

Pharmacognosy and Phytochemistry (Theory)

BP205T

A Textbook for B. Pharm II Semester Students
*As per the new Pharmacy Council of India (PCI)
Syllabus 2026 (NEP 2020)*

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Preface

Pharmacognosy sits at the meeting point of botany, chemistry, and pharmacy, and this book is built around a single idea that ties those strands together: the structure of a natural molecule governs what it does in the body, and the way a plant builds that molecule explains where it is found and how it is recognised. From the first chapter on biosynthetic pathways to the last on isolation and identification, the same thread runs through every crude drug, so that naming the chemical class of a constituent brings its origin, its chemical test, its solvent, and its action with it.

The book follows the B. Pharm syllabus for Pharmacognosy and Phytochemistry (BP205T) and is written for undergraduate pharmacy students meeting the subject as a formal course for the first time. It assumes the general chemistry and biology of the earlier years and builds from there, defining each term as it arrives and returning to it in later chapters so that the vocabulary becomes second nature. Five chapters map onto the five units of the syllabus, moving from the metabolic pathways that generate secondary metabolites, through the crude drugs that contain primary and secondary metabolites, to the practical work of extracting, separating, and identifying their constituents. Each chapter opens with its learning outcomes, develops the material through worked reasoning rather than lists to be memorised, and closes with a summary and a graded set of self-assessment questions aligned to the examination.

Every figure has been drawn to be read in print: the biosynthetic pathways as clean flowcharts, the crude-drug groups as classification trees, and the key constituents as accurate chemical structures. The tables gather the comparisons that examinations reward, and a glossary together with a consolidated table of identification tests closes the book for quick revision. The aim throughout has been a text rigorous enough to satisfy the syllabus and readable enough to be understood, so that the student finishes not with a set of facts to recall but with a way of reasoning about medicinal plants.

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Course Objectives

The objectives of this course are to:

1. Understand major metabolic pathways and the biogenetic origin of primary and secondary phytoconstituents, including the use of modern tools for pathway studies.
2. Study and interpret the pharmacognostic features of crude drugs containing primary metabolites such as carbohydrates, proteins/enzymes, and lipids.
3. Study and interpret the pharmacognostic features of crude drugs containing secondary metabolites such as alkaloids, glycosides, tannins, resins, volatile oils, flavonoids, phenolics, and terpenoids.
4. Impart knowledge of conventional and modern extraction techniques and enable selection of appropriate extraction methods.
5. Develop competency in isolation, identification, characterization, and quality evaluation of medicinal plants and botanicals.

Course Outcomes

Upon successful completion of this course, the students will be able to:

1. Describe biosynthetic pathways and genetic tools involved in phytoconstituent production.
2. Classify and explain drugs containing primary and secondary metabolites.
3. Apply traditional and modern extraction and isolation methods.
4. Explain qualitative and quantitative analysis of plant metabolites.
5. Evaluate identity, purity, and quality of herbal raw materials

Syllabus

Unit	Topics	No. of lectures
I	Metabolic Pathways and Biogenetic Studies Brief study of basic metabolic pathways and biosynthesis of secondary metabolites including: • Shikimic acid pathway • Acetate pathway • Amino acid pathways Utilization of radioactive isotopes in biogenetic studies. Introduction to pathway prediction tools and modern genetic tools such as CRISPR/Cas9.	10 Hours
II	Primary Metabolites General classification and identification tests Pharmacognostic study (biological source, distribution, identifying characters, chemical constituents, specific tests, therapeutic uses, and commercial applications) of: Carbohydrates: Acacia, Agar, Tragacanth, Honey Proteins and Enzymes: Gelatin, Casein; Proteolytic enzymes: Papain, Bromelain, Serratiopeptidase, Urokinase, Streptokinase, Pepsin Lipids (Waxes, Fats, Fixed Oils): Castor oil, Olive oil, Cocoa butter, Wool fat, Beeswax	12 Hours
III	Secondary Metabolites General classification and identification tests Pharmacognostic study (biological source, distribution, cultivation of underlined drugs, identifying characters, chemical constituents, specific tests, therapeutic uses, and commercial applications) of: Alkaloids: Vinca, Rauwolfia, Opium Volatile Oils: Lemongrass, Clove, Cinnamon, Fennel Tannins: Myrobalans, Catechu, Pomegranate Resins: Guggul, Asafoetida Glycosides: Senna, Liquorice, Digitalis Phenylpropanoids and Flavonoids: Green Tea, Ginkgo, Flax seed Iridoids, Other Terpenoids and Naphthoquinones: Gentian, Artemisia	12 Hours

