur. He is registered with the Pharmacy Council of India and as a life member of **IPA** and **MAPAI**. His research concern was the formulation and fabrication of controlled drug delivery system of water soluble drugs. He has published **7 patents** and over **03 research papers/communications** in **national journals** and **14 research papers/communications** in **international journals**. The author also attended over **25 national and international conference and workshop**. He also guided **09 students** for **UG** research project and **16 students** for **PG** research work. Presently he has been working as **Assistant professor** in Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur. He is approved supervisor and examiner of different universities at **UG** and **PG** levels.



**Dr. (Mrs.) Kanchan Upadhye** is working as an **Associate Professor** in Pharmaceutics in Priyadarshini J. L. College of Pharmacy since last **21 years**. She has completed her **Ph. D.** from Nagpur University. In these years she has taught the subject of Physical Pharmaceutics for about **14 years**. She has guided approximately **20 M. Pharm students** and has to her credit various publications and presentations in **national and international journals**. She has also filed **3 patents**.

## OUR HIGHLY RECOMMENDED TEXTBOOKS FOR B. PHARM VI SEM.

Subjects	Author Name
Medicinal Chemistry - III	Dr. (Mrs.) M. P. Puranik, D.K. Mahapatra
Pharmacology - III	S. S. Borkar, D.K. Mahapatra, S. B. Wakodkar, Dr. J.R. Baheti
Herbal Drug Technology	Mrs. S. G. Gurunani, Dr. B. N. Shah, Dr. V. D. Gulkari, Dr. (Mrs.) S. P. Motghare
Biopharmaceutics & Pharmacokinetics	Mr. Y. N. Gholve, Dr. R. H. Kasliwal, Dr. (Mrs.) J. G. Avari
Pharmaceutical Biotechnology	Mr. A. R. Thakre, Dr. R. H. Kasliwal, Dr. (Mrs.) K. Upadhye
Pharmaceutical Quality Assurance	Dr. A. N. Maliye, Dr. Rajesh A. Sahu, Mrs. R. R. Mishra

Published By :

**ABD PUBLISHERS & PRINTERS (P) LTD.**

Distributed By : **VBD PUBLICATIONS (P) LTD.**

Plot No. 236, Near Ram Coolers, Besides Ganesh Temple, Singada Market,  
Navi Shukrawari, Mahal, Nagpur-18 Ph. : 0712-2722235/36, 7620266004

ISBN : 978-93-87037-31-1



9 789387 037311

*TPS* - TECHNICAL PHARMACY SERIES

**A Textbook of**  
**PHARMACEUTICAL**  
**BIOTECHNOLOGY**

**Semester - VI, B. Pharm.**

By

**Mr. Anup R. Thakre**

**M.Pharm (Pharmaceutics)**  
**Assistant Professor**  
Priyadarshini J. L. College of Pharmacy,  
Nagpur.

**Dr. Rahul H. Kasliwal**

**M.Pharm,**  
**Ph.D (Pharmaceutical Sciences)**  
**Assistant Professor**  
Priyadarshini J. L. College of Pharmacy,  
Nagpur.

**Dr. Mrs. K.P. Upadhye**

**M.Pharm,**  
**PhD (Pharmaceutical Sciences)**  
**Associate Professor**  
**Head of Department of Pharmaceutics**  
Priyadarshini J. L. College of Pharmacy, Nagpur.

**SALIENT FEATURES**

- 100% coverage of PCI Syllabus.
- Prepared in **Simple and Lucid Language**.
- **Glossary** of difficult terms.
- **Points to Remember and Exercises** after each unit.

**STRICTLY AS PER NEW PCI SYLLABUS**

**Distributed by:**

**VBD Publications Pvt. Ltd.**

**Plot No. 236, Near Ram Coolers,**

**Besides Ganesh Temple,**

**Singada Market, Navi Shukrawari,**

**Mahal, Nagpur - 32**

**☎: 0712-2722235, 7620266004, Fax : 0712 - 2722236**

**Website : www.vbdpublications.com**

**E-mail : vbdbooks@gmail.com**

© Publishers

**ISBN : 978-93-87037-31-1**

**Price : Rs. 250/-**

**Latest Edition : For Current Academic Session**

**For online purchases, please visit [WWW.VBDPUBLICATIONS.COM](http://WWW.VBDPUBLICATIONS.COM)**

फोटोकॉपी (ड्रैगक्स) करने से मैटर बहुत छोटा हो जाता है और इसे पढ़ने से आपकी आँखें कमजोर होती हैं।  
As per Indian Copyright Act 1957, photocopying of a book is punishable under law.

*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 without the prior written permission of the publisher.*

Note: While every care and precautions have been taken regarding the contents and data of this book, the publisher does not hold responsibility for any error or omissions. Please refer prescribed text books. Any dispute will be subject to Nagpur Jurisdiction only.

**Published by : ABD Publishers & Printers Pvt. Ltd., Nagpur.**

## CONTENTS

### UNIT - I

1.1	Introduction	1
1.2	Brief introduction to biotechnology with reference to pharmaceutical sciences	2
1.2.1	Definition(s) of biotechnology	3
1.2.2	History of biotechnology	4
1.2.3	Biotechnology-a multidisciplinary growing tree	7
1.2.4	Biotechnological tools	8
1.2.5	Applications of biotechnology	8
1.2.6	Commercialization of biotechnology	9
1.2.7	Public perception of biotechnology	9
1.2.8	The future of biotechnology	10
1.3	Enzyme biotechnology	11
1.3.1	Advantages of immobilized enzymes	11
1.3.2	Disadvantages of enzyme immobilization	12
1.3.3	Supports or matrix used in immobilization technology	12
1.4	Methods of immobilization	14
1.4.1	Immobilization of whole cells	20
1.5	Applications of enzyme immobilization	22
1.6	Biosensors or enzyme electrodes	22
1.6.1	Principle of a biosensor	23
1.6.2	Working of a biosensor	23
1.6.3	Generalized biosensor	25
1.6.4	Underlying principle of biosensors	25
1.6.5	Methodology	26
1.6.6	Types of electrodes used in biosensors	26
1.6.7	Applications of biosensors	28
1.7	Protein engineering	29
1.7.1	Protein structures	30
1.7.2	Protein engineering tools	31
1.7.3	Production	33
1.7.4	Analysis	33
1.7.5	Applications	34
1.8	Use of microbes in industry	37

1.9	Production of enzymes	
1.9.1	Amylases	37
1.9.2	Fungal $\alpha$ - amylase	37
1.9.3	Bacterial $\alpha$ - amylase	38
1.10	Catalase	40
1.11	Peroxidases	43
1.12	Lipases	45
1.12.1	Production of lipase	47
1.13	Proteases (proteolytic enzymes)	48
1.14	Penicillinase	49
1.15	Genetic engineering	53
1.15.1	History of recombinant dna technology	54
1.15.2	An outline of recombinant dna technology	54
1.15.3	Molecular tools of genetic engineering	54
1.15	Points to remember	56
1.16	Exercise	58
		59
<b>UNIT -II</b>		
2.1	Introduction	
2.2	Study of cloning vectors, restriction endonucleases and DNA ligase	64
2.2.1	Cloning vectors	64
2.3	Restriction endonucleases	65
2.3.1	Nomenclature	76
2.3.2	Classification of restriction enzymes	76
2.3.3	Applications of restriction enzymes	77
2.4	DNA ligase	79
2.5	Recombinant DNA technology and application of genetic engineering in medicine	80
2.6	Application of rDNA technology and genetic engineering in the production of interferon, vaccines-hepatitis-B and hormones-insulin	83
2.6.1	Interferon	92
2.6.2	Vaccines-hepatitis-B	92
2.6.3	Hormones-insulin	96
2.7	Polymerase Chain Reaction (PCR)	97
2.8	Points to remember	100
2.9	Exercise	103
		104

