BP205T · B.PHARM THEORY

BP205T PHARMACOGNOSY AND PHYTOCHEMISTRY

Unit III — Secondary Metabolites

Pills & Python Notes

From-zero teaching standard: every technical term is defined before use.

Syllabus coverage: Unit III (12 hours).

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UNIT III — SECONDARY METABOLITES

BP205T PHARMACOGNOSY AND PHYTOCHEMISTRY — UNIT III: SECONDARY METABOLITES (12 HOURS)

How to use these notes: Every new word is defined the first time it appears. Read in order — concept first, then the simple explanation, then the example, then the analogy, then the key takeaway. Drug tables follow the same pattern for all 20 drugs so you can compare them side by side in exams.

Chapter 1 — What Are Secondary Metabolites?

1.1 Learning objectives

After studying this chapter, you will be able to:

1. Define primary and secondary metabolites in very simple words.
2. Explain why plants make secondary metabolites.
3. Classify secondary metabolites into the seven groups of this unit.
4. Give two examples of each group from the syllabus drugs.

1.2 The big idea: plants make two kinds of chemicals

Technical concept: Plants produce *primary metabolites* and *secondary metabolites*.

Simple explanation: Think of a plant like a small factory with two departments.

- **Department 1 — Survival department.** It makes sugars, proteins and fats. Every plant needs these to grow, make energy and build its body. These are called **primary metabolites** ("primary" = first, most basic). Example: glucose (a sugar), starch, amino acids.
- **Department 2 — Protection and attraction department.** It makes special chemicals that are NOT needed for basic growth, but help the plant survive in the wild — for example, bitter chemicals that stop insects from eating the leaves, or sweet-smelling chemicals that attract bees for pollination. These are called **secondary metabolites** ("secondary" = second, extra).

Example: The opium poppy makes morphine. The plant does not need morphine to grow — but morphine is bitter and poisonous to insects, so insects leave the plant alone. For humans, that same morphine is a powerful painkiller medicine.

Analogy: Primary metabolites are like the rice and dal a person eats every day to stay alive. Secondary metabolites are like the spices, perfume and medicines in the house — not needed for staying alive minute to minute, but they protect the house, make it smell nice, and heal people when they are sick.

Key takeaway: Primary metabolites = needed for growth (sugars, proteins, fats). Secondary metabolites = extra chemicals for protection and attraction — and these are the source of most plant medicines.

1.3 Definitions you must memorise

Term	Very simple meaning
Metabolite	Any chemical made inside a living plant or animal by its life processes.
Primary metabolite	A chemical every plant needs for growth and energy (carbohydrates, proteins, lipids).
Secondary metabolite	A special chemical a plant makes for defence, attraction or competition — the source of most herbal drugs.
Phytoconstituent	A chemical constituent found in a plant ("phyto" = plant).
Crude drug	A plant or plant part used as medicine in its natural, unprocessed form (dried leaves, bark, seeds, etc.).
Pharmacognostic study	The complete scientific study of a crude drug: its source plant, how it looks, what chemicals it contains, how to test it, and how it is used.

Terminology alert: Students often confuse *metabolite* with *medicine*. A metabolite is simply a chemical made by the plant. It becomes a *medicine* only when humans use it to treat disease.

1.4 General classification of secondary metabolites (the seven families of Unit III)

Technical concept: Secondary metabolites are grouped by the kind of chemistry they contain.

Simple explanation: Just as students in a college are grouped into departments (pharmacy, nursing, etc.), plant chemicals are grouped into families based on what atoms and structures they contain. Unit III studies **seven families**:

Family (group)	What it is, in simple words	Syllabus drugs in this family
1. Alkaloids	Chemicals that contain **nitrogen** and are usually bitter and strongly active on the body	Vinca, Rauwolfia, Opium
2. Volatile oils	Oils that **evaporate easily** and give plants their smell (also called essential oils)	Lemongrass, Clove, Cinnamon, Fennel
3. Tannins	Bitter, **astringent** chemicals that make your mouth feel dry and puckered (like unripe banana)	Myrobalans, Catechu, Pomegranate
4. Resins	Sticky, gum-like substances that plants release when the bark is injured — they **do not dissolve in water**	Guggul, Asafoetida
5. Glycosides	Chemicals made of a **sugar part + a non-sugar part** joined together	Senna, Liquorice, Digitalis
6. Phenylpropanoids and flavonoids	Yellow-coloured **plant pigments** and related protective chemicals (many are antioxidants)	Green tea, Ginkgo, Flax seed
7. Iridoids, other terpenoids and naphthoquinones	**Bitter** protective chemicals built from small repeating units (isoprene units); includes the antimalarial artemisinin	Gentian, Artemisia

Mnemonic for the seven groups (in syllabus order): "**A**ll **V**illage **T**eachers **R**ead **G**ood **P**oems **I**n **T**emple" → **A**lkaloids, **V**olatile oils, **T**annins, **R**esins, **G**lycosides, **P**henylpropanoids/flavonoids, **I**ridoids/**T**erpenoids.

Analogy: These seven families are like seven shelves in a medicine shop. When you learn a new drug, first ask: "Which shelf does it belong to?" That one question organises the whole unit.

Key takeaway: Unit III = 7 chemical families, 20 crude drugs. Learn the family first, then the drug.

1.5 Pharmacy relevance

Almost every plant-derived medicine in a pharmacy — morphine injections, digoxin tablets, senna laxatives, artemisinin antimalarials, vincristine cancer injections — is a secondary metabolite or made from one. A pharmacist who can identify these drugs and their tests can check the **quality** of herbal raw materials and counsel patients about safe use.