IV	Extraction Methods for Medicinal Plants Conventional Methods of Extraction: Infusion, Decoction, Digestion, Maceration, Percolation, Reflux, Distillation, Soxhlet extraction, Successive solvent extraction Modern Methods of Extraction: Supercritical fluid extraction, Microwave-assisted extraction, Ultrasonic-assisted extraction, Enzyme-assisted extraction, Pressurized liquid extraction	12 Hours
V	Overview of Isolation, Identification and Characterization Techniques Separation and Isolation Techniques: Planar chromatography, Column chromatography, Preparative TLC, Flash chromatography Identification Techniques: Phytochemical tests, Chromatographic techniques, Spectroscopic techniques Fingerprinting of medicinal plants using TLC/HPTLC Types and significance of markers (phytochemical reference standards) Screening and analysis of major metabolites: Alkaloids, Glycosides, Saponins, Tannins, Resins, Flavonoids, Phenolics, Steroids	14 Hours

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Chapter 1: Metabolic Pathways and Biogenetic Studies

Learning outcomes

After working through this chapter the student will be able to:

- 1. Distinguish primary from secondary metabolites and explain why a plant invests in compounds it does not need to stay alive.*
- 2. Trace the shikimic acid pathway from its two glycolytic precursors to the aromatic amino acids and the phenolic products that follow, and name the drug classes it supplies.*
- 3. Trace the acetate pathway through both its branches, the fatty-acid and polyketide branch and the mevalonate branch, and predict which natural product class each branch yields.*
- 4. Trace the amino acid pathways that build the major alkaloid skeletons, and match each amino acid precursor to the alkaloids it gives.*
- 5. Explain how a radioactive or stable isotope is fed to a plant, recovered in a metabolite, and located within it, and calculate percentage incorporation.*
- 6. Describe how pathway-prediction databases and CRISPR/Cas9 editing are used to map and re-route biosynthesis in medicinal plants.*

1.1 Introduction: Why a plant makes a poison it never uses

A foxglove leaf carries enough digoxin and digitoxin to stop a heart, yet the plant itself has no heart to stop. A poppy capsule is loaded with morphine, but the poppy feels no pain. This is the first puzzle of phytochemistry. A plant spends carbon, nitrogen, and energy building molecules that play no part in its own respiration, photosynthesis, or growth. Why?

The answer reframes the whole subject. These molecules are not metabolic accidents. They are the plant's chemistry of defence, attraction, and competition: alkaloids that poison a grazing insect, volatile oils that draw a pollinator, tannins that turn a wound astringent and shut out fungi, pigments that screen ultraviolet light. The plant gains nothing for its primary survival, so these compounds are called **secondary metabolites**. They are also, by a fortunate coincidence for medicine, the great majority of the drugs that pharmacognosy studies.

Understanding where these compounds come from is not an academic luxury. It is the most powerful organising idea in the subject. A constituent's pathway of origin predicts its chemical class, and the chemical class predicts its solubility, the colour test that detects it, the solvent that extracts it, and often its biological action. Learn the three pathways once, and the hundreds of drugs in the chapters that follow stop being a list to memorise and become a family tree to read. That is the first throughline of this book, and this chapter builds it.

Three carbon-and-nitrogen sources feed almost every secondary metabolite of pharmaceutical interest: acetate, shikimic acid, and a handful of amino acids. Each is itself a product of ordinary