**UNIT - III**

3.1	Introduction	
3.2	Types of immunity	109
3.2.1	Humoral immunity	110
3.1.2	Cell mediated immunity or cellular immunity	110
3.3	Structure of immunoglobulins	112
3.4	Structure and function of MHC	113
3.5	Hypersensitivity reactions	125
3.6	Immune stimulation and immune suppressions	129
3.6.1	Immunosuppressants	135
3.6.2	Immunostimulants	135
3.7	General method of the preparation immunological products	140
3.7.1	Bacterial vaccines	143
3.7.2	Toxoids	143
3.7.3	Viral vaccines	145
3.7.4	Antitoxins: preparations of passive immunization products (antitoxins)	146
3.7.5	Serum immune blood derivatives	148
3.7.6	Other product related to immunity	149
3.8	Storage conditions and stability of official vaccines	150
3.8.1	Vaccine storage	151
3.8.2	Stability of vaccines	151
3.9	Hybridoma technology- production, purification and applications	153
3.10	Blood products	154
3.11	Plasma substitutes	158
3.12	Points to remember	166
3.13	Exercise	168

**UNIT - IV**

4.1	Introduction	169
4.2	Immuno blotting techniques	173
4.2.1	Enzyme immunoassays	174
4.2.2	Western blotting	174
4.2.3	Southern blotting	178
4.3	Genetic organization of eukaryotes and prokaryotes	184
4.3.1	Eukaryotes	188
4.3.2	Prokaryotes	188
4.4	Microbial genetics including transformation, transduction, conjugation, plasmids and transposons	190
4.4.1	Conjugation	193
4.4.2	Transduction	194
4.4.3	Transformation	195



4.4.4	Plasmids	197
4.4.5	Transposons	199
4.5	Microbial biotransformation	202
4.6	Mutation	205
4.6.1	Types of mutations	205
4.8	Points to remember	208
4.9	Exercise	209
<b>UNIT - V</b>		
5.1	Introduction	214
5.2	Fermentation methods and general requirements, study of media, equipment, sterilization methods, aeration process, stirring	215
5.2.1	Fermentation methods and general	215
5.2.2	Study of media	222
5.2.3	Fermentation equipment	225
5.2.4	Sterilization methods	226
5.2.5	Aeration process	228
5.2.6	Stirring	229
5.3	Large scale production fermenter design and its various controls	229
5.3.1	Types of submerged bioreactors	232
5.3.2	Solid substrate fermentation	234
5.3.3	Types of solid substrate bioreactors	237
5.3.4	Media for industrial fermentations	239
5.4	Study of the production of - penicillins, citric acid, vitamin B12, glutamic acid, griseofulvin	240
5.4.1	Penicillin	240
5.4.2	Citric acid	241
5.4.3	Vitamin B12	244
5.4.4	Glutamic acid	247
5.4.5	Griseofulvin	
5.5	Blood products. collection, processing and storage of whole human blood, dried human plasma, plasma substitutes	249
5.5.1	Whole blood	249
5.5.2	Dried human plasma / fresh-frozen plasma (FFP)	250
5.5.3	Plasma substitutes	252
5.6	Points to remember	254
5.7	Exercise	254
	<b>Glossary</b>	258
	<b>Index</b>	262
	<b>Bibliography</b>	265

# TPS

**Technical Pharmacy Series**

*Strictly Based On PCI Syllabus*



## PHARMACEUTICS - I

**WITH  
VIVA-VOCE**

**FIRST SEM. B. PHARM**



**For On-line Purchases, Please Visit**

**vbdpublications.com OR amazon.in**

- ▶ **Dr. Gouri R. Dixit**
- ▶ **Dr. Kanchan P. Upadhye**
- ▶ **Dr. Suparna S. Bakhle**

## About the Book

This textbook is based on the syllabus prescribed by the Pharmacy Council of India. The salient features of this book are:

- Full coverage of PCI syllabus.
- Easy to understand language.
- Points to Remember & Exercises.
- Viva-voce for practical examination.

## About the Authors



**Dr. Gouri R. Dixit** has completed her B. Pharm., M. Pharm., and Ph. D. from R.T.M. Nagpur University, Nagpur. She has total 18 years of UG and 10 years of PG and research experience. Presently she is working as Assistant Professor, Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur. She has published and presented many papers in national and international journals and conferences of repute. She has guided about 20 students at master level. She is the life member of APTI and MAPAI.



**Dr. Kanchan Upadhye** is working as an Associate Professor in Pharmaceutics in Priyadarshini J. L. College of Pharmacy since last 21 years. In these years she has taught the subject of Physical Pharmaceutics for about 14 years. She has guided approximately 20 M. pharm students and has to her credit various publications and presentations in national and international journals. She has also filed three patents. She is an approved PhD guide in Pharmaceutical Sciences.



**Dr. Suparna S. Bakhle** is currently an Associate Professor at Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur. She did her graduation, post graduation from Department of Pharmaceutical Sciences, Nagpur and obtained her Doctorate-degree from R.T.M Nagpur University, Nagpur. She worked as a lecturer with Institute of Pharmaceutical Education and Research, Wardha and is working with Priyadarshini J. L. College of Pharmacy, Nagpur since 2000. She has a total teaching experience of about 22 years till date, has guided 15 students for M. Pharm, published several research papers in various national and international journals and has filed a patent. She has contributed a chapter "Diffusion and Dissolution" in the book entitled "Physicochemical Principles of Pharmaceutics" published by Himalaya Publishing House.

### OUR HIGHLY RECOMMENDED TEXTBOOKS FOR B. PHARM I SEM.

Subjects	Author Name
Pharmaceutical Inorganic Chemistry	Mrs. R. R. Mishra, Dr. R. A. Sahu, Dr. A. N. Maliye
Pharmaceutics-I	Dr. G. R. Dixit, Dr. K. P. Upadhye, Dr. S. S. Bakhle
Human Anatomy And Physiology - I	Mrs. S. V. Mangrulkar, Ms. Nitu Wankhede
Pharmaceutical Analysis	Mrs. Vijayshri V. Rokde
Communication Skills	Dr. Ajay Pise, Mrs. Shilpa Pise

For On-line Purchases, Please Visit

vbdpublications.com OR amazon.in

Published By :

**ABD PUBLISHERS & PRINTERS (P) LTD.**

Distributed By : **VBD PUBLICATIONS (P) LTD.**

Plot No. 236, Near Ram Coolers, Besides Ganesh Temple, Singada Market,  
Navi Shukrawari, Mahal, Nagpur-18 Ph. : 0712-272235/36, 7620266004

ISBN : 978-93-87037-14-4



9 789387 1037144

# **PHARMACEUTICS - I**

**Semester - I, B. Pharm.**

**By**

**Dr. Gouri R. Dixit**

**M.Pharm., Ph.D.**

**Assistant Professor, Dept. of  
Pharmaceutics**

**Priyadarshini J.L. College of  
Pharmacy, Nagpur**

**Dr. Suparna Bakhle**

**M.Pharm., Ph.D.**

**Associate Professor, Dept. of  
Pharmaceutics**

**Priyadarshini J.L. College of  
Pharmacy, Nagpur**

**Dr. Kanchan P. Upadhye**

**M.Pharm., Ph.D.**

**Associate Professor, Dept. of Pharmaceutics  
Priyadarshini J.L. College of Pharmacy, Nagpur**

## **SALIENT FEATURES**

- **100% coverage of PCI Syllabus.**
- **Prepared in Simple and Lucid Language.**
- **Viva-Voce from practical point of view.**
- **Glossary of difficult terms.**
- **Points to Remember and Exercises after each chapter.**

**STRICTLY AS PER NEW PCI SYLLABUS**

**Distributed by:**

**VBD Publications Pvt. Ltd.**

**477, Golchha Marg, Sadar, Nagpur - 440001.**

**Sales Office :**

**Plot No. 236, Near Ram Coolers,**

**Besides Ganesh Temple,**

**Singada Market, Navi Shukrawari,**

**Mahal, Nagpur - 32**

**☎: 0712 - 2722235, 7620266004, Fax : 0712 - 2722236**

**Website : www.vbdpublications.com**

**E-mail : vbdbooks@gmail.com**

**© Publishers**

**ISBN : 978-93-87037-14-4**

**Price : Rs. 250/-**

**Edition : 2019**

फोटोकॉपी (झेराक्स) करने से मैटर बहुत छोटा हो जाता है और इसे पढ़ने से आपकी आँखें कमजोर होती हैं।  
As per Indian Copyright Act 1957, photocopying of a book is punishable under law.