1.6 Common confusions

Confusion	Correction
"Volatile oil" and "fixed oil" are the same	No. Volatile oils evaporate and smell (clove oil); fixed oils are greasy cooking-type oils that do not evaporate (castor oil). Different families, different units.
Alkaloids always contain nitrogen	Yes — that is their defining feature. If a question asks "which group contains nitrogen?", the answer is alkaloids.
Tannins and resins feel the same	No. Tannins are water-soluble and astringent; resins are water-insoluble and sticky.

1.7 One-minute revision — Chapter 1

- Primary metabolites = growth chemicals (sugars, proteins, fats). Secondary metabolites = defence/attraction chemicals = most herbal drugs.
- 7 families: Alkaloids, Volatile oils, Tannins, Resins, Glycosides, Phenylpropanoids & flavonoids, Iridoids/terpenoids/naphthoquinones.
- 20 drugs in this unit (3 + 4 + 3 + 2 + 3 + 3 + 2).
- Mnemonic: "All Village Teachers Read Good Poems In Temple."

1.8 Practice questions — Chapter 1

MCQs

1. Which of the following is a secondary metabolite? (a) Glucose (b) Morphine (c) Starch (d) Amino acid
2. The defining element in alkaloids is: (a) Sulphur (b) Nitrogen (c) Phosphorus (d) Iron
3. Glycosides are made of: (a) Two sugars (b) Sugar + non-sugar part (c) Two alkaloids (d) Oil + resin

Short answers

1. Define primary and secondary metabolites with one example each.
2. Why do plants produce secondary metabolites? Give two reasons.

Long answer

1. Classify secondary metabolites studied in Unit III and give two drug examples for each class.

Viva

1. What is a crude drug? 2. Name the seven secondary metabolite groups in order.

Chapter 2 — General Identification Tests for Secondary Metabolites

2.1 Learning objectives

1. Explain what a phytochemical (identification) test is.
2. List the standard colour/precipitate tests for each of the seven families.
3. Interpret a positive test result correctly in exams and practicals.

2.2 The big idea: chemical detective work

Technical concept: *Phytochemical screening* means testing a plant extract with chemical reagents and watching for a colour change or a solid forming (precipitate).

Simple explanation: You cannot see morphine or tannin with your eyes. But if you add a special chemical (a **reagent**) to the plant extract, a hidden chemical announces itself — the liquid turns a bright colour, or a solid falls out. That visible change is the "identification test."

Example: Add Dragendorff's reagent (a solution containing bismuth) to a solution of vinca leaf extract. If alkaloids are present, an **orange-red solid** (precipitate) appears. No orange-red solid = probably no alkaloids.

Analogy: It is like a pregnancy test strip or a litmus paper — you add the sample, and a colour tells you the hidden answer.

Key takeaway: Reagent + plant extract → colour or precipitate = that chemical family is present.

2.3 Master table: identification tests for each family

Family	Test name	What you do (in short)	Positive result means
Alkaloids	Mayer's test	Add potassium mercuric iodide solution	**Cream/white precipitate**
	Dragendorff's test	Add potassium bismuth iodide solution	**Orange-red precipitate**
	Wagner's test	Add iodine in potassium iodide	**Reddish-brown precipitate**
	Hager's test	Add saturated picric acid solution	**Yellow precipitate**
Glycosides (anthraquinone type, e.g. senna)	Bornträger's test	Boil with dilute acid, extract with organic solvent, add ammonia	**Pink to red colour** in the ammonia layer
Glycosides (cardiac type, e.g. digitalis)	Keller–Kiliani test	Dissolve in glacial acetic acid + ferric chloride, layer with conc. sulphuric acid	**Reddish-brown ring** at the junction, bluish-green upper layer
	Legal's test	Dissolve in pyridine, add sodium nitroprusside	**Pink to red colour**
	Baljet's test	Add picric acid solution	**Orange colour**
Tannins	Ferric chloride test	Add dilute ferric chloride	**Blue-black** (hydrolysable tannins) or **green** (condensed tannins)
	Gelatin test	Add gelatin solution	**White precipitate**
	Lead acetate test	Add lead acetate	**White/cream precipitate**
Volatile oils	Solubility test	Shake with alcohol	Dissolves (volatile oils are **alcohol-soluble**)
	Grease-spot test	Put a drop on filter paper	**No permanent greasy spot** (the spot disappears as the oil evaporates — unlike fixed oils)
Resins	Alcohol–water test	Dissolve in alcohol, then pour into water	**Milky turbidity / precipitate** (resins come out of solution)
Flavonoids	Shinoda test	Add magnesium turnings + conc. HCl	**Pink to red colour**
	Alkaline reagent test	Add sodium hydroxide	**Intense yellow**, which fades when acid is added

Terminology alert: A *precipitate* is a solid that forms and falls out of a liquid — like paneer forming when milk curdles. *Turbidity* is cloudiness. Both count as positive results.

2.4 Common mistakes

1. **Writing only the test name without the observation.** In exams, "Dragendorff's test" alone gets half marks — always write "Dragendorff's test → orange-red precipitate."
2. **Mixing up Mayer's and Dragendorff's colours.** Memory hook: **M**ayer's = **M**ilky (cream-white); **D**ragendorff's = **D**ark orange-red.
3. **Saying Bornträger's test is for all glycosides.** It is specifically for **anthraquinone** glycosides (senna type). Cardiac glycosides (digitalis type) need Keller–Kiliani/Legal/Baljet.

2.5 One-minute revision — Chapter 2

- Alkaloids: Mayer's (cream ppt), Dragendorff's (orange-red ppt), Wagner's (reddish-brown ppt), Hager's (yellow ppt).
- Senna-type glycosides: Bornträger's (pink-red). Digitalis-type: Keller–Kiliani (brown ring), Legal's (pink-red), Baljet's (orange).
- Tannins: $FeCl_3$ (blue-black or green), gelatin (white ppt).
- Volatile oils: alcohol-soluble, no permanent grease spot.
- Resins: alcohol solution + water → milky turbidity.
- Flavonoids: Shinoda (pink-red), NaOH (yellow).
- Terpenoids: Salkowski (reddish-brown), Liebermann–Burchard (violet/blue-green).

