BP105T · B.PHARM THEORY

BP105T INTRODUCTION TO PHARMACOGNOSY

Unit IV — Metabolites of Plant Origin and Traditional Systems of Medicine

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Syllabus coverage: Unit IV (12 hours).

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UNIT IV — METABOLITES OF PLANT ORIGIN & TRADITIONAL SYSTEMS

Chapter 15: Plant Metabolites — Definitions, General Properties, Primary Metabolites

15.1 Learning Objectives

After studying this chapter, the student will be able to:

1. Define metabolite, metabolism, primary metabolite and secondary metabolite.
2. Distinguish primary from secondary metabolites by function, distribution and examples.
3. Describe the general properties of primary metabolites: carbohydrates, proteins and lipids.
4. Give classic pharmacognostic examples of each primary metabolite with biological source and uses.

15.2 Introduction — The Chemistry Inside Every Plant

Every plant is a tiny chemical factory. From sunlight, water and air it manufactures thousands of chemicals — sugars for energy, proteins for building, oils for storage, and a dazzling collection of special chemicals like morphine, quinine and menthol. These plant-made chemicals are called **metabolites**, and they are the entire subject matter of pharmacognosy: almost every crude drug in Units I–III is valuable because of the metabolites it contains. This chapter draws the master map — **primary vs secondary metabolites** — and studies the primary group in detail.

15.3 Definitions

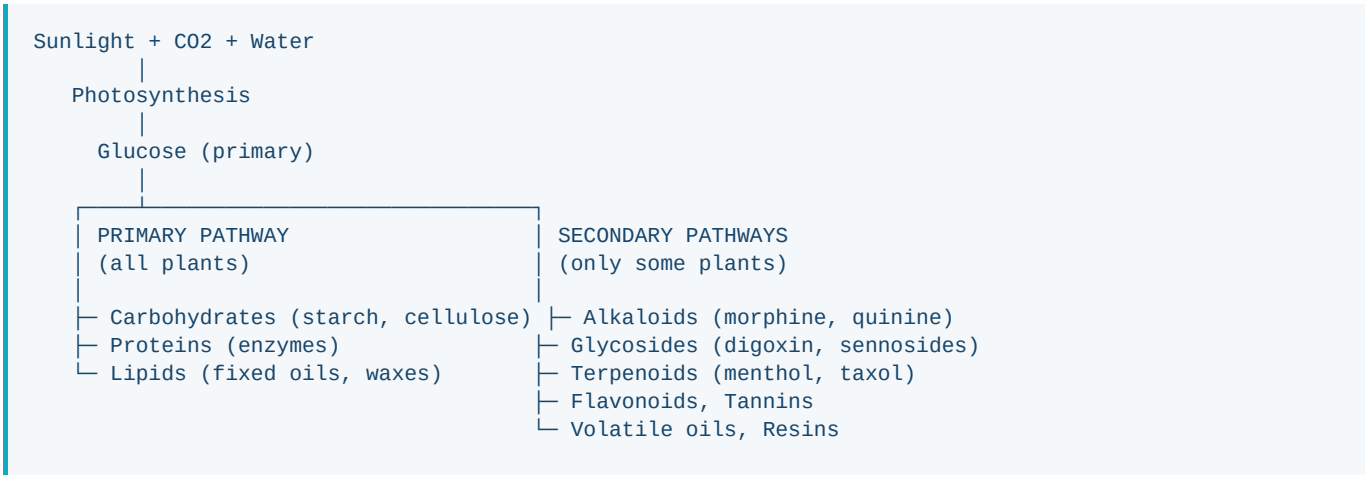
- **Metabolism:** the sum of all chemical reactions happening inside a living organism — building up and breaking down.
- **Metabolite:** any chemical substance produced by metabolism — i.e., any chemical a plant makes.
- **Anabolism:** building-up reactions (small molecules → big molecules, e.g., making starch from glucose).
- **Catabolism:** breaking-down reactions (big molecules → small molecules, releasing energy, e.g., glucose → energy during respiration).
- **Primary metabolite:** a chemical needed by **every plant** for basic life — growth, energy, reproduction (carbohydrates, proteins, lipids, nucleic acids).
- **Secondary metabolite:** a chemical **not** needed for basic survival, made only by **certain plants**, usually for protection, attraction or signalling — and very often the plant's **drug** (alkaloids, glycosides, flavonoids, tannins, terpenoids, volatile oils, resins).

Terminology alert. "Primary" does **not** mean "more important," and "secondary" does **not** mean "less important." Primary = needed for basic life; secondary = special-purpose chemicals. For a pharmacist, secondary metabolites are usually *more* important because they are the active constituents of drugs.

15.4 Primary vs Secondary Metabolites — The Master Distinction

Feature	Primary metabolites	Secondary metabolites
Function	basic life: energy, growth, reproduction	defence, attraction, signalling; not needed for basic survival
Distribution	found in **all** plants	found only in **specific** plants/families
Quantity	usually large amounts	usually small amounts
Examples	carbohydrates, proteins, lipids	alkaloids, glycosides, flavonoids, tannins, terpenoids, volatile oils, resins
Pharmaceutical role	excipients, nutrients, vehicles (starch, acacia, oils)	active constituents of drugs (morphine, quinine, digoxin)

Flowchart — the plant chemical factory:



Key takeaway. Primary metabolites keep the plant **alive**; secondary metabolites give the plant its **medicine**.

15.5 General Properties of Plant Metabolites

1. **They are organic compounds** — built mainly from carbon, hydrogen and oxygen (alkaloids also contain nitrogen).
2. **They are formed by enzyme-controlled pathways** — each step guided by a specific enzyme.
3. **Their amount varies** — with species, variety, age, season and environment (Unit II's nine factors apply here).
4. **They can be extracted** — with suitable solvents (water, alcohol) for study and manufacture.
5. **They show characteristic chemical tests** — colour or precipitate reactions used for identification (Chapters 16–17).

15.6 Carbohydrates — The Energy Currency

15.6.1 What they are

Carbohydrates are compounds of carbon, hydrogen and oxygen — the plant's food and fuel. Simple definition for exams: *"polyhydroxy aldehydes or ketones"* — molecules carrying many –OH groups with an aldehyde or ketone group. Built from simple **sugars (monosaccharides)** like glucose and fructose, joined into chains.

15.6.2 Classes (simple)

- **Monosaccharides** — single sugars: glucose, fructose (honey is mainly these two).
- **Disaccharides** — two sugars: sucrose (table sugar).
- **Polysaccharides** — long chains: **starch** (energy storage), **cellulose** (plant structure), **gums and mucilages** (acacia, agar — protective/colloidal).

15.6.3 Classic pharmacognostic examples

Drug	Biological source	Constituent type	Uses
Starch	Maize, potato, rice, wheat	polysaccharide (amylose + amylopectin)	tablet diluent/binder/disintegrant; dusting powder; nutrient
Acacia (gum arabic)	*Acacia* species (Fabaceae)	gum (polysaccharide)	emulsifier, suspending agent, demulcent, tablet binder
Agar	*Gelidium / Gracilaria* (red algae)	polysaccharide	laxative; culture medium in microbiology
Honey	Bees (*Apis* species)	invert sugar (glucose + fructose)	demulcent, sweetener, vehicle in cough syrups
Isabgol (psyllium)	*Plantago ovata* (Plantaginaceae)	mucilage (polysaccharide)	bulk laxative (Unit V drug — preview)

15.6.4 General properties of carbohydrate drugs

Sweet or tasteless, soluble in water (gums swell rather than dissolve), **insoluble in alcohol**, give characteristic tests (Molisch's test — violet ring — is the classic general test; Fehling's test for reducing sugars).

15.7 Proteins — The Builders and Workers

15.7.1 What they are

Proteins are long chains of **amino acids** joined by peptide bonds. They are the plant's builders (structure) and workers (**enzymes** — proteins that speed up chemical reactions).