**Books Available At ALL LEADING BOOK SELLERS  
OR CONTACT:**

**VIJAY BOOK DEPOT,  
GOLCHHA MARG, SADAR, NAGPUR**

**Ph. No. 0712 - 2520496**

**For online purchases, please visit [WWW.VBDPUBLICATIONS.COM](http://WWW.VBDPUBLICATIONS.COM)**

*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 without the prior written permission of the publisher.*

Note: While every care and precautions have been taken regarding the contents and data of this book, the publisher does not hold responsibility for any error or omissions. Please refer prescribed text books. Any dispute will be subject to Nagpur Jurisdiction only.

**Published by : ABD Publishers & Printers Pvt. Ltd., Nagpur.**

**PHARMACEUTICS - I (B.Pharm I SEM)**

## CONTENTS

### CHAPTER - 1

1.1	Introduction	1
1.2	History of Pharmacy profession	2
1.3	History of Pharmacy profession in India	6
1.4	Pharmacy Education in India	7
1.5	Pharmaceutical industry	11
1.6	Pharmacy as a career	15
1.7	History of pharmacopoeias	20
	1.7.1 Indian pharmacopoeia	21
	1.7.2 British pharmacopoeia	26
	1.7.3 United states pharmacopoeia	30
	1.7.4 The extra pharmacopoeia	33
1.8	Points to remember	35
1.9	Exercise	36

### CHAPTER - 2

2.1	Introduction	39
	2.1.1 Need of dosage form	39
	2.1.2 Desired properties of a dosage form	40
2.2	Classification of dosage form	41
2.3	Definitions of dosage forms	43
	2.3.1 Solid dosage forms	43
	2.3.2 Liquid dosage forms	49
	2.3.3 Semisolid dosage form	54
	2.3.4 Gaseous dosage forms	57
2.4	Points to remember	57
2.5	Exercise	58

### CHAPTER - 3

3.1	Introduction	61
3.2	Prescription	61
	3.2.1 Parts of prescription	62
	3.2.2 Handling of prescription	66
3.3	Errors in prescription	74
	3.3.1 Sources of errors in prescription	75
	3.3.2 Medication errors	77
	3.3.3 Prescribing faults	81
	3.3.4 Common types of medication errors	84

3.3.5 Medication errors due to failure to follow label instruction	
3.3.6 Medication error prevention	85
3.3.7 Achieving balanced prescribing	86
3.4 Points to remember	88
3.5 Exercise	89
<b>CHAPTER - 4</b>	89
4.1 Introduction	
4.2 Factors affecting posology	93
4.3 Pediatric dose calculations	94
4.4 Solved example	99
4.5 Points to remember	101
4.6 Exercise	104
<b>CHAPTER - 5</b>	105
5.1 Introduction	
5.2 Weights and measures	109
5.3 Measurement systems	109
5.4 Percentage solutions	110
5.5 Solved examples	117
5.6 Alligation method	118
5.7 Solved examples	120
5.8 Proof spirit	122
5.9 Solved examples	127
5.10 Isotonic solutions	127
5.10.1 Calculation of Isotonicity	129
5.11 Solved examples	130
5.12 Complete list of formulae	133
5.13 Problems for practice	135
5.14 Points to remember	136
5.15 Exercise	137
<b>CHAPTER - 6</b>	138
6.1 Introduction	141
6.2 Preparations of powders	142
6.3 Classification of powders	143
6.4 Advantages and disadvantages of powders	156
6.5 Preparation of powders	157
6.6 Problems encountered in powder incorporation	160

6.7	Points to remember	162
6.8	Exercise	163
<b>CHAPTER - 7</b>		
7.1	Introduction	167
7.2	Advantages and disadvantages of liquid dosage forms	167
7.3	Excipients : characteristics, advantages disadvantages, selection	168
7.4	Excipients used in formulation of liquid dosage forms	171
7.5	Solubility enhancement techniques	179
7.6	Points to remember	184
7.8	Exercise	185
<b>CHAPTER - 8</b>		
8.1	Introduction	189
8.2	Advantages and disadvantages of monophasic liquids	190
8.3	Formulation of monophasic liquids	190
8.4	Methods of preparation	194
8.5	Solutions used for oral-topical use	195
8.6	Points to remember	209
8.7	Exercise	210
<b>CHAPTER - 9</b>		
9.1	Introduction	213
9.2	Advantages and disadvantages of suspensions	214
9.3	Classification of suspension	215
9.4	Preparation of suspension	219
9.5	Flocculated and deflocculated suspensions	232
9.6	Suspension stability problems	234
9.7	Methods to overcome suspension stability	237
9.8	Points to remember	239
9.9	Exercise	239
<b>CHAPTER - 10</b>		
10.1	Introduction	243
10.2	Classification of emulsions	243
10.3	Advantages and disadvantages of emulsions	246
10.4	Identification test of emulsions	247
10.5	Emulsifying agents	250
10.6	Preparation of emulsions	257
10.7	Stability problems of emulsions	262
10.8	Points to remember	271
10.9	Exercise	272



<b>CHAPTER - 11</b>	
11.1 Introduction	275
11.2 Types of suppositories	276
11.3 Advantages and disadvantages of suppository	277
11.4 Types of suppository bases	278
11.5 Method of preparation	284
11.6 Displacement value and its calculation	289
11.7 Solved example	290
11.8 Evaluation of suppositories	292
11.9 Stability problem	295
11.10 Packing of suppositories	297
11.11 List of formula	297
11.12 Points to remember	297
11.13 Exercise	298
<b>CHAPTER - 12</b>	
12.1 Introduction	307
12.2 Classification of incompatibilities	301
12.3 Physical incompatibility	302
12.4 Chemical incompatibility	306
12.5 Therapeutic incompatibility	310
12.6 Points to remember	317
12.7 Exercise	317
<b>CHAPTER - 13</b>	
13.1 Introduction	321
13.2 Classification of semisolid dosage forms	323
13.3 Structure of human skin	324
13.4 Mechanism of dermal penetration of drugs	326
13.5 Factors influencing the drug penetration of drug	329
13.6 Excipients used in semisolid dosage forms	333
13.7 Preparation of semisolids	340
13.8 Evaluation of semisolid dosage forms	361
13.9 Points to remember	368
13.10 Exercise	369
<b>VIVA-VOCE</b>	373
<b>Glossary</b>	401
<b>Index</b>	405