2.6 Practice questions — Chapter 2

MCQs

1. Orange-red precipitate with Dragendorff's reagent indicates: (a) Tannins (b) Alkaloids (c) Glycosides (d) Resins
2. Bornträger's test gives a pink colour with: (a) Digitalis (b) Senna (c) Clove (d) Guggul
3. Keller–Kiliani test is used for: (a) Cardiac glycosides (b) Tannins (c) Alkaloids (d) Volatile oils

Short answers

1. Write the observation for Mayer's, Wagner's and Hager's tests.
2. How do you distinguish a volatile oil from a fixed oil using filter paper?

Application-based

1. A leaf extract gives a cream precipitate with Mayer's reagent and a pink colour in the Shinoda test. Which two families are present? (Answer: alkaloids and flavonoids.)

Viva

1. What is a reagent? 2. Why does resin give turbidity when its alcohol solution is poured into water?

Chapter 3 — Alkaloids: Vinca, Rauwolfia, Opium

3.1 Learning objectives

1. Define alkaloids and list their general properties.
2. Give the pharmacognostic study of vinca, rauwolfia and opium in the standard table format.
3. Name the general alkaloid tests and one specific test for opium.

3.2 The big idea: nitrogen-containing plant medicines

Technical concept: Alkaloids are nitrogen-containing, usually bitter, physiologically active plant compounds.

Simple explanation: The word "alkaloid" means "like an alkali" — these chemicals behave like mild bases (the opposite of acids). They almost always contain **nitrogen**, they usually taste **bitter**, and very small amounts have strong effects on the human body — that is why so many are powerful medicines (and also why some are poisons).

Example: Quinine (from cinchona bark) is an alkaloid that cures malaria; morphine (from opium) is an alkaloid that kills pain. Both are bitter, both contain nitrogen, both work in tiny doses.

Analogy: Alkaloids are like the chilli in food — a tiny amount changes everything. A little makes the dish tasty (medicine); too much burns (poison). Dose decides everything.

Key takeaway: Alkaloid = nitrogen + bitter + strong effect in small dose. Always handle and dose with respect.

> **Terminology alert:** *Physiologically active* means "it changes how the body works" — for example, lowering blood pressure or stopping pain.

3.3 Drug 1 — Vinca (Catharanthus)

Point	Details
Biological source	Dried whole plant (leaves are the richest part) of *Catharanthus roseus* (L.) G. Don, family Apocynaceae. Synonym: *Vinca rosea* — hence the common name "vinca".
Common names	Madagascar periwinkle, Sadabahar (Hindi — "ever-blooming")
Distribution	Native to Madagascar; widely cultivated in India (Tamil Nadu, Karnataka, Madhya Pradesh and others) as an ornamental and medicinal crop.
Identifying characters	Opposite, glossy, oval green leaves; pink or white five-petalled flowers blooming through most of the year; slender stems. The leaves are the commercial part for alkaloid extraction.
Chemical constituents	**Indole alkaloids** — the famous pair **vincristine** and **vinblastine** (dimeric alkaloids from leaves), plus ajmalicine, serpentine, vindoline and catharanthine.
Specific tests	General alkaloid tests (Mayer's → cream ppt; Dragendorff's → orange-red ppt); identification by thin-layer chromatography (TLC) comparing with reference alkaloids.
Therapeutic uses	Vincristine and vinblastine are **anticancer (antineoplastic) drugs** used in chemotherapy of leukaemias, lymphomas (including Hodgkin's disease) and some solid tumours. Used only in hospitals under a cancer specialist.
Commercial applications	Industrial extraction of vincristine and vinblastine for anticancer injections; ajmalicine is also extracted for circulatory preparations.

Pharmacy relevance: Vincristine and vinblastine injections are life-saving but highly toxic — they must never be given by the wrong route, and handling needs gloves. A pharmacist must know these come from a plant but are used as pure, precisely dosed chemicals.

India context: Sadabahar grows easily in Indian gardens and roadsides, which is why Indian students see it everywhere — but the garden plant is not the medicine; the pure alkaloids extracted in factories are.

3.4 Drug 2 — Rauwolfia (Indian Snakeroot)

Point	Details
Biological source	Dried roots of *Rauwolfia serpentina* (L.) Benth., family Apocynaceae.
Common names	Indian snakeroot, Sarpagandha ("smell of snake" — traditionally used against snakebite)
Distribution	Sub-Himalayan tracts, Bihar, Odisha, Madhya Pradesh, Western Ghats; collected from the wild and also cultivated in India.
Identifying characters	Tortuous (twisted), cylindrical root pieces with greyish-brown wrinkled bark; fracture is short; taste is bitter.
Chemical constituents	**Reserpine** (the most famous), rescinnamine, deserpidine, ajmaline, ajmalicine, serpentine — a mixture of indole alkaloids.
Specific tests	General alkaloid precipitation tests; reserpine identified and assayed by chromatographic methods (TLC/HPLC) against reference reserpine.
Therapeutic uses	**Antihypertensive** (lowers high blood pressure) and **tranquillizer/sedative** — reserpine calms severe agitation. (Modern use has reduced because of depressive side effects, but it remains a classic exam drug.)
Commercial applications	Manufacture of reserpine for antihypertensive formulations; raw material for Ayurvedic calmatives.

Common confusion: Students mix up *Rauwolfia* (antihypertensive root, Apocynaceae) with *Vinca* (anticancer leaf, same family Apocynaceae). Memory hook: "**R**auwolfia = **R**oot = **R**eserpine = **R**educes blood pressure." "**V**inca = lea**V**es = **V**incristine = fights cancer."