15.7.2 Pharmacognostic importance

Most protein drugs are **enzymes** used therapeutically:

- **Papain** — from the latex of unripe *Carica papaya* fruit (Caricaceae); a protein-digesting enzyme used as a digestive aid and in food processing.
- **Bromelain** — from pineapple (*Ananas comosus*, Bromeliaceae); anti-inflammatory and digestive enzyme.
- **Gelatin** — protein from animal collagen (Unit I's animal sources); used for **capsule shells** — every pharmacist handles it daily.

15.7.3 General properties

Complex large molecules; destroyed (**denatured**) by heat, strong acids and alcohol — which is why enzyme drugs need careful storage; give protein colour tests (biuret test — violet colour).

> **Confusion guard.** Enzymes *are* proteins — not a separate class of metabolite. If an examiner asks "give a protein drug," papain or gelatin is correct.

15.8 Lipids — Fats, Fixed Oils and Waxes

15.8.1 What they are

Lipids are fatty, water-insoluble substances — mainly **triglycerides** (glycerol + three fatty acids). In pharmacognosy we meet them as **fixed oils** (liquid at room temperature), **fats** (solid), and **waxes**.

15.8.2 Fixed oils vs volatile oils — the great divide

Feature	Fixed oils (primary, this chapter)	Volatile oils (secondary, Chapter 17)
Evaporation	do **not** evaporate; leave a permanent grease stain	evaporate at room temperature; stain disappears
Composition	triglycerides of fatty acids	terpenes and aromatic compounds
Odour	little or no odour	strong characteristic odour
Uses	vehicles, emollients, laxatives	flavours, carminatives, antiseptics

> **Exam favourite.** The **grease-spot test**: a drop on paper — fixed oil leaves a permanent translucent stain; volatile oil's stain fades as it evaporates.

15.8.3 Classic pharmacognostic examples

Drug	Biological source	Uses
Castor oil	*Ricinus communis* (Euphorbiaceae)	purgative/laxative; vehicle
Sesame (til) oil	*Sesamum indicum* (Pedaliaceae)	vehicle; base for medicated oils (AYUSH taila — Chapter 18)
Olive oil	*Olea europaea* (Oleaceae)	emollient, vehicle
Theobroma (cocoa butter)	*Theobroma cacao* (Sterculiaceae)	suppository base
Beeswax	Bees (*Apis* species)	stiffening agent in ointments

15.8.4 General properties

Insoluble in water, soluble in organic solvents; fixed oils can become **rancid** (oxidation — Unit II storage enemies); characterised by analytical values — **acid value and saponification value** (Unit III parameters measure these).

15.9 Analogy

> If the plant is a **village**, primary metabolites are the **food, houses and roads** every village needs (carbohydrates = food grain, proteins = workers, lipids = stored fuel), while secondary metabolites are the village's **special crafts** — only some villages make them, but they are what traders travel miles to buy (morphine, quinine, menthol).

15.10 Pharmacy Relevance

- Primary metabolites are the **excipients** of pharmacy: starch (tablet base), acacia (emulsifier), theobroma oil (suppository base), gelatin (capsules), sesame oil (injections/AYUSH oils).
- Every **secondary-metabolite drug** (Chapters 16–17) is extracted from a plant that also contains primary metabolites — extraction must separate the two.
- Understanding this classification is the **key to all of Unit IV and V**: Unit V's phyto-therapeutic agents are organised by the secondary metabolites they contain.

15.11 India Context

India's pharmaceutical industry is built on primary-metabolite excipients (starch, acacia) and its AYUSH industry on both groups — churnas carry secondary metabolites in a matrix of primary ones. The **Indian Pharmacopoeia** includes monographs for starch, acacia, agar, gelatin, castor oil and sesame oil.

15.12 High-Yield Points

- **Primary** = all plants, basic life (carbohydrates, proteins, lipids); **secondary** = some plants, special functions (alkaloids, glycosides, etc.).
- Carbohydrate drugs: **starch, acacia, agar, honey, isabgol**; general test: Molisch's.
- Protein drugs: **enzymes** — papain (*Carica papaya*), bromelain; gelatin for capsules.
- **Fixed oils** (triglycerides, non-volatile, grease stain permanent) vs **volatile oils** (evaporate, stain fades).
- Fixed-oil drugs: **castor oil** (*Ricinus communis* — purgative), sesame oil, theobroma oil (suppository base).
- Acid value and saponification value characterise fixed oils.

15.13 Common Confusions & Mistakes

- **Confusion:** "primary = most important." **Clarification:** primary = basic-life chemicals; the *drug* is usually a secondary metabolite.
- **Confusion:** fixed oils vs volatile oils. **Clarification:** fixed = fatty, non-volatile (castor oil); volatile = aromatic, evaporating (eucalyptus oil). Different chapters, different chemistry.
- **Mistake:** listing morphine or quinine as primary metabolites. They are **secondary** — the commonest classification error in exams.
- **Mistake:** saying enzymes are a separate metabolite class. Enzymes **are proteins**.

15.14 Mnemonic

"CPL — Crops Provide Life": **C**arbohydrates, **P**roteins, **L**ipids = the primary trio every plant needs to live.

15.15 Chapter Summary

- **Metabolites** are chemicals plants make; **primary** metabolites serve basic life in all plants, **secondary** metabolites serve special functions in some plants and are usually the drugs.
- **Carbohydrates** (starch, acacia, agar, honey, isabgol): energy/storage/protective; water-soluble, alcohol-insoluble.
- **Proteins** (papain, bromelain, gelatin): builders and enzyme workers; denatured by heat.
- **Lipids** (castor oil, sesame oil, theobroma oil, beeswax): triglycerides; fixed oils are non-volatile and distinguished from volatile oils by the grease-spot test.

15.16 One-Minute Revision

- Primary vs secondary: all plants/basic life vs some plants/special function (drugs).
- CPL: carbohydrates (starch, acacia, agar, honey), proteins (papain, gelatin), lipids (castor oil, theobroma oil).
- Fixed vs volatile oils: grease stain permanent vs fading.
- Enzymes are proteins; morphine/quinine are secondary.

15.17 Questions

MCQs

1. Which of the following is a primary metabolite? (a) Morphine (b) Quinine (c) Starch (d) Atropine
2. Papain is obtained from: (a) *Carica papaya* (b) *Ricinus communis* (c) *Acacia* species (d) *Sesamum indicum*
3. The grease-spot test distinguishes: (a) alkaloids from glycosides (b) fixed oils from volatile oils (c) starch from sugar (d) proteins from enzymes
4. Agar is obtained from: (a) bacteria (b) red algae (c) bees (d) seeds
5. Theobroma oil is used as: (a) purgative (b) suppository base (c) emulsifier (d) sweetener

Viva

1. Define primary and secondary metabolites with two examples each.
2. Why are secondary metabolites pharmaceutically more important than primary ones?
3. Differentiate fixed oils and volatile oils.
4. Name two enzyme drugs with their biological sources.
5. What are acid value and saponification value used for?

Application-based

1. A tablet manufacturer needs a cheap diluent, a binder and a capsule shell material. Name one primary-metabolite drug for each and justify.
2. A student calls menthol a primary metabolite because mint needs it to smell. Correct the error using the primary/secondary criteria.

Answers: 1-(c), 2-(a), 3-(b), 4-(b), 5-(b)

15.18 References

- Evans WC. *Trease and Evans Pharmacognosy.* 16th ed. London: Saunders Elsevier; 2009.
- Tyler VE, Brady LR, Robbers JE. *Pharmacognosy.* 9th ed. Philadelphia: Lea & Febiger; 1988.
- Kokate CK, Purohit AP, Gokhale SB. *Pharmacognosy.* Pune: Nirali Prakashan.

Chapter 16: Secondary Metabolites I — Alkaloids and Glycosides

16.1 Learning Objectives

After studying this chapter, the student will be able to:

1. Define alkaloids and glycosides and state their general properties.
2. Classify alkaloids (true, proto, pseudo; ring-type table) and glycosides (by aglycone).
3. Perform and interpret the classic chemical tests: Mayer's, Dragendorff's, Wagner's, Hager's (alkaloids); Borntrager's, Legal's, Keller-Kiliani (glycosides).
4. Give classic examples with biological source, family, constituents and uses: atropine, morphine, quinine, caffeine, ephedrine, reserpine; senna, digitalis, glycyrrhiza.