# TPS "Textbook"

**Technical Pharmacy Series**

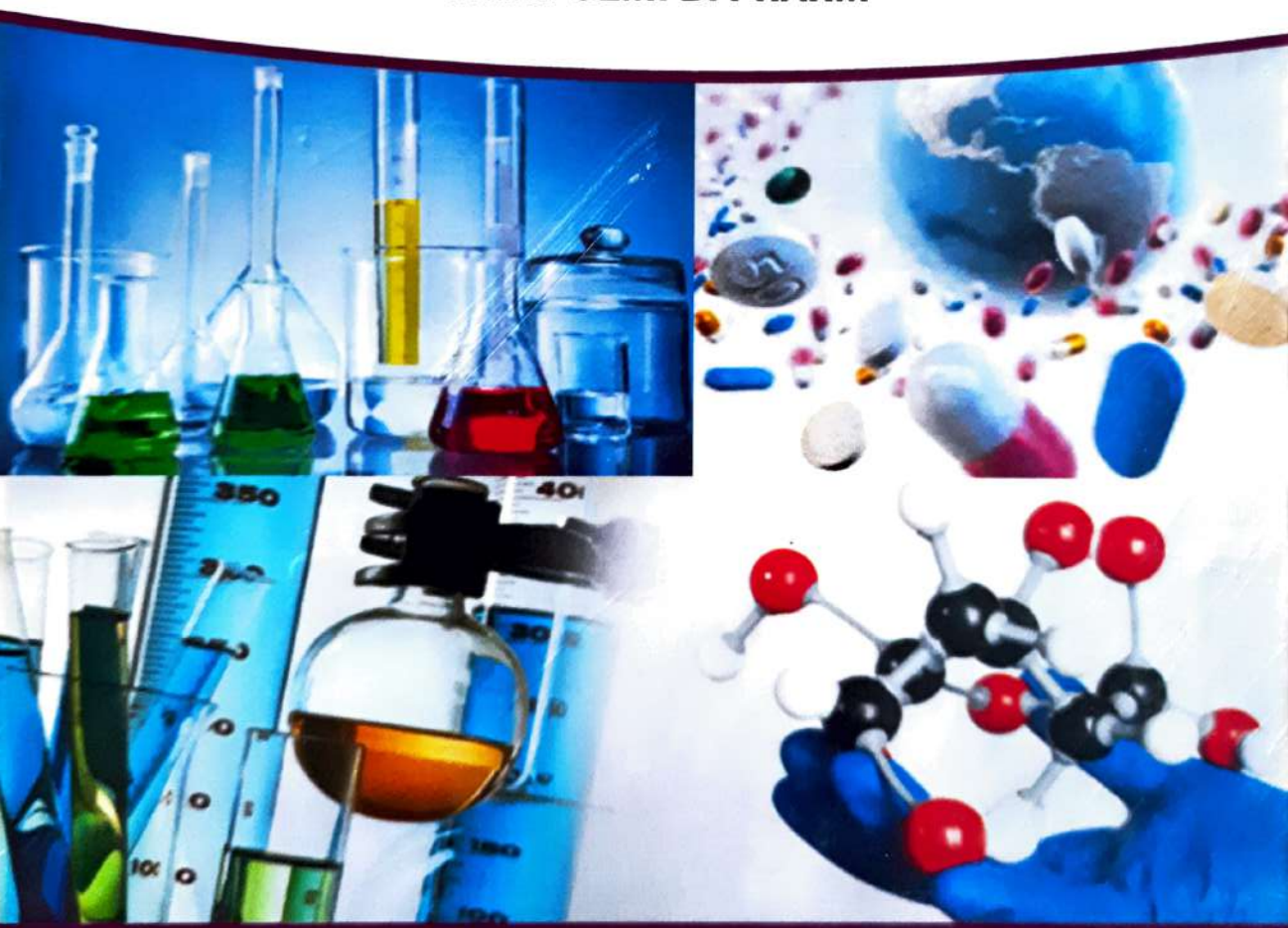
Strictly Based On PCI Syllabus



## PHYSICAL PHARMACEUTICS - I

WITH  
VIVA-VOCE

THIRD SEM. B. PHARM



For On-line Purchases, Please Visit  
[vbdpublications.com](http://vbdpublications.com) OR [amazon.in](http://amazon.in)

- ▶ Dr. (Mrs). K. P. Upadhye
- ▶ Dr. (Mrs). G. R. Dixit
- ▶ Dr. (Mrs). S. S. Bakhle

## About the Book

This textbook is based on the syllabus prescribed by the Pharmacy Council of India. The salient features of this book are:

- Full coverage of PCI syllabus.
- Points to Remember & Exercises.
- Easy to understand language.
- Viva-voce for practical examination.

## About the Authors



**Dr. (Mrs.) Kanchan Upadhye** is working as an Associate Professor in Pharmaceutics in Priyadarshini J. L. College of Pharmacy since last 21 years. In these years she has taught the subject of Physical Pharmaceutics for about 14 year. She has guided approximately 20 M. Pharm students and has to her credit various publications and presentations in national and international journals. She has also filed three patents. She is an approved Ph.D. guide in Pharmaceutical Sciences.



**Dr. (Mrs.) Gouri R. Dixit** has completed her B. Pharm., M. Pharm., and Ph. D. from R.T.M. Nagpur University, Nagpur. She has total 18 years of UG and 10 years of PG and research experience. Presently she is working as Assistant Professor, Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur. She has published and presented many papers in national and international journals and conferences of repute. She has guided about 20 students at master level. She is the life member of APTI and MAPAI.



**Dr. (Mrs.) S. S. Bakhle** is currently an Associate Professor at Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur. She did her graduation, post graduation from Department of Pharmaceutical Sciences, Nagpur and obtained her Doctorate degree from R.T.M Nagpur University, Nagpur. She worked as a lecturer with Institute of Pharmaceutical Education and Research, Wardha and is working with Priyadarshini J. L. College of Pharmacy, Nagpur since 2000. She has a total teaching experience of about 22 years till date, has guided 15 students for M. Pharm, published several research papers in various national and international journals and has filed a patent. She has contributed a chapter "Diffusion and Dissolution" in the book entitled "Physicochemical Principles of Pharmaceutics" published by Himalaya Publishing House.

### OUR HIGHLY RECOMMENDED TEXTBOOKS FOR B. PHARM III SEM.

Subjects	Author Name
Pharmaceutical Organic Chemistry-II	Dr. D. P. Kawade, Dr. A. J. Asnani, Dr. D. R. Chaple
Physical Pharmaceutics-I	Dr. K. P. Upadhye, Dr. G. R. Dixit, Dr. S. S. Bakhle
Pharmaceutical Microbiology	Vijay R. Tahilyani
Pharmaceutical Engineering	Dr. S. S. Bakhle, Dr. K. P. Upadhye, Dr. G. R. Dixit

For On-line Purchases, Please Visit

[vbdpublications.com](http://vbdpublications.com) OR [amazon.in](http://amazon.in)

Pullshed By :

**ABD PUBLISHERS & PRINTERS (P) LTD.**

Distributed By : **VBD PUBLICATIONS (P) LTD.**

Plot No. 236, Near Ram Coolers, Besides Ganesh Temple, Singada Market,  
Navi Shukrawari, Mahal, Nagpur-18 Ph. : 0712-2722235/36, 7620266004

ISBN : 978-93-87037-18-2



Distributed by:  
VBD Publications Pvt. Ltd.  
477, Golchha Marg, Sadar, Nagpur - 440001.

Sales Office.

Plot No. 236, Near Ram Coolers,  
Besides Ganesh Temple,  
Singada Market, Navi Shukrawari,  
Mahal, Nagpur - 32

☎: 0712-2722235, 7620266004, Fax. 0712-2722236

Website. [www.vbdpublications.com](http://www.vbdpublications.com)

E-mail. [vbdbooks@gmail.com](mailto:vbdbooks@gmail.com)

© Publishers

**ISBN : 978-93-87037-18-2**

Price. Rs. 160/-

**Edition. 2019**

फोटोकॉपी (डिस्क) करने से मैटर बहुत छोटा हो जाता है और इसे पढ़ने से आपकी आँखें कमजोर होती हैं।  
As per Indian Copyright Act 1957, photocopying of a book is punishable under law.

Books Available At ALL LEADING BOOK SELLERS  
OR CONTACT:  
VIJAY BOOK DEPOT,  
GOLCHHA MARG, SADAR, NAGPUR  
Ph. No. 0712 - 2520496

**For online purchases, please visit [WWW.VBDPUBLICATIONS.COM](http://WWW.VBDPUBLICATIONS.COM)**

*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 without the prior written permission of the publisher.*

Note: While every care and precautions have been taken regarding the contents and data of this book, the publisher does not hold responsibility for any error or omissions. Please refer prescribed text books. Any dispute will be subject to Nagpur Jurisdiction only.