3.5 Drug 3 — Opium

Point	Details
Biological source	The dried **latex** (milky juice) obtained by incising the **unripe capsules** of *Papaver somniferum* L., family Papaveraceae.
Common names	Afeem (Hindi)
Distribution	Cultivated under strict government licence in India (notably parts of Madhya Pradesh, Uttar Pradesh and Rajasthan); the crop is legally controlled everywhere.
Identifying characters	Dark brown rounded cakes or lumps; characteristic heavy odour; bitter taste; the latex darkens as it dries.
Chemical constituents	**Morphine** (the main alkaloid), **codeine**, **thebaine**, **papaverine**, **noscapine** (also called narcotine), plus meconic acid.
Specific tests	General alkaloid tests; **meconic acid test** — opium extract with ferric chloride gives a deep **blood-red colour** (specific for opium); morphine also identified by TLC.
Therapeutic uses	**Morphine** — powerful **analgesic** (painkiller) for severe pain; **codeine** — **antitussive** (stops cough); **papaverine** — **antispasmodic** (relaxes smooth-muscle spasm). All are used in carefully controlled doses.
Commercial applications	Industrial source of morphine and codeine for the pharmaceutical industry; poppy straw is also processed. Strictly regulated under narcotic laws (in India, the NDPS Act) — illegal possession is a serious offence.

Terminology alert: *Latex* here means the plant's milky juice — not the rubber of surgical gloves (though both are plant latices!). *Analgesic* = painkiller ("an-" = without, "-algesic" = pain). *Antitussive* = cough-stopper.

Common mistake: Saying "opium is obtained from ripe capsules." It is from **unripe** capsules — the milky latex flows only before the capsule ripens and dries.

3.6 Comparison table — the three alkaloid drugs

Feature	Vinca	Rauwolfia	Opium
Part used	Leaves (whole plant)	Roots	Latex of unripe capsules
Main alkaloid(s)	Vincristine, vinblastine	Reserpine	Morphine, codeine
Main use	Anticancer	Antihypertensive, tranquillizer	Analgesic, antitussive
Special test	TLC of alkaloids	Chromatography of reserpine	Meconic acid test (blood-red with $FeCl_3$)

3.7 Mnemonics

- **V**inca **V**anquishes cancer (V = vincristine/vinblastine).
- **R**auwolfia **R**elaxes (blood pressure and nerves — reserpine).
- **O**pium **O**ffers **O**bjectives: **M**orphine for pain, **C**odeine for cough, **P**apaverine for spasm — "**M**y **C**at **P**urrs."

3.8 One-minute revision — Chapter 3

- Alkaloid = nitrogen-containing, bitter, strongly active.
- Vinca (leaf, *Catharanthus roseus*): vincristine/vinblastine → anticancer.
- Rauwolfia (root, *R. serpentina*): reserpine → antihypertensive/tranquillizer.
- Opium (latex of unripe capsule, *Papaver somniferum*): morphine (analgesic), codeine (antitussive), papaverine (antispasmodic); meconic acid test → blood-red with $FeCl_3$.
- Opium is a controlled narcotic — legal only under licence.

3.9 Practice questions — Chapter 3

MCQs

1. Vincristine and vinblastine are obtained from: (a) Rauwolfia root (b) Vinca leaves (c) Opium latex (d) Senna leaves
2. Reserpine is used as: (a) Anticancer (b) Antihypertensive (c) Antimalarial (d) Laxative
3. The meconic acid test is specific for: (a) Vinca (b) Rauwolfia (c) Opium (d) Digitalis
4. Codeine is used as: (a) Analgesic (b) Antitussive (c) Antispasmodic (d) Purgative

Short answers

1. Give the biological source and one therapeutic use of vinca and rauwolfia.
2. Why is opium collection done from unripe capsules?

Long answer

1. Describe the pharmacognostic study of opium under the standard headings.

Application-based

1. A patient on reserpine complains of low mood. Which drug is responsible, and what class does it belong to? (Answer: reserpine from rauwolfia, an indole alkaloid; depressive mood is a known caution with it.)

Viva

1. Which family do all three drugs of this chapter belong to? 2. Name the two anticancer alkaloids of vinca.

Chapter 4 — Volatile Oils: Lemongrass, Clove, Cinnamon, Fennel

4.1 Learning objectives

1. Define volatile oils and distinguish them from fixed oils.
2. Give the pharmacognostic study of lemongrass, clove, cinnamon and fennel.
3. Name the main chemical constituent and use of each drug.

4.2 The big idea: the smell of the plant

Technical concept: Volatile oils (essential oils) are odorous, evaporating plant oils, usually obtained by steam distillation.

Simple explanation: Crush a clove bud or an orange peel between your fingers — the strong smell that hits your nose is the volatile oil escaping into the air. "Volatile" means "flies away easily." Unlike cooking oil, these oils **evaporate** and leave no permanent greasy mark on paper.

Example: Lemongrass oil smells strongly of lemon because it contains **citral**. Clove oil numbs a toothache because it contains **eugenol**.

Analogy: Volatile oils are like perfume — you smell them because they rise into the air. Fixed (cooking) oils are like ghee — they stay in the pan and make it greasy.

Key takeaway: Volatile oil = smells strong + evaporates + obtained by steam distillation. Uses: flavouring, carminative (relieves gas), perfumery.

> **Terminology alert:** *Carminative* = a medicine that relieves stomach gas and griping ("carminative" comes from a Latin word for cleansing the bowel of wind). *Steam distillation* = passing steam through plant material; the steam carries the oil vapours, which are then cooled back to liquid.