16.2 Introduction — Nature's Most Powerful Medicines

If secondary metabolites are the village's special crafts (Chapter 15), **alkaloids and glycosides** are the masterpieces — the most potent, most famous plant drugs in history. Morphine kills pain, quinine killed malaria's grip, atropine dilates the pupil, digoxin steadies a failing heart, senna moves the bowel. Almost every milestone drug of Unit I (morphine, quinine, aspirin → salicin, warfarin, taxol) belongs to these families. This chapter teaches you to **define, classify, test and exemplify** them — the four skills examiners demand.

16.3 Alkaloids

16.3.1 Definition

Alkaloids are naturally occurring, **nitrogen-containing, basic** compounds of plant origin that show marked physiological action. Memory version: *"alkali-like"* — they are plant bases, so they are **bitter in taste** and form **salts with acids** (which is how they are extracted and injected).

16.3.2 General properties

1. Contain **nitrogen** (usually in a ring).
2. **Basic** — neutralise acids, form crystalline salts.
3. **Bitter** taste (a quick field hint, never a lab test).
4. Usually **insoluble in water** as free bases, **soluble in dilute acids** (as salts) — the basis of extraction.
5. Give **precipitates with alkaloidal reagents** (Mayer's, Dragendorff's, Wagner's, Hager's) — the identification tests.
6. Powerful physiological action in **small doses**.

16.3.3 Classification

A. By origin of nitrogen (textbook classification):

- **True alkaloids** — nitrogen in a heterocyclic ring, derived from amino acids: atropine, morphine, quinine, reserpine.
- **Protoalkaloids** — nitrogen **not** in a ring, derived from amino acids: ephedrine, colchicine.
- **Pseudoalkaloids** — nitrogen **not** derived from amino acids: caffeine (purine/xanthine), steroidal alkaloids.

B. By ring system (exam table):

Ring type	Examples
Tropane	atropine, hyoscyamine, cocaine
Isoquinoline	morphine, codeine, papaverine
Quinoline	quinine, quinidine
Indole	reserpine, vincristine, strychnine
Purine (xanthine)	caffeine, theobromine, theophylline
Steroidal	solanine
Pyrrolizidine	(hepatotoxic group — caution example)

16.3.4 Chemical tests — step by step

General procedure: powder the drug, extract with **dilute hydrochloric acid**, filter. The clear acid filtrate is tested — alkaloids are present as soluble salts.

Test	Reagent (standard textbook)	Observation	Inference
Mayer's	potassium mercuric iodide solution	**cream/whitish precipitate**	alkaloids present
Dragendorff's	potassium bismuth iodide solution	**orange/reddish-brown precipitate**	alkaloids present
Wagner's	iodine in potassium iodide solution	**reddish-brown precipitate**	alkaloids present
Hager's	saturated picric acid solution	**yellow precipitate**	alkaloids present

> **How to write it in exams:** "The acid extract gives a cream precipitate with Mayer's reagent, indicating alkaloids." One positive test is suggestive; the pharmacopoeia usually requires the pattern.

Mnemonic for observations: *"Cream Mayer, Orange Dragon, Brown Wagner, Yellow Hager."*

16.3.5 Classic examples

Drug / Alkaloid	Biological source (family)	Type	Uses
Atropine	*Atropa belladonna* (Solanaceae), leaves/roots	tropane (true)	mydriatic (dilates pupil), antispasmodic, pre-anaesthetic
Morphine	*Papaver somniferum* (Papaveraceae), opium latex	isoquinoline (true)	powerful analgesic; the Unit I milestone
Quinine	*Cinchona* bark (Rubiaceae)	quinoline (true)	antimalarial; the Unit I milestone
Caffeine	Tea *Camellia sinensis* (Theaceae), coffee	purine (pseudo)	CNS stimulant
Ephedrine	*Ephedra* species (Ephedraceae)	protoalkaloid	bronchodilator, nasal decongestant
Reserpine	*Rauwolfia serpentina* (Apocynaceae), roots	indole (true)	antihypertensive, tranquilizer

Drug / Alkaloid	Biological source (family)	Type	Uses
Colchicine	*Colchicum autumnale* (Liliaceae)	protoalkaloid	gout; also the polyploidy-inducing agent of Chapter 9

16.4 Glycosides

16.4.1 Definition

Glycosides are compounds that yield, on hydrolysis (by acids or enzymes), a **sugar part (glycone)** and a **non-sugar part (aglycone or genin)**, joined by a **glycosidic bond**. Simple version: *sugar + active chemical, clipped together; water/acid unclips them.*

16.4.2 General properties

1. Usually **bitter** (senna, quinine-like bitterness is no coincidence — many bitters are glycosides).
2. **Non-reducing** (the sugar's reactive end is tied up in the bond) — until hydrolysed.
3. **Hydrolysed by acids and enzymes** — stomach acid and gut enzymes can release the aglycone inside the body, which is often the truly active form.
4. Soluble in **water and alcohol**.
5. The **aglycone decides the action**; the sugar mainly helps solubility and absorption.

16.4.3 Classification by aglycone (exam table)

Class	Aglycone type	Classic example	Use
Anthraquinone	anthraquinone	senna (sennosides)	laxative/purgative
Cardiac	steroidal (cardenolide)	digitalis (digoxin, digitoxin)	cardiotonic
Saponin	triterpene or steroid	glycyrrhiza (glycyrrhizin); dioscorea (diosgenin)	expectorant/sweetener; steroid precursor
Cyanogenic	releases HCN on hydrolysis	bitter almond (amygdalin)	textbook example (toxic)
Isothiocyanate	mustard-oil type	black mustard (sinigrin)	counterirritant
Flavonoid	flavonoid	rutin	capillary protectant (also Chapter 17)
Phenolic	simple phenol	willow (salicin)	historical precursor link to aspirin (Unit I)

16.4.4 Chemical tests — step by step

A. Borntrager's test (anthraquinone glycosides — senna, cascara):

1. Boil the drug with **dilute sulphuric/hydrochloric acid** (hydrolysis), cool and filter.
2. Extract the filtrate with an organic solvent (chloroform/benzene layer).
3. Add **dilute ammonia** and shake → **pink to red colour in the ammoniacal (aqueous) layer** = anthraquinone glycosides present.

- **Modified Borntrager's** (for C-glycosides like aloin): boil first with **ferric chloride + dilute HCl** (oxidative hydrolysis), then proceed as above → rose-pink to red.

B. Legal's test (cardiac glycosides): Dissolve extract in **pyridine**, add **sodium nitroprusside**, make alkaline → **pink to blood-red colour** = cardenolide (unsaturated lactone) present.

C. Keller-Kiliani test (deoxy sugars of cardiac glycosides): Dissolve in **glacial acetic acid containing ferric chloride**, then carefully layer **concentrated sulphuric acid → reddish-brown ring at the junction**, turning blue in the upper acetic acid layer = cardiac glycosides present.

D. Foam test (saponin glycosides): Shake the aqueous extract vigorously → **persistent honeycomb-like foam** lasting minutes = saponins present.

16.4.5 Classic examples

Drug / Glycoside	Biological source (family)	Class	Uses
Senna (sennosides A & B)	*Cassia angustifolia* (Fabaceae/Leguminosae), leaflets	anthraquinone	stimulant laxative
Digitalis (digoxin, digitoxin)	*Digitalis purpurea / D. lanata* (Scrophulariaceae), leaves	cardiac	cardiotonic in heart failure
Glycyrrhiza (glycyrrhizin)	*Glycyrrhiza glabra* (Fabaceae), roots	saponin (triterpene)	expectorant, sweetener, demulcent
Dioscorea (diosgenin)	*Dioscorea deltoidea* (Dioscoreaceae), tubers	saponin (steroidal)	starting material for steroid drugs
Bitter almond (amygdalin)	*Prunus amygdalus* var. *amara* (Rosaceae)	cyanogenic	textbook example — releases HCN; toxic
Black mustard (sinigrin)	*Brassica nigra* (Brassicaceae)	isothiocyanate	counterirritant (mustard plaster)

Terminology alert. *Aglycone* = *genin* (same thing). *Glycone* = the sugar part. Students constantly swap these — the **a-** in aglycone means "**a**bsent sugar."

