Textbook of
Pharmacognosy and Phytochemistry II
Theory and Practical Course Codes BP504T and BP508P
for **Fifth Semester Bachelor in Pharmacy**

is aimed to serve as a complete textbook for the fifth semester students of Bachelor in Pharmacy covering both theoretical and practical parts as per the latest syllabus prescribed by the Pharmacy Council of India (Course Codes BP504T and BP508P).

The main objective of this book is to provide students with the knowledge of how secondary metabolites are generated in crude drugs, and how they are isolated and identified, and produced industrially. Also, the subject includes the study of chemistry and chemical classes, biosources, therapeutic uses, and commercial applications of drugs containing secondary metabolites. Upon completion of the study of this book, students will be able to use modern extraction techniques, characterization and identification, isolation, and identification of phytoconstituents of herbal medicines and phytoconstituents.

This book gives a comprehensive treatment of various metabolic pathways, modern extraction methods, separation methods, and spectroscopy techniques. It strikes a balance between essential and advanced areas of knowledge, apart from general topics. The subject matter is comprehensive and written in an easy to follow language, is suitably illustrated with well-labelled diagrams and contains tables in both the theoretical and practical parts.

Md Rafiul Haque MPharm PhD
is a member of faculty at School of Pharmacy, Al-Karim University, Katihar, Bihar. He obtained his PhD (Pharmacognosy and Phytochemistry), BPharm (2006) and MPharm (2009) from School of Pharmaceutical Education and Research (SPER), Hamdard University, New Delhi. He obtained AICTE Fellowship during his tenure in MPharm. He worked as a Senior Research Fellow in the CCRUM Project, Department of AYUSH, New Delhi, and in various unit operations of Hamdard Lab (India), Manesar, Gurugram (Haryana). He has great work experience in the field of teaching, industry, and research. He has published various research articles in international reputed journals and a few papers in national journals of repute, and also presented papers at many national and international conferences. He is GATE qualified and has been honored by the institute for his dynamic contribution to the growth of the organization. He is an active member of the IPA. He is a reviewer of various journals like *Pharmaceutical Biology, Toxicology Mechanisms and Methods.*

Dedicated to Education
CBSPD
CBS Publishers & Distributors Pvt Ltd
4819/XI, Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India
E-mail: delhi@cbspd.com, customercare@cbspd.com; Website: www.cbspd.com
New Delhi | Bengaluru | Chennai | Kochi | Kolkata | Lucknow | Mumbai
Hyderabad | Jharkhand | Nagpur | Patna | Pune | Uttarakhand

Scan for the price of this book and catalogue

ISBN: 978-93-5466-449-6

Textbook of **Pharmacognosy and Phytochemistry II** Haque

CBSPD

Textbook of
Pharmacognosy and Phytochemistry II
Theory and Practical
Course Codes BP504T and BP508P
for **Fifth Semester Bachelor in Pharmacy**
As per the latest syllabus prescribed by Pharmacy Council of India

Md Rafiul Haque

50 Years in Publishing
Dedicated to Education

CBSPD Dedicated to Education
CBS Publishers & Distributors Pvt Ltd

Textbook of Pharmacognosy and Phytochemistry II

Theory and Practical

Course Codes BP504T and BP508P

for Fifth Semester Bachelor in Pharmacy

As per the latest syllabus prescribed by Pharmacy Council of India

Textbook of Pharmacognosy and Phytochemistry II

Theory and Practical

Course Codes BP504T and BP508P

for Fifth Semester Bachelor in Pharmacy

As per the latest syllabus prescribed by Pharmacy Council of India

Md Rafiul Haque M Pharm PhD
School of Pharmacy
Al-Karim University, Katihar, Bihar

CBSPD

CBS Publishers & Distributors Pvt Ltd

New Delhi • Bengaluru • Chennai • Kochi • Kolkata • Lucknow • Mumbai

Hyderabad • Jharkhand • Nagpur • Patna • Pune • Uttarakhand

Disclaimer

Science and technology are constantly changing fields. New research and experience broaden the scope of information and knowledge. The author has tried his best in giving information available to him while preparing the material for this book. Although all efforts have been made to ensure optimum accuracy of the material, yet it is quite possible some errors might have been left uncorrected. The publisher, the printer and the author will not be held responsible for any inadvertent errors or inaccuracies.

Textbook of
Pharmacognosy and Phytochemistry II
Theory and Practical

Course Codes BP504T and BP508P
for Fifth Semester Bachelor in Pharmacy
As per the latest syllabus prescribed by Pharmacy Council of India

ISBN: 978-93-5466-449-6

Copyright © Author and Publisher

First Edition: 2023

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system without permission, in written, from the author and the publisher.