4.3 Drug 1 — Lemongrass (oil)

Point	Details
Biological source	Volatile oil obtained by **steam distillation** of the leaves of *Cymbopogon citratus* / *Cymbopogon flexuosus*, family Poaceae (Gramineae).
Common names	Lemon grass, "Gandhatrina"
Distribution	Cultivated in Kerala, Assam, Uttar Pradesh, Karnataka and other Indian states; also grown in other tropical countries.
Identifying characters	Yellow to brownish-yellow mobile oil with an intense **lemon-like odour**; the leaves are long, grass-like blades.
Chemical constituents	**Citral** (a mixture of geranial and neral — the lemon-smelling aldehyde, the major component), geraniol.
Specific tests	Characteristic lemon odour; determination of aldehyde (citral) content; identification by TLC/gas chromatography.
Therapeutic uses	**Carminative**, flavouring agent in medicines and foods.
Commercial applications	Commercial source of **citral**, which is converted into ionones and used in vitamin A manufacture; widely used in perfumery, soaps and cosmetics.

4.4 Drug 2 — Clove

Point	Details
Biological source	Dried **flower buds** of *Syzygium aromaticum* (L.) Merr., family Myrtaceae. Synonym: *Eugenia caryophyllus*.
Common names	Laung (Hindi)
Distribution	Native to the Molucca (spice) islands; cultivated in Kerala, Tamil Nadu and Karnataka.
Identifying characters	Dark brown, nail-shaped buds: a four-toothed calyx cup topped by a globular head of unopened petals; strong aromatic odour; pungent taste. A quality check: good cloves **float vertically** in water (the dense oil sinks the head down).
Chemical constituents	**Eugenol** (the major component), eugenyl acetate, caryophyllene.
Specific tests	**Ferric chloride test** — eugenol is phenolic and gives a **blue colour**; pressed bud exudes oil; clove oil is heavier than water and sinks.
Therapeutic uses	**Dental analgesic** (toothache — clove oil numbs the gum), **carminative**, flavouring.
Commercial applications	Spice; clove oil; eugenol is used to make **vanillin** (artificial vanilla flavour) and **zinc oxide–eugenol dental cement**.

4.5 Drug 3 — Cinnamon

Point	Details
Biological source	Dried **inner bark** of *Cinnamomum zeylanicum* Nees (syn. *C. verum*), family Lauraceae.
Common names	Dalchini (Hindi), true cinnamon
Distribution	Sri Lanka and South India — Kerala, Tamil Nadu, Karnataka.
Identifying characters	Thin, papery **quills** (rolled bark tubes, often compound quills with smaller quills inside); light brown; sweet, aromatic odour; sweet then warm-pungent taste.
Chemical constituents	**Cinnamaldehyde** (the major component — the warm sweet smell), eugenol.
Specific tests	Identification of cinnamaldehyde by TLC; determination of volatile-oil content.
Therapeutic uses	**Carminative**, flavouring agent, mild astringent; used in stomach remedies.
Commercial applications	Major spice; cinnamon oil in perfumery, confectionery and liquors.

Common confusion: *Cinnamon* (thin true-cinnamon quills, sweet) vs *cassia* (thicker, darker, harsher bark of *Cinnamomum cassia* — often sold as "cinnamon" but a different, cheaper drug). In exams, write the source as *C. zeylanicum* for true cinnamon.

4.6 Drug 4 — Fennel

Point	Details
Biological source	Dried **ripe fruits** (called cremocarps, splitting into two mericarps) of *Foeniculum vulgare* Mill., family Apiaceae (Umbelliferae).
Common names	Saunf (Hindi)
Distribution	Gujarat, Rajasthan, Uttar Pradesh; Mediterranean region.
Identifying characters	Yellowish-green, ribbed, oval fruits with a sweet aromatic odour and sweet taste — the familiar mouth-freshener seed.
Chemical constituents	**Anethole** (the major component — sweet anise-like smell), fenchone.
Specific tests	TLC identification of anethole; determination of volatile-oil content.
Therapeutic uses	**Carminative** — famously given to infants as **gripe water** for colic; mild expectorant; flavouring that masks bitter tastes.
Commercial applications	Spice and mouth freshener (saunf); fennel oil in liquors, pickles and paediatric syrups.

4.7 Comparison table — the four volatile-oil drugs

Feature	Lemongrass	Clove	Cinnamon	Fennel
Part used	Leaves (oil)	Flower buds	Inner bark	Ripe fruits
Main constituent	Citral	Eugenol	Cinnamaldehyde	Anethole
Signature test	Citral content	$FeCl_3$ → blue	TLC of cinnamaldehyde	TLC of anethole
Main use	Carminative, citral source	Dental analgesic	Carminative, spice	Carminative (gripe water)

4.8 Mnemonics

- "**L**emon **C**loves **C**alm **F**latulence" — **L**emongrass (citral), **C**love (eugenol), **C**innamon (cinnamaldehyde), **F**ennel (anethole) — all carminatives.
- Pair each drug with its chemical: "**L**emongrass–cita**L**", "**C**love–eugeno**L**" (both end in L!), "**C**innamon–**C**innamaldehyde", "**F**ennel–anethole (**F** for **F**lavour-sweet)".

4.9 One-minute revision — Chapter 4

- Volatile oil = evaporates, smells, steam-distilled; no permanent grease spot.
- Lemongrass: citral — carminative, vitamin A raw material.
- Clove (flower buds): eugenol — toothache, $FeCl_3$ blue test.
- Cinnamon (inner bark quills): cinnamaldehyde — carminative spice.
- Fennel (fruits): anethole — gripe water carminative.

4.10 Practice questions — Chapter 4

MCQs

1. Eugenol is the main constituent of: (a) Cinnamon (b) Clove (c) Fennel (d) Lemongrass
2. Cinnamaldehyde is found in: (a) Bark (b) Buds (c) Fruits (d) Leaves
3. Gripe water contains: (a) Clove (b) Fennel (c) Cinnamon (d) Lemongrass
4. Blue colour with ferric chloride is given by: (a) Anethole (b) Eugenol (c) Citral (d) Cinnamaldehyde

Short answers

1. Distinguish volatile oils from fixed oils with two points.
2. Give the biological source and main constituent of clove and cinnamon.