16.5 Alkaloids vs Glycosides — quick contrast

Feature	Alkaloids	Glycosides
Key atom	nitrogen, basic	sugar + aglycone, neutral
Taste	bitter	often bitter
Signature test	precipitate with Mayer's/Dragendorff's	Borntrager's (anthraquinone); Legal's / Keller-Kiliani (cardiac)
Examples	morphine, quinine, atropine	sennosides, digoxin, glycyrrhizin

16.6 Analogy

Alkaloids are the plant's **security guards** — nitrogen-armed, bitter, and potent in tiny doses (a little morphine, a little strychnine, goes a long way). Glycosides are **locked treasure chests** — the sugar is the lock, the aglycone is the treasure; acid or enzymes in the gut turn the key.

16.7 Pharmacy Relevance

- Alkaloid extraction logic (acid → salt → base → free alkaloid) is the **industrial basis** of morphine, quinine and atropine manufacture.
- Glycoside hydrolysis explains **delayed action**: senna works after gut bacteria free the aglycone — counsel patients it takes 6–12 hours.
- Digoxin has a **narrow therapeutic index** — the pharmacist's classic example of why plant drugs need standardised doses.
- These chemical tests are still the **first-line QC screens** for crude drugs before instrumental analysis (Unit III link).

16.8 India Context

India cultivates *Papaver somniferum* under strict government licence (opium alkaloids for the pharmaceutical industry), grows *Cinchona* in West Bengal/Tamil Nadu, and *Rauwolfia serpentina* is a classic Indian drug — reserpine's discovery from it is an Indian contribution to world medicine. Senna (*Cassia angustifolia*) from Tamil Nadu/Tuticorin is a major export laxative drug.

16.9 High-Yield Points

- **Alkaloids** = N-containing plant bases; bitter; precipitate with Mayer's (cream), Dragendorff's (orange), Wagner's (reddish-brown), Hager's (yellow).
- True (atropine, morphine, quinine, reserpine) / proto (ephedrine, colchicine) / pseudo (caffeine).
- **Glycosides** = sugar + aglycone; hydrolysable; aglycone decides action.
- Borntrager's (pink-red, anthraquinone) incl. **modified** ($FeCl_3$ + HCl for C-glycosides); Legal's (pink-red, cardiac); Keller-Kiliani (brown ring + blue layer, cardiac deoxy sugars); foam test (saponins).
- Classics: **atropine** (*Atropa belladonna*, mydriatic), **morphine** (*Papaver somniferum*, analgesic), **quinine** (*Cinchona*, antimalarial), **sennosides** (senna, laxative), **digoxin/digitoxin** (*Digitalis*, cardiotonic), **glycyrrhizin** (expectorant/sweetener).

16.10 Common Confusions & Mistakes

- **Confusion:** aglycone vs glycone. **Clarification:** aglycone = non-sugar part; glycone = sugar part.
- **Confusion:** Borntrager's vs modified Borntrager's. **Clarification:** ordinary = O-glycosides (senna); **modified** ($FeCl_3$ + HCl first) = C-glycosides (aloin, cascarosides).
- **Mistake:** calling caffeine a true alkaloid. It is a **pseudoalkaloid** (purine; N not from amino acids).
- **Mistake:** writing that Legal's test is for anthraquinones. Legal's = **cardiac** glycosides; Borntrager's = **anthraquinone**.
- **Mistake:** describing glycosides as nitrogen-containing. That is alkaloids; glycosides are **sugar + aglycone**.

16.11 Mnemonic

"My Dear Wife Has" — **M**ayer's (cream), **D**ragendorff's (orange), **W**agner's (brown), **H**ager's (yellow). And **"BLK-F"** for glycoside tests: **B**orntrager's, **L**egal's, **K**eller-Kiliani, **F**oam.

16.12 Chapter Summary

- **Alkaloids** are basic nitrogenous plant compounds with potent action; classified as true/proto/pseudo and by ring type; identified by precipitation tests (Mayer's, Dragendorff's, Wagner's, Hager's).
- Classic alkaloids: atropine, morphine, quinine, caffeine, ephedrine, reserpine, colchicine.

- **Glycosides** are sugar + aglycone combinations, hydrolysable, with the aglycone deciding action; classified by aglycone (anthraquinone, cardiac, saponin, cyanogenic, isothiocyanate, flavonoid, phenolic).
- Identified by Borntrager's (modified for C-glycosides), Legal's, Keller-Kiliani, and foam tests.
- Classic glycosides: sennosides, digoxin/digitoxin, glycyrrhizin, diosgenin, amygdalin, sinigrin.

16.13 One-Minute Revision

- Alkaloids: N-bases; tests MDWH — cream, orange, brown, yellow.
- True/proto/pseudo: atropine-morphine-quinine / ephedrine-colchicine / caffeine.
- Glycosides: sugar + aglycone; tests BLK-F.
- Borntrager's = anthraquinone (pink-red); Legal's & Keller-Kiliani = cardiac.

16.14 Questions

MCQs

1. Mayer's reagent gives with alkaloids a: (a) orange precipitate (b) cream precipitate (c) yellow precipitate (d) blue colour
2. Modified Borntrager's test (with $FeCl_3$ + HCl) is used for: (a) O-glycosides (b) C-glycosides like aloin (c) cardiac glycosides (d) saponins
3. Caffeine is classified as a: (a) true alkaloid (b) protoalkaloid (c) pseudoalkaloid (d) glycoside
4. Keller-Kiliani test detects: (a) anthraquinones (b) deoxy sugars of cardiac glycosides (c) saponins (d) tannins
5. Sennosides belong to which glycoside class? (a) Cardiac (b) Anthraquinone (c) Saponin (d) Cyanogenic

Viva

1. Define alkaloid and glycoside.
2. Differentiate true, proto and pseudo alkaloids with one example each.
3. Describe Borntrager's test with observation.
4. What is the difference between ordinary and modified Borntrager's test?
5. Why does senna take 6–12 hours to act?

Application-based

1. An acid extract of a leaf powder gives an orange precipitate with Dragendorff's reagent and a reddish-brown precipitate with Wagner's. What class of compounds is indicated, and what is your next step for a preliminary conclusion?
2. A patient on digoxin tablets asks why the dose is so small and precise. Explain using glycoside properties.

Answers: 1-(b), 2-(b), 3-(c), 4-(b), 5-(b)

16.15 References

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Chapter 17: Secondary Metabolites II — Flavonoids, Tannins, Terpenoids, Volatile Oils and Resins

17.1 Learning Objectives

After studying this chapter, the student will be able to:

1. Define flavonoids, tannins, terpenoids, volatile oils and resins, and state one general property of each.
2. Classify each group with a table and give the standard chemical test where one exists (Shinoda, ferric chloride, gelatin).
3. Give classic examples with biological source, family, constituents and uses: rutin, quercetin, tannic acid/myrobalan, menthol, artemisinin, taxol, eucalyptus oil, clove oil, benzoin, asafoetida.
4. Distinguish volatile oils from fixed oils and resins from gums.

17.2 Introduction — The Remaining Treasure Rooms

Chapter 16 covered the two most famous secondary-metabolite families. This chapter tours the remaining five — the **colours** (flavonoids), the **astringents** (tannins), the **isoprene empire** (terpenoids), the **fragrances** (volatile oils) and the **sticky protectors** (resins). Between them they give us antioxidants, antimalarials, anticancer drugs, flavours, perfumes and wound protectors — and they complete the syllabus list of secondary metabolites.

17.3 Flavonoids — The Plant Pigments

17.3.1 Definition

Flavonoids are polyphenolic secondary metabolites with a **C6–C3–C6 skeleton** (two benzene rings joined by a three-carbon bridge) — in plain words, yellow/orange plant pigments built on a fifteen-carbon framework. They colour flowers and fruits and act as **antioxidants** (mopping up harmful free radicals).

17.3.2 General properties

Yellow to orange pigments; polyphenolic (many –OH groups); antioxidant activity; often occur as **glycosides** (rutin is a flavonoid glycoside — the Chapter 16 link); soluble in alcohol and alkalis.