Published by Satish Kumar Jain and produced by Varun Jain for
CBS Publishers & Distributors Pvt Ltd
4819/XI Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India
Ph: 011-23289259, 23266861, 23266867 Fax: 011-23243014
Website: www.cbspd.com e-mail: delhi@cbspd.com; cbspubs@airtelmail.in

Corporate Office: 204 FIE, Industrial Area, Patparganj, Delhi 110 092, India
Ph: 011-49344934 Fax: 011-49344935 e-mail: publishing@cbspd.com; publicity@cbspd.com

Branches

- **Bengaluru:** Seema House 2975, 17th Cross, K.R. Road, Banasankari 2nd Stage, Bengaluru 560 070, Karnataka, India
  Ph: +91-80-26771678/79 Fax: +91-80-26771680 e-mail: bangalore@cbspd.com
- **Chennai:** 7, Subbaraya Street, Shenoy Nagar, Chennai 600 030, Tamil Nadu, India
  Ph: +91-44-26680620, 26681266 Fax: +91-44-42032115 e-mail: chennai@cbspd.com
- **Kochi:** 42/1325, 1326, Power House Road, Opposite KSEB, Power House, Ernakulum 682 018, Kochi, Kerala, India
  Ph: +91-484-4059061–67 Fax: +91-484-4059065 e-mail: kochi@cbspd.com
- **Kolkata:** 147, Hind Ceramics Compound, 1st Floor, Nilgunj Road, Belghoria, Kolkata 700 056, West Bengal, India
  Ph: +91-33-25330055/56 e-mail: kolkata@cbspd.com
- **Lucknow:** Basement, Khushuma Complex, 7 Meerabai Marg (behind Jawahar Bhawan), Lucknow 226 001, UP, India
  Ph: +91-522-4000032 e-mail: tiwari.lucknow@cbspd.com
- **Mumbai:** PWD Shed, Gala No. 25/26, Ramchandra Bhatt Marg, Next JJ Hospital Gate No. 2,
  Opp. Union Bank of India, Noorbaug, Mumbai 400 009, Maharashtra, India
  Ph: +91-22-66661880/89 e-mail: mumbai@cbspd.com

Representatives

• **Hyderabad**	0-9885175004	• **Jharkhand**	0-9811541605	• **Nagpur**	0-9421945513
• **Patna**	0-9334159340	• **Pune**	0-9923910676	• **Uttarakhand**	0-9716462459

Printed at: Glorious Printers, Dayaganj, Delhi, India.

Preface

It is a pleasure for the students of the fifth semester (3rd year) of BPharm to get acquainted with the first edition of *Textbook of Pharmacognosy and Phytochemistry II* as per the new PCI regulation. This book has both theoretical and practical parts for the convenience of students and teachers.

The theoretical part of this book is designed to provide basic knowledge on metabolic pathways and the formation of various secondary metabolites via the shikimic acid pathway, acetate pathway, and amino acid pathway and their determination through the use of radioactive isotopes in biogenetic studies.

This book will help in understanding the basic concepts of extraction of plant material, separation or isolation of active chemical constituents, and characterization or structure interpretation through spectroscopy techniques. In the theoretical part of this book, the chemistry and chemical classes, biosources, therapeutic uses, and commercial applications of drugs containing secondary metabolites such as alkaloids, glycosides, flavonoids, resins, volatiles, steroids and iridoids are discussed. The isolation, industrial production, identification, and uses of some important plant components are also discussed in this book.

The experimental part of this book is designed to provide basic practical knowledge on morphology, histology, and powder characteristics and the detection of cinchona, cinnamon, senna, clove, ephedra, and fennel, coriander, etc. Using this book will also help in understanding basic practical knowledge on extraction and isolation of some important active phytoconstituents and analysis of some unconsolidated crude oils (asafoetida, benzoin, colophony, aloe, myrrh) with the help of chemical tests.

The subject matter is illustrated with well-designed diagrams and tables. This book will be beneficial for the students as well as the professors.

Suggestions and criticisms are welcome.

Md Rafiul Haque

Contents

Preface *v*

Syllabus *xi*

Theory

1. Metabolic Pathways in Higher Plants and their Determination 3

Introduction 3
Biosynthesis 4
Shikimic acid pathway (SAP) 5
Acetate pathways 9
Amino acid pathway 14
Study of the utilization of radioactive isotopes in the investigation of biogenetic studies 16

2. Plant Secondary Metabolites Containing Drugs 22

Introduction 22
Types of Secondary Metabolites 22
Alkaloids 23
Vinca/Periwinkle 26
Rauwolfia/sarpagandha 27
Belladonna 29
Opium/poppy plant 30
Phenylpropanoids and Flavonoids 31
Phenylpropanoids 31
Lignan 32
Tea 33
Ruta 34
Volatile Oils 35
Mentha oil 35
Cinnamon 36
Clove bud 37
Fennel fruit 38
Coriander 38
Tannin 39
Pale Catechu 40
Black catechu 40
Pterocarpus (Kino) 41
Resins 42
Asafoetida 42
Guggulu 43
Sumatra benzoin (Indonesia) 44
Siam benzoin (Thailand) 45
Ginger 45
Myrrh 47
Colophony 48
Anthraquinones glycosides 49
Senna 50
Aloe Vera 51
Bitter almond 53
Cardiac glycosides 55
Digitalis 56
Tetracyclic triterpenoid saponin or steroidal saponins 58
Dioscorea 59
Triterpenoid saponins 59
Liquorice 60
Iridoid 61
Gentian 62
Artemisia 63
Taxus 64
Carotenoids 65