Long answer

1. Describe the pharmacognostic study of clove under the standard headings.

Viva

1. Why is clove oil used in toothache? 2. What is citral and where is it used industrially?

Chapter 5 — Tannins: Myrobalans, Catechu, Pomegranate

5.1 Learning objectives

1. Define tannins and explain astringency.
2. Distinguish hydrolysable and condensed tannins.
3. Give the pharmacognostic study of myrobalans, catechu and pomegranate.

5.2 The big idea: the puckering chemicals

Technical concept: Tannins are water-soluble plant polyphenols that precipitate proteins — this causes the **astringent** (mouth-puckering) effect.

Simple explanation: Bite into an unripe banana or sip very strong black tea — your mouth feels dry, rough and puckered. That feeling is called **astringency**, and the chemicals causing it are **tannins**. They work by grabbing the proteins in your saliva and skin and clumping them together (precipitation) — which tightens tissues, stops minor bleeding and makes a protective layer.

Example: When you have diarrhoea, astringent tannin medicines tighten the loose intestinal lining and reduce fluid loss. That is why myrobalan and catechu are used for diarrhoea.

Analogy: Tannins are like alum (fitkari) used by barbers — they tighten and close. Just as alum stops a shaving cut from bleeding, tannins tighten loose, weeping tissues.

Key takeaway: Tannin = water-soluble + puckering/astringent + precipitates protein. Main uses: astringent (diarrhoea), tanning leather, inks and dyes.

> **Terminology alert:** *Astringent* = causes contraction/tightening of tissues. *Hydrolysable tannins* = tannins that break apart in water/acid into gallic or ellagic acid (gallotannins, ellagitannins). *Condensed tannins* = tannins that do not break apart so easily; they give a **green** colour with ferric chloride (also called proanthocyanidins).

5.3 Drug 1 — Myrobalans (Chebulic Myrobalan)

Point	Details
Biological source	Dried **mature fruits** of *Terminalia chebula* Retz., family Combretaceae.
Common names	Haritaki, Harad (Hindi), Chebulic myrobalan
Distribution	Sub-Himalayan tracts, Madhya Pradesh, Maharashtra, Tamil Nadu — common in Indian deciduous forests.
Identifying characters	Ovoid, wrinkled, yellowish-brown to blackish fruits with a hard stone inside; astringent taste.
Chemical constituents	**Hydrolysable tannins** — chebulinic acid, chebulagic acid, gallic acid, ellagic acid.
Specific tests	Tannin tests: ferric chloride → **blue-black colour** (hydrolysable type); gelatin solution → white precipitate.
Therapeutic uses	**Astringent** (diarrhoea, dysentery); mild **laxative** in larger doses; a chief ingredient of **Triphala** (the famous Ayurvedic combination of three myrobalans).
Commercial applications	Tanning of leather; manufacture of inks and dyes; large-scale Ayurvedic formulations.

5.4 Drug 2 — Catechu

Point	Details
Biological source	Two kinds: **(a) Black catechu (cutch)** — dried aqueous extract of the **heartwood** of *Acacia catechu* Willd., family Leguminosae; **(b) Pale catechu (gambier)** — dried aqueous extract of the **leaves and young twigs** of *Uncaria gambir* Roxb., family Rubiaceae.
Common names	Katha (Hindi — the brown paste in paan)
Distribution	*Acacia catechu* — sub-Himalayan tracts, Bihar, Madhya Pradesh; *Uncaria gambir* — Malaysia/Indonesia region.
Identifying characters	Black catechu: dark brown to black shining masses; pale catechu: light brown cubes or masses; both astringent, slightly sweet then bitter.
Chemical constituents	**Condensed tannins** — catechin, catechutannic acid.
Specific tests	Ferric chloride → **green colour** (condensed type); gelatin → precipitate.
Therapeutic uses	**Astringent** (diarrhoea); used in paan (betel quid) as katha.
Commercial applications	Dyeing (khaki dye — the colour of "khaki" cloth comes from catechu!), tanning, paan masala industry.

5.5 Drug 3 — Pomegranate

Point	Details
Biological source	Dried **bark of stem and root**, and dried **rind of the fruit**, of *Punica granatum* L., family Punicaceae (Lythraceae).
Common names	Anar (Hindi)
Distribution	Maharashtra, Karnataka, Gujarat, Himachal Pradesh; Mediterranean countries.
Identifying characters	Bark in greyish quills; fruit rind reddish-brown, leathery; astringent taste.
Chemical constituents	**Ellagitannins** (hydrolysable) — punicalagin, punicalin; the bark also contains the alkaloid **pelletierine**.
Specific tests	Tannin tests ($FeCl_3$ → blue-black); pelletierine answers general alkaloid tests.
Therapeutic uses	Bark — traditional **anthelmintic** (expels intestinal worms, especially tapeworm); rind — **astringent** for diarrhoea and dysentery.
Commercial applications	Tanning and dyeing; Ayurvedic astringent formulations; pomegranate rind powder in herbal products.

Terminology alert: *Anthelmintic* = a medicine that expels intestinal worms ("anti-" = against, "helminth" = worm).

5.6 Comparison table — the three tannin drugs

Feature	Myrobalans	Catechu	Pomegranate
Part used	Fruits	Heartwood extract / leaf extract	Bark, fruit rind
Tannin type	Hydrolysable (blue-black with $FeCl_3$)	Condensed (green with $FeCl_3$)	Hydrolysable (ellagitannins)
Special point	Triphala ingredient	Khaki dye source	Pelletierine alkaloid in bark

5.7 Common mistakes

- **Forgetting there are two catechus.** Black (Acacia heartwood) and pale (Uncaria leaves) — examiners love asking "distinguish black and pale catechu."
- **Writing "tannins are insoluble in water."** Wrong — tannins ARE water-soluble (that is how katha dissolves in the mouth). It is **resins** that are water-insoluble.