17.3.3 Classification (exam table)

Class	Example	Occurrence note
Flavonols	quercetin, rutin	widespread in fruits/vegetables
Flavones	(general class)	leaves and flowers
Flavanones	hesperidin	citrus peels
Anthocyanins	(general class)	red/blue flower and fruit pigments
Isoflavones	(general class)	legumes

17.3.4 Chemical test — Shinoda test

To the **alcoholic extract** add **magnesium turnings**, then **concentrated hydrochloric acid** dropwise → **pink to magenta/scarlet colour** = flavonoids present. (The magnesium + acid reduces the flavonoid to a coloured form.)

17.3.5 Classic examples

Drug / Compound	Biological source (family)	Uses
Rutin	Buckwheat *Fagopyrum esculentum* (Polygonaceae); also *Ruta graveolens*	capillary protectant ("vitamin P" action), antioxidant
Quercetin	widely distributed (onion skins, fruits)	antioxidant; textbook flavonol
Hesperidin	citrus peels (Rutaceae)	capillary protectant

17.4 Tannins — The Astringents

17.4.1 Definition

Tannins are high-molecular-weight **polyphenolic** compounds that are **astringent** (they pucker the mouth) because they **precipitate proteins**. The name comes from **tanning leather** — tannins convert animal skin into leather by binding its proteins.

17.4.2 General properties

Astringent taste; precipitate **proteins, gelatin and alkaloids** (this is why strong tea, rich in tannins, goes cloudy with milk protein — and why tannins can interfere with alkaloid absorption); soluble in water and alcohol; used as antidotes for alkaloid poisoning in traditional practice.

17.4.3 Classification (exam table)

Type	Structure	Test hint ($FeCl_3$)	Example
Hydrolysable tannins	esters of sugars + phenolic acids; hydrolysed by acids	**blue-black** colour	tannic acid (oak galls)
Condensed tannins	polymerised flavonoid units; not hydrolysable	**green** colour	catechu; cinchona bark tannins

17.4.4 Chemical tests

- **Ferric chloride test:** add dilute ferric chloride to the aqueous extract → **blue-black** (hydrolysable) or **green** (condensed) colour = tannins present.
- **Gelatin test:** add gelatin solution → **white/buff precipitate** = tannins present (protein precipitation in action).

17.4.5 Classic examples

Drug	Biological source (family)	Tannin type	Uses
Tannic acid	Oak galls *Quercus infectoria* (Fagaceae)	hydrolysable	astringent; leather tanning (namesake)

Drug	Biological source (family)	Tannin type	Uses
Myrobalan	*Terminalia chebula* (Combretaceae), fruits	hydrolysable	astringent, mild laxative; AYUSH drug (Triphala ingredient)
Black catechu	*Acacia catechu* (Fabaceae)	condensed	astringent

Terminology alert. *Astringent* = causes tissues to contract/pucker (tannins). Do not confuse with *bitter* (alkaloids/glycosides) — different sensation, different chemistry.

17.5 Terpenoids — The Isoprene Empire

17.5.1 Definition

Terpenoids (terpenes) are secondary metabolites built from **isoprene units** — five-carbon building blocks (C_5H_8). The **isoprene rule**: count the carbons in multiples of five, and you can name the class.

17.5.2 Classification by isoprene units (exam favourite)

Class	Carbon atoms	Isoprene units	Classic example
Hemiterpene	C_5	1	(basic unit)
Monoterpene	C_{10}	2	**menthol**, camphor, eucalyptol
Sesquiterpene	C_{15}	3	**artemisinin**
Diterpene	C_{20}	4	**taxol (paclitaxel)**
Triterpene	C_{30}	6	glycyrrhetinic acid; steroidal saponins
Tetraterpene	C_{40}	8	carotenoids (plant pigments)

17.5.3 Classic examples

Compound	Biological source (family)	Terpene class	Uses
Menthol	*Mentha piperita / M. arvensis* (Lamiaceae), volatile oil	monoterpene alcohol	carminative, cooling antipruritic, flavour
Camphor	*Cinnamomum camphora* (Lauraceae)	monoterpene ketone	rubefacient, counterirritant
Artemisinin	*Artemisia annua* (Asteraceae)	sesquiterpene lactone	antimalarial — the Unit I milestone
Taxol (paclitaxel)	*Taxus* species (Taxaceae), bark	diterpene	anticancer — the Unit I milestone
Eucalyptol (cineole)	*Eucalyptus globulus* (Myrtaceae)	monoterpene ether	decongestant, antiseptic

Memory hook. "Menthol cools the **M**outh (Mono, C_{10}); **S**esqui kills the **S**hivers of malaria (artemisinin, C_{15}); **D**i fights **D**isease of cells (taxol, C_{20})."

17.6 Volatile Oils — The Fragrances

17.6.1 Definition

Volatile oils (essential oils) are **aromatic, evaporating** secondary metabolites — odorous liquids that **vaporise at room temperature** (steam-distillable). They are the plant's perfume and chemical weapon combined.

17.6.2 General properties

Strong characteristic **odour**; **lighter than water** (mostly); soluble in **organic solvents and alcohol**, poorly in water; evaporate leaving **no permanent grease stain** (the Chapter 15 test); usually mixtures with one **major constituent** (eucalyptus oil ≈ eucalyptol; clove oil ≈ eugenol).

17.6.3 Volatile oils vs fixed oils — recalled from Chapter 15

Fixed oils: triglycerides, non-volatile, permanent grease stain, little odour (castor oil). Volatile oils: terpenes/aromatics, evaporate, fading stain, strong odour (eucalyptus oil). **Always write both columns in exams.**

17.6.4 Classification by functional group (exam table)

Group	Example oil (major constituent)
Hydrocarbon	turpentine oil (pinene)
Alcohol	peppermint oil (menthol); coriander oil
Aldehyde	lemon oil (citral); cinnamon oil (cinnamaldehyde)
Ketone	camphor; caraway oil (carvone)
Phenol	clove oil (eugenol); thyme oil (thymol)
Ether	eucalyptus oil (eucalyptol/cineole)
Ester	wintergreen oil (methyl salicylate)

17.6.5 Classic examples

Oil	Biological source (family)	Major constituent	Uses
Eucalyptus oil	*Eucalyptus globulus* (Myrtaceae), leaves	eucalyptol (cineole)	decongestant, antiseptic, inhalant
Peppermint oil	*Mentha piperita* (Lamiaceae)	menthol	carminative, flavour, antipruritic
Clove oil	*Syzygium aromaticum* (Myrtaceae), flower buds	eugenol	dental analgesic/antiseptic
Turpentine oil	*Pinus* species (Pinaceae), oleo-resin	pinene	counterirritant, solvent

17.6.6 Extraction in one line

Volatile oils are classically obtained by **steam distillation** (steam carries the oil vapours; they condense and separate from water) — with special methods (expression for citrus peels, enfleurage for delicate flowers) in advanced study.

17.7 Resins — The Sticky Protectors

17.7.1 Definition

Resins are **solid or semisolid**, amorphous plant exudates — complex mixtures formed by **oxidation/polymerisation of volatile oils**. They do **not** evaporate, are **insoluble in water**, soluble in alcohol.

17.7.2 General properties

Hard/brittle or sticky; insoluble in water, soluble in alcohol and organic solvents; burn with a **sooty flame**; often strongly odorous.