**Published by. ABD Publishers & Printers Pvt. Ltd., Nagpur.**

# CONTENTS

## UNIT - I :

1.1	Introduction	1
1.1.1	Some important definitions	2
1.1.2	Solubility expressions	2
1.2	Mechanisms of solvent-solute interactions	3
1.3	Ideal solubility parameters	6
1.4	Solvation and association	10
1.5	Factors affecting solubility of drugs	11
1.6	Diffusion principles in biological systems	14
1.6.1	Gastrointestinal drug absorption	14
1.6.2	Percutaneous drug absorption	15
1.7	Solubility of gases in liquids	16
1.7.1	Factors affecting solubility of gases in liquids	16
1.8	Solubility of liquids in liquids	18
1.8.1	Ideal and non ideal solutions	18
1.8.2	Raoult's law	19
1.8.3	Applications of critical solution temperature	23
1.9	Distribution law	23
1.9.1	Deviations from distribution law	24
1.9.2	Applications of distribution law	25
1.9.3	Limitations of distribution law	26
1.10	Points to remember	26
1.11	Exercise	27

## UNIT - II

### (a) States of matter and properties of matter :

2.1	Introduction	34
2.2	States of matter	35
2.3	Changes in the states of matter	36
2.4	Latent heats	37

2.5	Vapour pressure	39
2.5.1	Factors affecting vapour pressure	40
2.5.2	Methods for measuring vapour pressure	41
2.6	Sublimation	42
2.7	Critical point	44
2.8	Eutetic mixture	46
2.8.1	Applications of eutectic mixtures	47
2.9	Gas	49
2.9.1	Gas laws	49
2.9.2	Kinetic molecular theory of gases	56
2.10	Aerosols inhalers	58
2.10.1	Inhalers	59
2.11	Relative humidity	61
2.12	Liquid complexes	63
2.13	Liquid crystals	64
2.13.1	Lyotropic liquid crystal	65
2.13.2	Thermotropic liquid crystals	67
2.13.3	Metallotropic liquid crystals	67
2.13.4	Applications of liquid crystals	68
2.14	Glassy states	69
2.14.1	Types of glassy states	71
2.15	Solids	71
2.15.1	Types of solids	71
2.15.2	Properties of crystals	72
2.15.3	Classification of crystals	74
2.16	Polymorphism	75
2.16.1	Types of allotropy	76
2.16.1	Detection of polymorphism	76
2.16.2	Pharmaceutical significance of polymorphism	77
(b)	<b>Physicochemical properties of drug molecules</b>	
2.17	Introduction	79
2.18	Refractive index	80
2.18.1	Measurement of refractive index	82

2.18.2 Applications of refractive index	89
2.19 Optical rotation	89
2.19.1 Plane polarised light	89
2.19.2 Optical activity	90
2.19.3 Measurement of optical rotation	91
2.19.4 Applications	92
2.20 Dielectric constant	92
2.20.1 Measurement of dielectric constant	93
2.20.2 Applications	93
2.21 Dipole moment	94
2.21.1 Measurement of dipole moment	95
2.21.2 Applications of dipole moment	96
2.22 Dissociation constant	96
2.22.1 Methods of determination of dissociation constant	98
2.22.2 Applications of dissociation constant	99
2.23 Points to remember	100
2.24 Exercise	103

### UNIT - III :

3.1 Introduction	111
3.2 Liquid interface	112
3.3 Surface and interfacial tension	113
3.3.1 Methods for measurement of surface and interfacial tension	115
3.4 Surface free energy	122
3.5 Spreading coefficient	122
3.5.1 Factors affecting spreading	125
3.6 Adsorption	126
3.6.1 Adsorption at liquid interface	126
3.6.2 Surfactants	126
3.6.3 HLB scale	129
3.6.4 Applications of surfactants	132
3.6.5 Adsorption at solid interfaces	137
3.7 Points to remember	144
3.8 Exercise	146

**UNIT - IV :**

4.1	Introduction	151
4.2	Classification of complexes	151
4.3	Applications of complexation	163
4.4	Methods to determine complexes	164
4.5	Protein binding	174
	4.5.1 Methods to study protein binding	177
4.6	Complexation and drug action	178
4.7	Thermodynamic treatment of stability constant	183
4.8	Crystalline structure of complexes	185
4.9	Points to remember	186
4.10	Exercise	187

**UNIT - V :**

5.1	Introduction	191
5.2	Sorensen's pH scale	191
5.3	Determination of pH	194
5.4	Buffers	199
5.5	Applications of buffer	202
5.6	Buffer equation	202
	5.6.1 Significance of buffer equation	204
5.7	Buffer capacity	205
	5.7.1 Maximum buffer capacity	207
5.8	Buffers in pharmaceutical and biologic systems	207
5.9	Buffered isotonic solutions	209
	5.9.1 Measurement of tonicity	211
	5.9.2 Methods of adjusting tonicity	212
5.10	Points to remember	219
5.11	Exercise	221
	<b>VIVA-VOCE</b>	225
	<b>Glossary</b>	249
	<b>Index</b>	261



# TPS

**Technical Pharmacy Series**

*Strictly Based On PCI Syllabus*



## PHARMACEUTICAL ENGINEERING



**THIRD SEM. B. PHARM**



For On-line Purchases, Please Visit  
[vbdpublications.com](http://vbdpublications.com) OR [amazon.in](http://amazon.in)

- ▶ **Dr. (Mrs). S. S. Bakhle**
- ▶ **Dr. (Mrs). K. P. Upadhye**
- ▶ **Dr. (Mrs). G. R. Dixit**

## About the Book

This textbook is based on the syllabus prescribed by the Pharmacy Council of India. The salient features of this book are:

- Full coverage of PCI syllabus.
- Easy to understand language.
- Points to Remember & Exercises.
- Viva-voce for practical examination.

## About the Authors



**Dr. (Mrs.) S. S. Bakhle** is currently an Associate Professor at Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur. She did her graduation, post graduation from Department of Pharmaceutical Sciences, Nagpur and obtained her Doctorate degree from R.T.M Nagpur University, Nagpur. She worked as a lecturer with Institute of Pharmaceutical Education and Research, Wardha and is working with Priyadarshini J. L. College of Pharmacy, Nagpur since 2000. She has a total teaching experience of about 22 years till date, has guided 15 students for M. Pharm, published several research papers in various national and international journals and has filed a patent. She has contributed a chapter "Diffusion and Dissolution" in the book entitled "Physicochemical Principles of Pharmaceutics" published by Himalaya Publishing House.



**Dr. (Mrs.) Kanchan Upadhye** is working as an Associate Professor in Pharmaceutics in Priyadarshini J. L. College of Pharmacy since last 21 years. In these years she has taught the subject of Physical Pharmaceutics for about 14 year. She has guided approximately 20 M. Pharm students and has to her credit various publications and presentations in national and international journals. She has also filed three patents. She is an approved Ph.D. guide in Pharmaceutical Sciences.



**Dr. (Mrs.) Gouri R. Dixit** has completed her B. Pharm., M. Pharm., and Ph. D. from R.T.M. Nagpur University, Nagpur. She has total 18 years of UG and 10 years of PG and research experience. Presently she is working as Assistant Professor, Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur. She has published and presented many papers in national and international journals and conferences of repute. She has guided about 20 students at master level. She is the life member of APTI and MAPAI.

### OUR HIGHLY RECOMMENDED TEXTBOOKS FOR B. PHARM III SEM.

Subjects	Author Name
Pharmaceutical Organic Chemistry-II	Dr. D. P. Kawade, Dr. A. J. Asnani, Dr. D. R. Chaple
Physical Pharmaceutics-I	Dr. K. P. Upadhye, Dr. G. R. Dixit, Dr. S. S. Bakhle
Pharmaceutical Microbiology	Vijay R. Tahilyani
Pharmaceutical Engineering	Dr. S. S. Bakhle, Dr. K. P. Upadhye, Dr. G. R. Dixit

For On-line Purchases, Please Visit

[vbdpublications.com](http://vbdpublications.com) OR [amazon.in](http://amazon.in)

Published By :

**ABD PUBLISHERS & PRINTERS (P) LTD.**

Distributed By : **VBD PUBLICATIONS (P) LTD.**

Plot No. 236, Near Ram Coolers, Besides Ganesh Temple, Singada Market,  
Navi Shukrawari, Mahal, Nagpur-18 Ph. : 0712-2722235/36, 7620266004

ISBN : 978-93-87037-20-5



# **PHARMACEUTICAL ENGINEERING**

**Semester - III, B. Pharm.**

**By**

**Dr. (Mrs.) S. S. Bakhle**

**M. Pharm, Ph. D.**  
Associate Professor  
Pharmaceutics Department  
Priyadarshini J. L College of  
Pharmacy, Nagpur.

**Dr. (Mrs.) K. P. Upadhye**

**M. Pharm, Ph. D.**  
Associate Professor  
Pharmaceutics Department  
Priyadarshini J. L College of  
Pharmacy, Nagpur.

**Dr. (Mrs.) G. R. Dixit**

**M. Pharm, Ph. D.**  
Assistant Professor, Pharmaceutics Department,  
Priyadarshini J. L College of Pharmacy, Nagpur.

## **SALIENT FEATURES**

- 100% coverage of PCI Syllabus.
- Prepared in **Simple and Lucid Language**.
- **Viva-Voce** from practical point of view.
- **Glossary** of difficult terms.
- **Points to Remember and Exercises** after each chapter.