5.8 One-minute revision — Chapter 5

- Tannin = astringent, precipitates protein, water-soluble.
- Myrobalans (*Terminalia chebula*, fruit): chebulinic/chebulagic acids — Triphala, diarrhoea.
- Catechu: black (*Acacia catechu* heartwood) + pale (*Uncaria gambir* leaves); catechin — khaki dye, paan.
- Pomegranate (*Punica granatum*, bark/rind): punicalagin; bark anthelmintic.
- $FeCl_3$: blue-black = hydrolysable; green = condensed.

5.9 Practice questions — Chapter 5

MCQs

1. Chebulinic acid is found in: (a) Catechu (b) Myrobalans (c) Pomegranate (d) Guggul
2. Green colour with ferric chloride indicates: (a) Hydrolysable tannins (b) Condensed tannins (c) Alkaloids (d) Glycosides
3. Pale catechu is obtained from: (a) Acacia catechu (b) Uncaria gambir (c) Terminalia chebula (d) Punica granatum
4. Pelletierine is present in the bark of: (a) Cinnamon (b) Pomegranate (c) Catechu (d) Myrobalans

Short answers

1. Define astringency and give two therapeutic uses of astringents.
2. Distinguish black catechu from pale catechu.

Long answer

1. Describe the pharmacognostic study of myrobalans under the standard headings.

Viva

1. Why does strong tea feel puckering? 2. Name the Ayurvedic preparation containing myrobalans.

Chapter 6 — Resins: Guggul, Asafoetida

6.1 Learning objectives

1. Define resins and oleo-gum-resins.
2. Give the pharmacognostic study of guggul and asafoetida.
3. Explain the alcohol–water test for resins.

6.2 The big idea: the plant's sticky bandage

Technical concept: Resins are water-insoluble, alcohol-soluble plant exudates; an **oleo-gum-resin** additionally contains volatile oil ("oleo") and gum.

Simple explanation: When a tree's bark is cut, sticky juice oozes out and hardens in the air — that is a resin. It is the plant's bandage: it seals the wound and its strong smell keeps insects away. Resins **do not dissolve in water** (try mixing candle wax with water — same idea) but **dissolve in alcohol**.

Example: Guggul is the hardened oleo-gum-resin of the *Commiphora* tree; asafoetida ("hing") is the oleo-gum-resin of *Ferula* roots — the strong-smelling spice in Indian tadka.

Analogy: Resin is like fevicol glue — sticky, water-resistant, and it hardens on exposure to air. Tannins were like alum (water-soluble tighteners); resins are the opposite — water-hating stickers.

Key takeaway: Resin = sticky + water-insoluble + alcohol-soluble. Test: dissolve in alcohol, pour into water → **milky turbidity**.

> **Terminology alert:** *Oleo-gum-resin* = three parts in one — **oleo** (volatile oil, gives smell) + **gum** (water-soluble part) + **resin** (alcohol-soluble part). *Exudate* = any substance that oozes out of a plant.

6.3 Drug 1 — Guggul

Point	Details
Biological source	**Oleo-gum-resin** obtained from the bark of *Commiphora mukul* Engl. (syn. *C. wightii*), family Burseraceae.
Common names	Guggul, Indian bdellium
Distribution	Arid regions of Rajasthan, Gujarat and Karnataka; collected by tapping the bark.
Identifying characters	Brown, translucent tears or irregular lumps; aromatic balsamic odour; bitter taste; softens on warming.
Chemical constituents	**Guggulsterones E and Z** (the active steroidal compounds), myrrhanol and related terpenoids.
Specific tests	Resin tests: soluble in alcohol, and the alcoholic solution gives **milky turbidity** when poured into water; identification of guggulsterones by TLC.
Therapeutic uses	**Hypolipidaemic** (lowers blood cholesterol — a famous Ayurvedic claim now studied scientifically), **anti-inflammatory** (joint pains/arthritis in Ayurveda).
Commercial applications	Large-scale Ayurvedic formulations (guggul tablets, yogaraj guggulu); incense and dhoop.

Terminology alert: *Hypolipidaemic* = lowers lipids (fats/cholesterol) in the blood. *Tapping* = making small cuts in bark to collect the oozing resin.

6.4 Drug 2 — Asafoetida

Point	Details
Biological source	**Oleo-gum-resin** obtained from the rhizomes and roots of *Ferula asafoetida* L. / *F. foetida*, family Apiaceae.
Common names	Hing (Hindi), devil's dung (English — because of the strong smell!)
Distribution	Afghanistan and Iran; India **imports** almost its entire commercial supply (it is not a cultivated crop in India on a commercial scale).
Identifying characters	Yellowish-brown tears or masses with an intensely **pungent, garlic-like (alliaceous) odour**; bitter, acrid taste. The smell is so strong that a pinch flavours a whole dish.
Chemical constituents	Ferulic acid esters, **umbelliferone**, and sulphur-containing volatile compounds (disulphides — these give the garlic smell).
Specific tests	Resin tests (alcohol-soluble; milky emulsion when triturated with water); with ammonia solution it shows **blue fluorescence** (due to umbelliferone) — a classic identification test.
Therapeutic uses	**Carminative** and **antispasmodic** — the classic home remedy for stomach ache, gas and infant colic.
Commercial applications	Essential Indian condiment (hing in tadka, pickles); flavouring in the food industry.

Common confusion: Students write "asafoetida is cultivated in India." The safe exam answer: commercial asafoetida is **imported from Afghanistan/Iran**; India's own production is negligible.