17.7.3 Classification (exam table)

Type	Composition	Example
Oleo-resins	resin + volatile oil	turpentine (Pinus); Canada balsam
Gum-resins	resin + gum	asafoetida (*Ferula asafoetida*)
Oleo-gum-resins	resin + volatile oil + gum	myrrh
Balsams	resin + aromatic acids (benzoic/cinnamic)	benzoin; Peru balsam

17.7.4 Resins vs gums — quick contrast

Feature	Resins	Gums
Solubility	insoluble in water, soluble in alcohol	soluble/swell in water
Origin chemistry	oxidised volatile oils	polysaccharides (carbohydrates!)
Example	benzoin, asafoetida	acacia (Chapter 15)

17.7.5 Classic examples

Drug	Biological source (family)	Type	Uses
Benzoin	*Styrax benzoin* (Styraceae)	balsam	expectorant, protective in Friar's balsam
Asafoetida	*Ferula asafoetida* (Apiaceae), oleo-gum-resin	gum-resin	carminative, antispasmodic
Turpentine (resin part)	*Pinus* species (Pinaceae)	oleo-resin	counterirritant; colophony residue

17.8 The Overlap Map — how the families connect

```
Volatile oils ── contain ──► monoterpenes & sesquiterpenes (terpenoids)
Resins ── formed from ──► oxidised volatile oils
Flavonoids ── occur as ──► flavonoid glycosides (rutin)
Tannins ── condensed type ──► built from flavonoid units
Saponin glycosides (Ch 16) ── are ──► triterpene/steroid glycosides
```

Key takeaway. The families are chapters of one story, not separate subjects — examiners reward students who show the links.

17.9 Analogy

If secondary metabolites are a **spice market**: flavonoids are the **colour stalls** (bright yellows), tannins the **leather-and-pickle corner** (puckering, preserving), terpenoids the **wholesale godown** (everything built from five-carbon sacks), volatile oils the **perfume row** (you smell them before you see them), and resins the **sticky-sweet shop** at the end that seals and protects everything.

17.10 Pharmacy Relevance

- **Menthol, eucalyptol, eugenol** are in cough syrups, balms, mouthwashes and dental preparations the pharmacist dispenses daily.
- **Artemisinin-based combination therapies** and **taxol** are frontline modern drugs — proof that pharmacognosy feeds allopathy (Chapter 18).
- Tannin–protein binding explains **drug interactions** (e.g., reduced absorption when alkaloid drugs meet tannin-rich preparations).
- Volatile-oil quality (major-constituent percentage) is a **pharmacopoeial specification** — QC relevance (Unit III link).

17.11 India Context

India is a world leader in **mint oil/menthol** production (CIMAP varieties — Unit II link); eucalyptus and clove oils are standard in Indian cough and dental preparations; myrobalan (*Terminalia chebula*) and catechu are classical AYUSH astringents; asafoetida (*hing*) is both a kitchen spice and a pharmacopoeial carminative.

17.12 High-Yield Points

- **Flavonoids**: C6–C3–C6 polyphenolic pigments, antioxidant; Shinoda test (Mg + conc. HCl → pink/magenta); rutin, quercetin, hesperidin.
- **Tannins**: polyphenolic, astringent, precipitate proteins; hydrolysable ($FeCl_3$ blue-black; tannic acid) vs condensed ($FeCl_3$ green); gelatin test (white precipitate).
- **Terpenoids**: built from **isoprene (C_5)** units — mono C_{10} (menthol), sesqui C_{15} (artemisinin), di C_{20} (taxol), tri C_{30}, tetra C_{40}.
- **Volatile oils**: aromatic, evaporate, fading grease stain; classified by functional group; eucalyptus (eucalyptol), peppermint (menthol), clove (eugenol); steam distillation.
- **Resins**: solid/semisolid oxidised oils, water-insoluble; oleo-/gum-/oleo-gum-resins and **balsams** (benzoin, asafoetida).

17.13 Common Confusions & Mistakes

- **Confusion:** volatile oils vs fixed oils. **Clarification:** volatile = evaporate, aromatic (Ch 17); fixed = fatty, non-volatile (Ch 15, castor oil).
- **Confusion:** resins vs gums. **Clarification:** resins = alcohol-soluble, water-insoluble (benzoin); gums = water-soluble polysaccharides (acacia).
- **Confusion:** menthol as "volatile oil." **Clarification:** menthol is a **monoterpene** that is the major constituent *of* peppermint volatile oil — compound vs mixture.
- **Mistake:** calling tannins sweet or alkaloids non-bitter. Tannins = **astringent**, alkaloids = **bitter**.
- **Mistake:** writing Shinoda test with wrong reagents. It is **magnesium + concentrated HCl** on an alcoholic extract.

17.14 Mnemonic

"Fragrant Teachers Take Vitamins Regularly" — **F**lavonoids, **T**annins, **T**erpenoids, **V**olatile oils, **R**esins. And for terpenes: **"My Son Dances To Tunes"** — **M**ono C_{10}, **S**esqui C_{15}, **D**i C_{20}, **T**ri C_{30}, **T**etra C_{40}.

17.15 Chapter Summary

- **Flavonoids** (rutin, quercetin): C6–C3–C6 pigments, antioxidant; Shinoda test.
- **Tannins** (tannic acid, myrobalan): astringent protein-precipitants; hydrolysable (blue-black $FeCl_3$) vs condensed (green); gelatin test.
- **Terpenoids**: isoprene-unit multiples — menthol (C_{10}), artemisinin (C_{15}), taxol (C_{20}).
- **Volatile oils** (eucalyptus, peppermint, clove): aromatic evaporating mixtures; classified by functional group; steam-distilled.
- **Resins** (benzoin, asafoetida): solid oxidised oils; oleo-/gum-/oleo-gum-resins and balsams; contrast with gums.

17.16 One-Minute Revision

- F-T-T-V-R: flavonoids (Shinoda, rutin), tannins ($FeCl_3$, gelatin; astringent), terpenoids (isoprene rule; menthol-artemisinin-taxol), volatile oils (functional groups; eucalyptol-eugenol-menthol), resins (balsams: benzoin).
- Volatile vs fixed: evaporate/fading stain vs fatty/permanent stain.
- Resins vs gums: alcohol-soluble vs water-soluble.

17.17 Questions

MCQs

1. The Shinoda test is used to detect: (a) alkaloids (b) flavonoids (c) tannins (d) resins
2. Artemisinin is a: (a) monoterpene (b) sesquiterpene lactone (c) diterpene (d) triterpene
3. Hydrolysable tannins give with ferric chloride a: (a) green colour (b) blue-black colour (c) yellow precipitate (d) white precipitate
4. The major constituent of clove oil is: (a) menthol (b) eucalyptol (c) eugenol (d) pinene
5. Benzoin is classified as a: (a) gum (b) balsam (c) oleo-resin (d) fixed oil

Viva

1. State the isoprene rule and classify menthol, artemisinin and taxol by it.
2. Differentiate volatile oils and fixed oils.

3. Differentiate resins and gums.
4. Describe the Shinoda test with observation.
5. What are balsams? Give one example with uses.

Application-based

1. A cough-balm manufacturer wants a cooling, aromatic, counterirritant ingredient set. Pick two volatile-oil drugs and one terpenoid from this chapter and justify each choice.
2. A herbal tea rich in tannins is taken with an alkaloid-containing tonic. Predict and explain the pharmaceutical problem.

Answers: 1-(b), 2-(b), 3-(b), 4-(c), 5-(b)

17.18 References

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Chapter 18: Traditional Systems of Medicine

18.1 Learning Objectives

After studying this chapter, the student will be able to:

1. Expand AYUSH and name its six systems with one-line origins.
2. State the basic principles of treatment in Ayurveda, Unani, Siddha, Homoeopathy, Yoga & Naturopathy, and TCM.
3. List the standard AYUSH dosage forms (churna, kwatha, taila, ghrita, vati, asava, arista, avaleha, bhasma, arka) with one-line descriptions.
4. Explain the role of pharmacognosy in allopathy and in traditional systems (AYUSH, TCM).

18.2 Introduction — Medicine Is Older Than Laboratories

Long before tablets and injections, every civilisation had its own complete system of healing — its own theory of why we fall ill and how plants, minerals and practices restore health. India officially recognises six such systems under **AYUSH**, and China has **Traditional Chinese Medicine (TCM)**. A pharmacist in India will dispense, counsel on, and quality-check these medicines throughout their career. This chapter introduces each system's **core treatment principles** (not rituals, not controversies — just the textbook basics), the **dosage forms** AYUSH medicines come in, and where **pharmacognosy** fits into all of it.