**STRICTLY AS PER NEW PCI SYLLABUS**

# CONTENTS

## CHAPTER - 1

1.1	Introduction	1
1.2	Fluid statics	2
1.2.1	Difference in pressure between layers of fluid	2
1.2.2	Applications of fluid statics	4
1.2.3	Manometers	4
1.2.4	Simple manometer	5
1.2.5	Differential manometers	6
1.2.6	Inclined manometer	7
1.3	Fluid dynamics	8
1.3.1	Nature of fluid flow : Reynold's experiment	8
1.4	Bernoulli's theorem	12
1.5	Energy losses	15
1.5.1	Frictional losses	15
1.5.2	Losses in fittings	16
1.5.3	Enlargement losses	17
1.5.4	Contraction losses	17
1.6	Measurement of rate of flow of fluids	17
1.6.1	Direct weighing or measuring devices	18
1.6.2	Hydrodynamic methods	18
1.7	Points to remember	25
1.8	Exercise	26

## CHAPTER - 2

2.1	Introduction	31
2.2	Objectives of size reduction	32
2.2.1	Disadvantages of size reduction	33
2.3	Mechanisms of size reduction	34
2.4	Theory and laws governing size reduction	35
2.4.1	Mechanical behavior of solids	35

2.4.2	Theory of size reduction	36
2.4.3	Laws governing size reduction/ energy of comminution	37
2.5	Size reduction equipments	39
2.5.1	General parts of size reduction equipment	40
2.5.2	Hammer mill	41
2.5.3	Ball mill	44
2.5.4	Fluid energy mill	47
2.5.5	Edge runner mill	49
2.5.6	End runner mill	51
2.6	Factors influencing size reduction	52
2.6.1	Factors related to the nature of raw materials	53
2.6.2	Factors related to the nature of finished product	55
2.7	Points to remember	56
2.8	Exercise	57
<b>CHAPTER - 3</b>		
3.1	Introduction	65
3.2	Objectives and applications of size separation	65
3.3	Mechanisms of size separation	66
3.3.1	Modes of motion in size separation	67
3.4	Official standards for powders	69
3.5	Sieves	70
3.5.1	Types of sieves	71
3.5.2	Standards for sieve	72
3.5.3	Specifications for sieve	73
3.6	Sieve shaker machine	74
3.7	Cyclone separator	75
3.8	Air separator	77
3.9	Bag filter	78
3.10	Size separation by sedimentation and elutriation	81
3.10.1	Sedimentation tanks	81
3.10.2	Continuous sedimentation tank	82

<b>3.10.3</b> Elutriation methods	83
<b>3.11</b> Points to remember	85
<b>3.12</b> Exercise	86
<b>CHAPTER - 4</b>	
<b>4.1</b> Introduction	91
<b>4.2</b> Objectives of heat transfer	91
<b>4.3</b> Applications of heat transfer	92
<b>4.4</b> Mechanisms of heat transfer	92
<b>4.4.1</b> Conduction	93
<b>4.4.2</b> Convection	94
<b>4.4.3</b> Radiation	94
<b>4.5</b> Heat transfer by conduction	95
<b>4.5.1</b> Fourier's law	95
<b>4.5.2</b> Thermal conductivity	98
<b>4.5.3</b> Heat transfer through compound resistance in series	99
<b>4.6</b> Heat transfer by convection	100
<b>4.6.1</b> Heat transfer between fluid and solid boundary	101
<b>4.7</b> Heat transfer by radiation	104
<b>4.7.1</b> Stefan-Boltzmann law	105
<b>4.8</b> Heat exchangers and heat interchangers	106
<b>4.8.1</b> Heaters or heat exchangers	106
<b>4.8.2</b> Heat interchangers	113
<b>4.9</b> Points to remember	119
<b>4.10</b> Exercise	121
<b>CHAPTER - 5</b>	
<b>5.1</b> Introduction	127
<b>5.2</b> Objectives, applications and factors influencing evaporation	128
<b>5.3</b> Difference between evaporation and other heat processes	131
<b>5.4</b> Classification of evaporators	132
<b>5.4.1</b> Evaporating pan/steam jacketed kettle	132
<b>5.4.2</b> Horizontal tube evaporator	134
<b>5.4.3</b> Climbing film evaporator	136

5.4.4	Forced circulation evaporator	140
5.4.5	Multiple effect evaporators	142
5.4.6	Methods of feeding in multiple effect evaporator	145
5.5	Economy of the evaporator	148
5.6	Capacity of evaporator	149
5.7	Points to remember	150
5.8	Exercise	152
<b>CHAPTER - 6</b>		
6.1	Introduction	157
6.2	Basic principles of distillation	158
6.2.1	General equipments for distillation	158
6.2.2	Distillation methods	159
6.3	Methodology of simple distillation	160
6.3.1	Assembly of simple distillation unit on a laboratory scale	160
6.3.2	Simple distillation unit on industrial scale	162
6.3.3	Preparation of purified water and water for injection by distillation	163
6.4	Flash distillation	164
6.5	Distillation under reduced pressure	167
6.5.1	Distillation under reduced pressure on large scale	171
6.6	Steam distillation	171
6.6.1	Theory of steam distillation	172
6.6.2	Steam distillation unit on an industrial scale	174
6.7	Fractional distillation	175
6.7.1	Theory	176
6.7.2	Boiling point diagram	176
6.7.3	Assembly of fractional distillation unit (lab scale)	178
6.7.4	Assembly of fractional distillation unit (industrial scale)	181
6.7.5	Fractionating columns	182
6.7.6	Types of mixtures of miscible liquids	186

<b>6.8</b>	Molecular distillation	188
<b>6.8.1</b>	Principle	188
<b>6.8.2</b>	Theory	189
<b>6.8.3</b>	Characteristics of molecular distillation process	190
<b>6.8.4</b>	Falling film molecular still or wiped film molecular still	190
<b>6.8.5</b>	Centrifugal molecular still	192
<b>6.8.6</b>	Applications	193
<b>6.9</b>	Points to remember	194
<b>6.10</b>	Exercise	196
<b>CHAPTER - 7</b>		
<b>7.1</b>	Introduction	201
<b>7.2</b>	Difference between drying and evaporation	203
<b>7.4</b>	Applications of drying	203
<b>7.3</b>	Objectives of drying	204
<b>7.5</b>	Drying of wet solids	205
<b>7.5.1</b>	Mechanism of drying	207
<b>7.5.2</b>	Rate of drying curve	208
<b>7.5.3</b>	Measurement and applications of equilibrium moisture content (emc)	211
<b>7.6</b>	Classification of dryers	213
<b>7.7</b>	Points to remember	233
<b>7.8</b>	Exercise	235
<b>CHAPTER - 8</b>		
<b>8.1</b>	Introduction	241
<b>8.2</b>	Types of mixtures	242
<b>8.3</b>	The mixing process	242
<b>8.4</b>	Objectives of mixing	244
<b>8.5</b>	Applications of mixing	245
<b>8.6</b>	Difference between solid and liquid mixing	245
<b>8.7</b>	Mechanism of mixing in solids	246
<b>8.7.1</b>	Factors affecting mixing	247



8.7.2	Classification of equipments for solid mixing	248
8.8	Mixing of miscible liquids and suspensions	259
8.8.1	Mechanism of liquid mixing	259
8.8.2	Factors influencing mixing	260
8.8.3	Mixing equipment	261
8.8.4	Mixing devices / impellers	262
8.9	Mixing of immiscible liquids	268
8.10	Mixing of semi-solids	270
8.11	Points to remember	271
8.12	Exercise	274
<b>CHAPTER - 9</b>		
9.1	Introduction	
9.2	Objectives and applications of filtration	281
9.3	Mechanisms of filtration	282
9.4	Types of filtration	283
9.5	Theories of filtration	286
9.5.1	Poiseuille's equation	287
9.5.2	Darcy's equation	288
9.5.3	Kozeny-Carman equation	288
9.6	Factors influencing filtration	289
9.7	Filter medium	290
9.8	Filter aid	292
9.9	Filtration equipments	294
9.10	Points to remember	316
9.11	Exercise	319
<b>CHAPTER - 10</b>		
10.1	Introduction	325
10.2	Applications of centrifugation in pharmaceutical industries	325
10.3	Principles of centrifugation	327
10.4	Types of centrifuges	329
10.5	Points to remember	338