3. Isolation, Identification, and Analysis of Phytoconstituents 69

Introduction 69
Menthol 70
Citral 71
Artemisinin 72
Glycyrrhetinic acid 73
Rutin 74
Atropine 75
Quinine 76
Reserpine 78
Caffeine 79
Podophyllotoxin 81
Curcumin 82

4. Industrial Production, Estimation, and Utilization of the Phytoconstituents 86

Introduction 86
Forskolin 87
Sennosides 91
Artemisinin 93
Diosgenin 95
Digoxin 96
Atropine 98
Podophyllotoxin 99
Caffeine 101
Taxol 102
Vincristine and vinblastine 103

5. Basics of Phytochemistry 107

Introduction 107
Maceration (soaking) 112
Ultrasonication assisted extraction (UAE) 120
Supercritical fluid extraction (SFE) 121
Separation method 124
Spectroscopy technique 136
Electrophoresis 141

Practical

Experiment 1 147

Senna 147
Cinchona 149
Cinnamon 151
Clove 153
Fennel 155
Coriander 157
Nux-vomica 158
Ginger 160
Ipecac 163
Datura 164
Ephedra 167

Experiment 2 170

Caffeine 170
Introduction 170
Diosgenin 170
Introduction 170
Atropine 171
Introduction 171
Sennosides 172
Introduction 172

Experiment 3 173

Paper chromatography 173
Introduction 173
Thin Layer chromatography 175
Introduction 175
Distillation of volatile oils and detection of phytoconstituents by TLC 175
Introduction 175

Experiment 4 178

Asafoetida 178
Benzoin 179
Colophony 180
Aloes 181
Myrrh 183

Important Reagents used in Pharmacognosy Laboratory 185

Important Terms used in Pharmacognosy and Phytochemistry 188

Index 195

Syllabus

PHARMACOGNOSY AND PHYTOCHEMISTRY II

THEORY

Course Code BP504T **45 Hours**

Scope: The main purpose of subject is to impart the students the knowledge of how the secondary metabolites are produced in the crude drugs, how to isolate and identify and produce them industrially. Also this subject involves the study of producing the plants and phytochemicals through plant tissue culture, drug interactions and basic principles of traditional system of medicine

Objectives: Upon completion of the course, the student shall be able

1. to know the modern extraction techniques, characterization and identification of the herbal drugs and phytoconstituents
2. to understand the preparation and development of herbal formulation.
3. to understand the herbal drug interactions
4. to carryout isolation and identification of phytoconstituents

Course Content

UNIT I **7 Hours**

- **Metabolic pathways in higher plants and their determination**

a. Brief study of basic metabolic pathways and formation of different secondary metabolites through these pathways—shikimic acid pathway, acetate pathways and amino acid pathway.

b. Study of utilization of radioactive isotopes in the investigation of biogenetic studies.

UNIT II **14 Hours**

General introduction, composition, chemistry and chemical classes, biosources, therapeutic uses and commercial applications of following secondary metabolites:

- **Alkaloids:** Vinca, rauwolfia, belladonna, opium,
- **Phenylpropanoids and flavonoids:** Lignans, Tea, Ruta
- **Steroids, cardiac glycosides and triterpenoids:** Liquorice, dioscorea, digitalis
- **Volatile oils:** Mentha, clove, cinnamon, fennel, coriander,
- **Tannins:** Catechu, pterocarpus
- **Resins:** Benzoin, guggul, ginger, asafoetida, myrrh, colophony

- **Glycosides:** Senna, aloes, bitter almond
- **Iridoids, other terpenoids and naphthaquinones:** Gentian, artemisia, taxus, carotenoids

UNIT III **06 Hours**

Isolation, identification and analysis of phytoconstituents

a. **Terpenoids:** Menthol, citral, artemisin
b. **Glycosides:** Glycyrhetinic acid and rutin
c. **Alkaloids:** Atropine, quinine, reserpine, caffeine
d. **Resins:** Podophyllotoxin, curcumin

UNIT IV **10 Hours**

Industrial production, estimation and utilization of the following phytoconstituents: Forskolin, sennoside, artemisinin, diosgenin, digoxin, atropine, podophyllotoxin, caffeine, taxol, vincristine and vinblastine

UNIT V **8 Hours**

Basics of Phytochemistry: Modern methods of extraction, application of latest techniques like spectroscopy, chromatography and electrophoresis in the isolation, purification and identification of crude drugs.

PRACTICAL

Course Code BP508P **4 Hours/Week**

1. Morphology, histology and powder characteristics and extraction and detection of: Cinchona, cinnamon, senna, clove, ephedra, fennel and coriander
2. Exercise involving isolation and detection of active principles
   - Caffeine from tea dust.
   - Diosgenin from dioscorea
   - Atropine from belladonna
   - Sennosides from senna
3. Separation of sugars by paper chromatography
4. TLC of herbal extract
5. Distillation of volatile oils and detection of phytoconstitutents by TLC
6. Analysis of crude drugs by chemical tests: (i) Asafoetida; (ii) benzoin; (iii) colophony; (iv) aloes; (v) myrrh