18.3 Definitions

- **Traditional system of medicine:** a complete, historically developed framework of health, disease and treatment belonging to a culture or region.
- **AYUSH: A**yurveda, **Y**oga & Naturopathy, **U**nani, **S**iddha, **H**omoeopathy — the traditional systems officially recognised and promoted by the **Ministry of AYUSH, Government of India**.
- **Dosage form:** the physical form in which a medicine is administered (powder, decoction, oil, pill — the same concept as tablets/syrups in allopathy).
- **Materia medica:** the body of knowledge about medicinal substances and their uses — every traditional system has one.

18.4 The AYUSH Systems — Basic Principles of Treatment

18.4.1 Ayurveda — the science of life

- **Origin line:** India's oldest documented system, rooted in the Vedas (classical texts: *Charaka Samhita*, *Sushruta Samhita* — traditionally ascribed).
- **Core theory — Tridosha:** health is the balance of three functional principles: **Vata** (movement/air), **Pitta** (transformation/fire), **Kapha** (structure/water-earth). Disease = dosha imbalance.
- **Panchamahabhuta:** everything, including the body, is built from five elements — earth, water, fire, air, space.
- **Treatment principles (introductory):** restore dosha balance through **shodhana** (purifying procedures, e.g., panchakarma) and **shamana** (palliative herbal treatment), with diet (*ahara*) and lifestyle (*vihara*) as therapy pillars. Diagnosis is individualised — two patients with the "same" disease may receive different treatment.

18.4.2 Yoga & Naturopathy

- **Yoga:** the eight-limbed (*ashtanga*) discipline — yama, niyama, **asana** (postures), **pranayama** (breath control), pratyahara, dharana, dhyana, **samadhi** — used preventively and therapeutically for mind-body balance.
- **Naturopathy: drugless** healing based on the five elements and the body's self-healing power — hydrotherapy, mud therapy, fasting, diet and massage.

18.4.3 Unani — Greco-Arab medicine

- **Origin line:** Greek roots (Hippocrates, Galen), developed by Arab and Persian scholars, established in India centuries ago.
- **Core theory — four humours: Dam** (blood), **Balgham** (phlegm), **Safra** (yellow bile), **Sauda** (black bile); each person has a **mizaj** (temperament) from their humoural mix.
- **Treatment principle:** restore humoural balance, classically **by opposites** (*ilaj-bil-zid*) — a "hot" disease treated with "cold" drugs and regimens — using herbal, mineral and regimental therapies.

18.4.4 Siddha — the Tamil tradition

- **Origin line:** the traditional system of Tamil Nadu, traditionally attributed to the sage **Agastya** and the Siddhars.
- **Core theory:** closely parallels Ayurveda — three humours **vatham, pitham, kapham** (corresponding to vata, pitta, kapha); strong emphasis on **alchemy** — purified minerals and metals (*muppu*) alongside herbs.
- **Treatment:** herbal, mineral and herbo-mineral preparations with diet and yogic discipline.

18.4.5 Homoeopathy

- **Origin line:** founded by **Christian Friedrich Samuel Hahnemann** (Germany, late 18th century).
- **Core principles:**

1. **Similia similibus curentur** — "like cures like": a substance causing symptoms in a healthy person treats similar symptoms in the sick.
2. **Minimum dose** — medicines given in highly diluted amounts.
3. **Potentization (dynamization)** — serial dilution with vigorous shaking (*succussion*) at each step.
4. **Single remedy** — one medicine at a time, matched to the total symptom picture.

> **Exam-ready contrast.** Ayurveda/Unani/Siddha treat by **restoring balance of body principles** (doshas/humours); Homoeopathy treats by the **like-cures-like** law with potentized doses.

18.5 Traditional Chinese Medicine (TCM) — Basic Principles

- **Core theory — Yin-Yang:** health is the dynamic balance of **yin** (cool, passive, nourishing) and **yang** (warm, active, functional); disease = their imbalance.
- **Five elements: wood, fire, earth, metal, water** — a framework relating organs, emotions, seasons and tastes.
- **Qi and meridians: qi** (vital energy) flows through channels (**meridians**); blockage or deficiency causes disease.
- **Treatment principle: pattern differentiation** — diagnose the pattern of imbalance (not just the disease name) and restore harmony, classically with **herbal formulas** (multi-herb combinations), and also acupuncture, diet and exercise practices.

Terminology alert. In TCM, "pattern" ≠ "disease": two patients with the same biomedical disease can receive different formulas if their patterns differ — the same individualisation logic as Ayurveda's dosha approach.

18.6 Systems at a Glance (exam table)

System	Origin	Core principle	Treatment logic
Ayurveda	India (Vedic)	tridosha (vata-pitta-kapha)	restore dosha balance: shodhana/shamana
Yoga & Naturopathy	India	eight limbs; five elements	mind-body discipline; drugless nature cure
Unani	Greco-Arab	four humours; mizaj	balance humours, treat by opposites
Siddha	Tamil Nadu	vatham-pitham-kapham; alchemy	herbal + herbo-mineral preparations
Homoeopathy	Germany (Hahnemann)	like cures like	potentized single remedy, minimum dose
TCM	China	yin-yang; five elements; qi	pattern differentiation, restore harmony

18.7 Types of Dosage Forms in AYUSH Medicines

The same concept as tablets/syrups — the physical form of the medicine. Classical AYUSH dosage forms:

Dosage form	What it is (one line)	Example
Churna	fine **powder** of dried herbs	Triphala churna
Kwatha (kashaya)	**decoction** — herbs boiled in water and reduced	—
Taila	**medicated oil** — herbs processed in sesame/coconut oil	—
Ghrita	**medicated ghee** — herbs processed in clarified butter	—
Vati / Gutika	**pills/tablets** — rolled or compressed masses	—
Asava	**fermented** preparation from fresh herb juice or cold infusion (no boiling step)	—
Arista	**fermented** preparation from a **decoction** (kwatha) base	—
Avaleha / Lehya	**confection** — semi-solid sweet mass (herbs + sugar/jaggery)	Chyawanprash (avaleha type)
Bhasma	**calcined** metal/mineral ash — specialised herbo-mineral preparation	—
Arka	**distillate** — aromatic water distilled from herbs	—

Asava vs Arista — the classic distinction: asava starts from **unboiled** material (fresh juice/infusion); arista starts from a **boiled decoction**. Both then ferment. Examiners test exactly this.
Pharmacognosy link. Taila/ghrita are built on **sesame oil** (Chapter 15's fixed oils); churnas and kwathas carry the **secondary metabolites** of Chapters 16–17; bhasmas need strict **quality control** (Unit III evaluation logic).

18.8 Role of Pharmacognosy in Allopathy

1. **Drug discovery:** the Unit I milestones — morphine, quinine, digoxin, taxol, artemisinin, penicillin — all came from natural sources; pharmacognosy remains the **entry gate** for natural-product drug discovery.
2. **Lead compounds:** natural metabolites are templates chemists modify (aspirin from salicin-logic; artemisinin derivatives).
3. **Quality control of herbal products:** identification, adulteration detection and standardisation (Unit III methods) protect allopathic-adjacent herbal medicines.
4. **Excipients and vehicles:** starch, acacia, oils, gelatin (Chapter 15) are pharmacognosy-sourced allopathic excipients.
5. **Understanding herb–drug interactions:** pharmacognostic knowledge (e.g., tannin–alkaloid binding) informs safe co-prescribing.

18.9 Role of Pharmacognosy in Traditional Systems (AYUSH & TCM)

1. **Correct identification:** classical texts use ancient names — pharmacognosy maps each name to the **correct botanical species**, preventing dangerous substitutions.
2. **Standardisation of classical formulations:** defining quality parameters for churnas, kwathas, asavas, bhasmas so every batch matches the classical standard.
3. **Cultivation and conservation:** ensuring sustained supply of formulation ingredients (Unit II) — including endangered species like kutki.
4. **Evaluation methods:** organoleptic, microscopic, chemical and biological evaluation (Unit III) applied to AYUSH raw materials and finished products.
5. **Scientific validation:** phytochemical and pharmacological study of traditional claims builds the evidence bridge between traditional use and modern acceptance (without overclaiming — validation is ongoing work).
6. **Pharmacopoeias:** the Ayurvedic, Unani and Siddha Pharmacopoeias of India are pharmacognosy in official form — identity, purity and strength standards for traditional drugs.