10.6 Exercise	340
<b>CHAPTER - 11</b>	
11.1 Introduction	345
11.2 Factors influencing selection of materials for pharmaceutical plant	345
11.3 Classification of materials for pharmaceutical plant	349
11.4 Points to remember	362
11.5 Exercise	363
<b>CHAPTER - 12</b>	
12.1 Introduction	369
12.2 Importance of corrosion	371
12.3 Theories of corrosion	371
12.4 Types of corrosion	375
12.5 Factors influencing corrosion	382
12.6 Prevention and control of corrosion	384
12.7 Points to remember	389
12.8 Exercise	390
<b>CHAPTER - 13</b>	

**10.6 Exercise**

**CHAPTER - 11**

**11.1 Introduction**

**11.2 Factors influencing selection of materials  
for pharmaceutical plant**

**11.3 Classification of materials for pharmaceutical plant**

**11.4 Points to remember**

**11.5 Exercise**

**CHAPTER - 12**

**12.1 Introduction**

**12.2 Importance of corrosion**

**12.3 Theories of corrosion**

**12.4 Types of corrosion**

**12.5 Factors influencing corrosion**

**12.6 Prevention and control of corrosion**

**12.7 Points to remember**

**12.8 Exercise**

**CHAPTER - 13**

**13.1 Introduction**

**13.2 Basics of material handling system**

**13.2.1 Objectives of material handling**

**13.2.3 Material handling equipments**

**13.3 Points to remember**

**13.4 Exercise**

**VIVA-VOCE**

**Glossary**

**Index**

**Distributed by:**

**VBD Publications Pvt. Ltd.**

**477, Golchha Marg, Sadar, Nagpur - 440001.**

**Sales Office :**

**Plot No. 236, Near Ram Coolers,**

**Besides Ganesh Temple,**

**Singada Market, Navi Shukrawari,**

**Mahal, Nagpur - 32**

**☎: 0712-2722235, 7620266004, Fax : 0712-2722236**

**Website : www.vbdpublications.com**

**E-mail : vbdbooks@gmail.com**

**© Publishers**

**ISBN : 978-93-87037-20-5**

**Price : Rs. 250/-**

**Edition : 2019**

फोटोकॉपी (झेराक्स) करने से मैटर बहुत छोटा हो जाता है और इसे पढ़ने से आपकी आँखें कमजोर होती हैं।  
As per Indian Copyright Act 1957, photocopying of a book is punishable under law.

**Books Available At ALL LEADING BOOK SELLERS**

**OR CONTACT:**

**VIJAY BOOK DEPOT,**

**GOLCHHA MARG, SADAR, NAGPUR**

**Ph. No. 0712 - 2520496**

**For online purchases, please visit WWW.VBDPUBLICATIONS.COM**

*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 without the prior written permission of the publisher.*

Note: While every care and precautions have been taken regarding the contents and data of this book, the publisher does not hold responsibility for any error or omissions. Please refer prescribed text books. Any dispute will be subject to Nagpur Jurisdiction only.

**Published by : ABD Publishers & Printers Pvt. Ltd., Nagpur.**

# TPS

**Technical Pharmacy Series**

*Strictly Based On PCI Syllabus*



# INDUSTRIAL PHARMACY - I

**PART - I**

VIVA

**FIFTH SEM. B. PHARM**



For On-line Purchases, Please Visit

[vbdpublications.com](http://vbdpublications.com) OR [amazon.in](http://amazon.in)

- ▶ **Yogesh N. Gholse**
- ▶ **Dr. Rahul H. Kasliwal**
- ▶ **Dr. Dinesh R. Chaple**

## About the Book

This textbook is based on the syllabus prescribed by the Pharmacy Council of India. The salient features of this book are:

- Full coverage of PCI syllabus.
- Points to Remember & Exercises.
- Easy to understand language.
- Viva-voce for practical examination.

## About the Authors



**Yogesh N. Gholve**, The author has completed D. Pharm. (2004), B. Pharm. (2007) and M. Pharm. (Industrial Pharmacy) (2009). Currently he is pursuing Ph. D. from RTMNU, Nagpur. He is registered as a life member of APTI and The Indian Science Congress Association. He has published over 08 research papers/communications in national journals and 07 research papers/communications in International journals. The author also attended over 19 national and international conference and workshop. He also guided 09 students for UG research project. He has also delivered 04 guest lectures. Presently he has been working as

Assistant professor in Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur.



**Dr. R. H. Kasliwal**, He has completed D. Pharm. (1998), B. Pharm. (2001) and M. Pharm. (2003) from IPER, Wardha. Later on in 2008 he completed his Ph. D. (Pharmaceutics) from RTMNU, Nagpur. He is registered with the Pharmacy Council of India and as a life member of IPA and MAPAI. His research concern was the formulation and fabrication of controlled drug delivery system of water soluble drugs. He has published seven patents and over 3 research papers/communications in national journals and 14 research papers/communications in international journals. The author also attended over 25 national and international conference and workshop. He also guided 09 students for UG research project and 16

students for PG research work. Presently he has been working as Assistant professor in Department of Pharmaceutics, Priyadarshini J. L. College of Pharmacy, Nagpur. He is approved supervisor and examiner of different universities at UG and PG levels



**Dr. Dinesh R. Chaple**, has been working as Principal at Priyadarshini J. L. College of Pharmacy, Nagpur since 2010. He has completed B. Pharm. (1988) and M. Pharm. (1990). Later on in 2010 he completed his Ph. D. (Pharmaceutical Chemistry) from RTMNU, Nagpur. He possesses about 29 years of experience in academics. He is registered with the Pharmacy Council of India and as a life member of The Indian Pharmaceutical Association, Indian Society for Technical Education, Association of Pharmaceutical Teachers In India. He has published over 28 research papers/communications in national journals and 13 research papers/communications in international journals. The author also attended more than 25

national and international conference and workshop. He has authored a book entitled "Spectrophotometric Estimation of Fluroquinolones antibacterial agent: Ion-Pair with acid dyes". He also guided 9 students for UG research project, 31 students for PG research work and 01 students of Ph.D. He is approved Ph. D. supervisor and examiner of different universities at UG and PG levels.

## OUR HIGHLY RECOMMENDED TEXTBOOKS FOR B. PHARM V SEM.

Subjects	Author Name
Medicinal Chemistry-II	Debarshi Kar Mahapatra, Mrs. Ruchi S. Shivhare
Industrial Pharmacy - I	Yogesh N. Gholve, Dr. R. H. Kasliwal, Dr. D.R. Chaple
Pharmacology-II	Md. H. Shaikh, Md. R. Y. Shaikh, Ms. H. V. Sonaye
Pharmacognosy And Phytochemistry-II	Dr. R. A. Sahu, Mrs. R. R. Mishra, M. P. Sonekar
Pharmaceutical Jurisprudence	Ms. Harsha V. Sonaye, Md. Rafik Y. Shaikh

For On-line Purchases, Please Visit

[vbdpublications.com](http://vbdpublications.com) OR [amazon.in](http://amazon.in)

Published By :

**ABD PUBLISHERS & PRINTERS (P) LTD.**

Distributed By : **VBD PUBLICATIONS (P) LTD.**

Plot No. 236, Near Ram Coolers, Besides Ganesh Temple, Singada Market,  
Navi Shukrawari, Mahal, Nagpur-18 Ph. : 0712-272235/36, 7620266004

ISBN : 978-93-87037-22-9



# **INDUSTRIAL PHARMACY - I**

**Semester - V, B. Pharm.**

By

**Yogesh N. Gholve**

M. Pharm. (Indl. Pharm.)  
Assistant Professor,  
Department of Pharmaceutics,  
Priyadarshini J.L. College of  
Pharmacy, Nagpur.