Exam-ready sentence: "Pharmacognosy is the **quality backbone** of traditional systems and the **discovery engine** of allopathy — it identifies, standardises, conserves and validates drugs of natural origin for both."

18.10 Analogy

> Think of the world's medical systems as **different cuisines**: Ayurveda, TCM, Unani each have their own recipes, spices and cooking philosophy (doshas, yin-yang, humours). **Pharmacognosy is the food inspector and the spice botanist** — it verifies that the turmeric is really turmeric, that it is pure and potent, and it discovers new spices the chefs never knew existed — serving every cuisine at once.

18.11 Pharmacy Relevance

- Indian pharmacists **dispense AYUSH medicines daily** — knowing what a churna, asava or bhasma is, is basic professional literacy.
- Counselling points: fermented asava/arista contain **self-generated alcohol** (patients who avoid alcohol should know); bhasmas are **metal/mineral** preparations needing quality-assured sources.
- Pharmacognosy graduates work in AYUSH **QC, standardisation and pharmacopoeial** laboratories.

18.12 India Context

The **Ministry of AYUSH** (Government of India) promotes these systems; the **Ayurvedic, Unani and Siddha Pharmacopoeias of India** set official quality standards; the **National Medicinal Plants Board** supports raw-material supply. India's dual strength — a modern pharmaceutical industry plus living traditional systems — makes pharmacognosy a uniquely Indian professional asset.

18.13 High-Yield Points

- **AYUSH** = Ayurveda, Yoga & Naturopathy, Unani, Siddha, Homoeopathy.
- Ayurveda: **tridosha** (vata-pitta-kapha), panchamahabhuta; shodhana/shamana.
- Unani: **four humours** (dam, balgham, safra, sauda), mizaj; treat by opposites.
- Siddha: vatham-pitham-kapham; herbo-mineral/alchemy tradition (Agastya).
- Homoeopathy: **Hahnemann**; like cures like; minimum dose; potentization; single remedy.
- TCM: **yin-yang**, five elements (wood-fire-earth-metal-water), qi/meridians, pattern differentiation.
- AYUSH dosage forms: churna, kwatha, **taila**, **ghrita**, vati, **asava** (unboiled) vs **arista** (decoction), avaleha, bhasma, arka.
- Pharmacognosy = **discovery engine** of allopathy + **quality backbone** of traditional systems.

18.14 Common Confusions & Mistakes

- **Confusion:** asava vs arista. **Clarification:** asava = fermented from **unboiled** juice/infusion; arista = fermented from a **decoction**. Both are fermented — the starting step differs.
- **Confusion:** taila vs ghrita. **Clarification:** taila = **medicated oil**; ghrita = **medicated ghee** (clarified butter).
- **Mistake:** expanding AYUSH wrongly (missing Yoga & Naturopathy or Homoeopathy). Write all six words.
- **Mistake:** attributing "like cures like" to Ayurveda. It is **Homoeopathy (Hahnemann)**.
- **Mistake:** describing traditional systems' principles as proven biomedical facts. Write them as **the system's own framework** ("Ayurveda holds that...").

18.15 Mnemonic

"A Young Uncle Sings Hymns" — **A**yurveda, **Y**oga & Naturopathy, **U**nani, **S**iddha, **H**omoeopathy. For dosage forms: **"Cute Kittens Take Green Vitamins After All Baths Regularly"** — **C**hurna, **K**watha, **T**aila, **G**hrita, **V**ati, **A**sava, **A**rista, **B**hasma, **a**Rka (avaleha tucked in "All").

18.16 Chapter Summary

- **AYUSH** comprises six officially recognised systems; **TCM** is China's traditional system.
- Each has a core treatment framework: tridosha (Ayurveda), eight limbs/drugless nature cure (Yoga & Naturopathy), four humours (Unani), vatham-pitham-kapham + alchemy (Siddha), like-cures-like (Homoeopathy), yin-yang/five elements/qi (TCM).
- Classical AYUSH dosage forms: churna, kwatha, taila, ghrita, vati, asava, arista, avaleha, bhasma, arka.
- Pharmacognosy serves allopathy through **discovery, leads, QC and excipients**, and traditional systems through **identification, standardisation, conservation, evaluation and validation**.

18.17 One-Minute Revision

- AYUSH: A-Y-U-S-H (six systems).
- Ayurveda: tridosha; Unani: 4 humours; Siddha: 3 humours + minerals; Homoeopathy: Hahnemann, like-cures-like; TCM: yin-yang, 5 elements.
- Asava (unboiled) vs arista (decoction); taila (oil) vs ghrita (ghee).
- Pharmacognosy: discovery engine (allopathy) + quality backbone (traditional).

18.18 Questions

MCQs

1. "Like cures like" is the basic principle of: (a) Ayurveda (b) Unani (c) Homoeopathy (d) Siddha
2. The four humours (dam, balgham, safra, sauda) belong to: (a) Ayurveda (b) Unani (c) TCM (d) Homoeopathy
3. Asava differs from arista in that asava is prepared from: (a) a decoction (b) unboiled juice/infusion (c) distilled water (d) calcined metals
4. Taila is a: (a) medicated ghee (b) medicated oil (c) fermented preparation (d) fine powder
5. The five elements in TCM are: (a) earth, water, fire, air, space (b) wood, fire, earth, metal, water (c) vata, pitta, kapha, blood, bone (d) yin, yang, qi, blood, essence

Viva

1. Expand AYUSH.
2. State the tridosha theory in one minute.
3. Differentiate asava and arista.
4. What is potentization in Homoeopathy?
5. Explain the role of pharmacognosy in standardisation of AYUSH formulations.

Application-based

1. A patient avoiding alcohol asks whether an arista preparation is suitable. What do you tell them, and why?
2. A manufacturer wants to launch a "Triphala churna" but sources fruits from three different suppliers. Which pharmacognosy functions (from §18.9) must be applied before launch, and why?

Answers: 1-(c), 2-(b), 3-(b), 4-(b), 5-(b)

18.19 References

- Evans WC. *Trease and Evans Pharmacognosy.* 16th ed. London: Saunders Elsevier; 2009.
- Tyler VE, Brady LR, Robbers JE. *Pharmacognosy.* 9th ed. Philadelphia: Lea & Febiger; 1988.
- Kokate CK, Purohit AP, Gokhale SB. *Pharmacognosy.* Pune: Nirali Prakashan.
- WHO. *WHO Traditional Medicine Strategy 2002–2005.* Geneva: World Health Organization; 2002.

Unit IV Infographic Concept — "The Plant Chemical Family Tree"

Layout: a large tree diagram.

- **Roots:** "Metabolism" label.
- **Trunk splits into two main branches: PRIMARY** (all plants — growth & energy) and **SECONDARY** (some plants — defence & drugs).
- **Primary branch leaves:** Carbohydrates (starch, acacia, honey) · Proteins (papain, gelatin) · Lipids (castor oil, theobroma oil).
- **Secondary branch leaves (7 clusters):** Alkaloids (morphine, quinine) · Glycosides (digoxin, sennosides) · Flavonoids (rutin) · Tannins (tannic acid) · Terpenoids (menthol, artemisinin, taxol) · Volatile oils (eucalyptus, clove) · Resins (benzoin).
- **Fruits hanging from secondary branches:** labelled "modern drugs" — morphine, quinine, digoxin, taxol, artemisinin.
- **A second smaller tree beside it:** "Traditional Systems" — six roots labelled Ayurveda, Yoga & Naturopathy, Unani, Siddha, Homoeopathy, TCM, feeding one trunk: "Pharmacognosy — the quality backbone & discovery engine."

Unit IV References (combined)

- Evans WC. *Trease and Evans Pharmacognosy.* 16th ed. London: Saunders Elsevier; 2009.
- Tyler VE, Brady LR, Robbers JE. *Pharmacognosy.* 9th ed. Philadelphia: Lea & Febiger; 1988.
- Kokate CK, Purohit AP, Gokhale SB. *Pharmacognosy.* Pune: Nirali Prakashan.
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