**Dr. Dinesh R. Chaple**

M. Pharm. Ph. D.  
(Pharmaceutical Chemistry)  
Principal,  
Priyadarshini J.L. College of  
Pharmacy, Nagpur.

**Dr. Rahul H. Kasliwal**

M. Pharm. Ph. D. (Pharmaceutics)  
Assistant Professor,  
Department of Pharmaceutics,  
Priyadarshini J.L. College of Pharmacy, Nagpur.

## **SALIENT FEATURES**

- 100% coverage of PCI Syllabus.
- Prepared in **Simple and Lucid Language**.
- **Viva-Voce** from practical point of view.
- **Glossary** of difficult terms.
- **Points to Remember and Exercises** after each unit.

**STRICTLY AS PER NEW PCI SYLLABUS**

**Distributed by:**  
**VBD Publications Pvt. Ltd.**  
**477, Golchha Marg, Sadar, Nagpur - 440001.**

**Sales Office :**  
**Plot No. 236, Near Ram Coolers,**  
**Besides Ganesh Temple,**  
**Singada Market, Navi Shukrawari,**  
**Mahal, Nagpur - 32**  
**☎: 0712-2722235, 7620266004, Fax : 0712-2722236**  
**Website : www.vbdpublications.com**  
**E-mail : vbdbooks@gmail.com**

© **Publishers**

**ISBN : 978-93-87037-22-9**

**Price : Rs. 340/-**

**Edition : 2019**

फोटोकॉपी (ड्रैगक्स) करने से मैटर बहुत छोटा हो जाता है और इसे पढ़ने से आपकी आँखें कमजोर होती हैं।  
 As per Indian Copyright Act 1957, photocopying of a book is punishable under law.

**Books Available At ALL LEADING BOOK SELLERS  
 OR CONTACT:  
 VIJAY BOOK DEPOT,  
 GOLCHHA MARG, SADAR, NAGPUR  
 Ph. No. 0712 - 2520496**

**For online purchases, please visit [WWW.VBDPUBLICATIONS.COM](http://WWW.VBDPUBLICATIONS.COM)**

*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 without the prior written permission of the publisher.*

Note: While every care and precautions have been taken regarding the contents and data of this book, the publisher does not hold responsibility for any error or omissions. Please refer prescribed text books. Any dispute will be subject to Nagpur Jurisdiction only.

**Published by : ABD Publishers & Printers Pvt. Ltd., Nagpur.**



## CONTENTS OF PART I

### UNIT - I

1.1	Introduction	1
1.2	Goals and objectives	2
1.3	Study of physicochemical characteristics of drug substances	3
1.4	Physical properties	4
1.5	Chemical properties	19
1.6	BCS classification of drugs and its significance	23
1.7	Application of preformulation considerations in the development of solid dosage forms and its impact on stability	33
1.8	Application of preformulation considerations in the development of liquid oral dosage forms and its impact on stability	36
1.9	Application of preformulation considerations in the development of parenteral dosage forms and its impact on stability	38
1.10	Points to remember	43
1.11	Exercise	44

### UNIT - II

#### Tablets :

2.1	Introduction	49
2.2	Definition	50
2.3	Ideal characteristics of tablets	51
2.4	Classification of tablets	52
2.5	Excipients	55
2.6	Formulation of tablets	62

2.7	Granulation methods	66
2.8	Compressions	75
2.9	Processing problems	80
2.10	Equipments and tablet tooling	91
2.11	Tablet coating	97
2.12	Types of coating	100
2.13	Coating materials	100
2.14	Formulation of coating composition	108
2.15	Methods of coating	211
2.16	Equipment employed	126
2.17	Quality control tests	131
2.17.1	In process and finished product tests	131
2.17.2	IPQC and FPQC test for pharmaceutical tablets according to pharmacopoeias are listed below	133
<b>Liquid orals :</b>		
2.18	Introduction	141
2.18.1	Formulation and manufacturing consideration of syrups	142
2.19	Formulation and manufacturing consideration of elixirs	151
2.20	Formulation and manufacturing consideration of suspensions	155
2.21	Formulation and manufacturing consideration of emulsions	167
2.22	Filling and packaging	182
2.23	Evaluation of liquid orals official in pharmacopoeia	186
2.24	Points to remember	192
2.25	Exercise	195

**UNIT - III****Capsule :**

<b>3.1</b>	Introduction	199
<b>3.2</b>	Definition	200
<b>3.3</b>	Hard gelatin capsules	201
<b>3.3.1</b>	Production of hard gelatin capsule shells	204
<b>3.3.2</b>	Size of capsules	209
<b>3.3.3</b>	Filling and finishing	210
<b>3.3.4</b>	Special techniques of formulation of hard gelatin capsules	222
<b>3.3.5</b>	Manufacturing defects	249
<b>3.3.6</b>	In-process and final product quality control tests for capsules	256
<b>3.4</b>	Soft gelatin capsules	258
<b>3.4.1</b>	Nature of shell	261
<b>3.4.2</b>	Capsule content	265
<b>3.4.3</b>	Size of capsules	267
<b>3.4.4</b>	Importance of base adsorption and minimum /gram factors	268
<b>3.4.5</b>	Production	271
<b>3.4.6</b>	In-process and final product quality control tests	275
<b>3.4.7</b>	Packing and storage	278
<b>3.4.8</b>	stability testing of soft gelatin capsules	280
<b>3.4.9</b>	Applications	283
<b>Pellets :</b>		
<b>3.5</b>	Introduction	288
<b>3.6</b>	Formulation requirements	292
<b>3.7</b>	Pelletization process	301
<b>3.8</b>	Equipments for manufacture of pellets	318
<b>3.9</b>	Points to remember	328
<b>3.10</b>	Exercise	332

## CONTENTS OF PART II

### UNIT - IV

#### Parenteral products :

		335
4.1	Introduction	
4.2	Definition, types, advantages and limitations of parenteral product	336
4.3	Preformulation factors	342
4.4	Essential requirements, vehicles and additives	346
4.5	Importance of isotonicity	354
4.6	Production procedure, production facilities, controls and aseptic processing	358
4.7	Formulation of injections	365
4.8	Formulation of sterile powders	374
4.9	Formulation of large volume parenterals	376
4.10	Formulation of lyophilized products	378
4.11	Containers and closures selection, filling and sealing of ampoules	382
4.12	Containers and closures selection, filling and sealing of vials	385
4.13	Containers and closures selection, filling and sealing of infusion fluids	386
4.14	Quality control tests of parenteral products, ophthalmic preparations	398

#### Ophthalmic Preparations :

		410
4.15	Introduction	
4.16	Definition, properties, characteristics, types of ophthalmic dosage forms	411
4.17	Formulation considerations	413
4.18	Eye drops	418

4.19	Eye lotions	425
4.20	Eye ointments	430
4.21	Evaluation of ophthalmic preparations	433
4.22	Points to remember	449
4.23	Exercise	450

## UNIT - V

### Cosmetics :

5.1	Introduction	453
5.2	Formulation and preparation of the lipsticks	454
5.3	Formulation and preparation of the shampoos	458
5.4	Formulation and preparation of the cold cream	464
5.5	Formulation and preparation of the vanishing cream	465
5.6	Formulation and preparation of the tooth pastes	467
5.7	Formulation and preparation of the hair dyes	472
5.8	Formulation and preparation of the sunscreens	475

### Pharmaceutical aerosols :

5.9	Introduction	477
5.10	Propellants	478
5.11	Containers	482
5.12	Valves	484
5.13	Actuators	489
5.14	Types of aerosol systems	491
5.15	Formulation of aerosols	494
5.16	Manufacture of aerosols	495
5.17	Evaluation of aerosols	500
5.18	Quality control	505
5.19	Stability studies	509

**Packaging material science :**

<b>5.20</b>	Introduction	511
<b>5.21</b>	Materials used for packaging of pharmaceutical products	512
<b>5.22</b>	Factors influencing choice of containers	538
<b>5.23</b>	Legal and official requirements for containers	542
<b>5.24</b>	Stability aspects of packaging materials	550
<b>5.25</b>	Quality control tests	551
<b>5.26</b>	Points to remember	563
<b>5.27</b>	Exercise	566

**VIVA-VOCE**

571

**Glossary**

595

**Index**

607