6.5 Comparison table — the two resins

Feature	Guggul	Asafoetida
Source plant	*Commiphora mukul* (bark)	*Ferula* species (roots/rhizomes)
Odour	Balsamic, pleasant	Pungent, garlic-like
Main constituents	Guggulsterones E & Z	Ferulic esters, umbelliferone, sulphur compounds
Special test	TLC of guggulsterones	Blue fluorescence with ammonia
Main use	Hypolipidaemic, anti-inflammatory	Carminative, condiment

6.6 One-minute revision — Chapter 6

- Resin = water-insoluble, alcohol-soluble; oleo-gum-resin = oil + gum + resin.
- Test: alcohol solution + water → milky turbidity.
- Guggul (*Commiphora mukul*): guggulsterones — cholesterol-lowering, anti-inflammatory.
- Asafoetida (*Ferula* spp., imported): hing — carminative; blue fluorescence with ammonia (umbelliferone).

6.7 Practice questions — Chapter 6

MCQs

1. Guggulsterones are present in: (a) Asafoetida (b) Guggul (c) Catechu (d) Myrobalans
2. Blue fluorescence with ammonia is shown by: (a) Guggul (b) Asafoetida (c) Clove (d) Senna
3. An oleo-gum-resin contains: (a) Only resin (b) Oil + gum + resin (c) Only gum (d) Only oil

Short answers

1. Define oleo-gum-resin with two examples.
2. Describe the alcohol–water test for resins and explain the observation.

Long answer

1. Describe the pharmacognostic study of asafoetida under the standard headings.

Viva

1. Why does hing smell of garlic? 2. How is guggul collected?

Chapter 7 — Glycosides: Senna, Liquorice, Digitalis

7.1 Learning objectives

1. Define glycosides and name their two parts.
2. Distinguish anthraquinone glycosides from cardiac glycosides.
3. Give the pharmacognostic study of senna, liquorice and digitalis.
4. State the safety caution for digitalis.

7.2 The big idea: sugar + active part, joined together

Technical concept: A glycoside = a **sugar part (glycone)** joined to a **non-sugar part (aglycone)**.

Simple explanation: Imagine a medicine molecule wearing a sugar coat. The sugar coat (glycone) makes it dissolve and travel in the body; the inner part (aglycone) does the actual work. In the intestine, the sugar coat is cut off and the active part is released — like unwrapping a toffee to eat the centre.

Example: In senna leaves, sennosides are glycosides. Your gut bacteria cut off the sugar, releasing the active anthraquinone that stimulates the bowel — that is why senna is a laxative.

Analogy: A glycoside is like a gift parcel — the wrapping paper (sugar) and the gift inside (active part). The body opens the parcel where it is needed.

Key takeaway: Glycoside = sugar + non-sugar. Two important types here: **anthraquinone glycosides** (senna — laxative, Bornträger's test) and **cardiac glycosides** (digitalis — heart tonic, Keller–Kiliani test, dangerous in overdose).

> **Terminology alert:** *Aglycone* (also called genin) = the non-sugar part. *Glycone* = the sugar part. *Cardiotonic* = strengthens the heartbeat.

7.3 Drug 1 — Senna

Point	Details
Biological source	Dried **leaflets** of *Cassia angustifolia* Vahl (**Indian/Tinnevelly senna**) and *Cassia acutifolia* Delile (**Alexandrian senna**), family Leguminosae.
Common names	Senna, Sana (Hindi)
Distribution	*C. angustifolia* — Tamil Nadu (Tirunelveli region, hence "Tinnevelly senna"), Gujarat, Rajasthan; *C. acutifolia* — Sudan/Egypt region.
Identifying characters	Lanceolate (spear-shaped) leaflets, yellowish-green, with an **asymmetric base** (one side of the leaf base is lower than the other — a classic identification point); faint odour, slightly bitter taste.
Chemical constituents	**Anthraquinone glycosides** — **sennosides A, B, C and D**, plus rhein and aloe-emodin.
Specific tests	**Bornträger's test**: boil the leaf with dilute acid, extract with an organic solvent, add dilute ammonia → **pink to red colour** in the ammonia layer.
Therapeutic uses	**Stimulant purgative/laxative** — used for constipation; acts on the large intestine.
Commercial applications	Senna tablets, syrups and granules; herbal slimming/laxative teas.

Common mistake: Calling senna a "mild" laxative and ignoring dose. It is a **stimulant** purgative — overuse causes griping (stomach cramps) and lazy bowel. Always mention this caution.

7.4 Drug 2 — Liquorice

Point	Details
Biological source	Dried **roots and stolons** of *Glycyrrhiza glabra* L., family Leguminosae.
Common names	Mulethi, Jethimadh (Hindi)
Distribution	Mediterranean region, Central Asia; India imports much of its supply, with some cultivation in northern states.
Identifying characters	Yellowish-brown cylindrical root pieces; **intensely sweet taste** (about 50 times sweeter than sugar); fibrous fracture.
Chemical constituents	**Glycyrrhizin** (glycyrrhizic acid, present as potassium/calcium salts — the sweet triterpenoid saponin glycoside), flavonoids such as liquiritin.
Specific tests	Intense sweetness; **foam test** (glycyrrhizin is saponin-like and gives persistent froth on shaking with water); TLC identification.
Therapeutic uses	**Demulcent** (soothes irritated throat/mouth), **expectorant** (helps expel cough mucus), flavouring/sweetening agent that masks bitter tastes. **Caution:** excessive use can cause water retention and low potassium (*pseudoaldosteronism*) — a favourite exam caution point.
Commercial applications	Cough syrups and lozenges; confectionery and tobacco flavouring; Ayurvedic formulations.

Terminology alert: *Demulcent* = soothes irritated surfaces (like honey on a sore throat). *Expectorant* = helps bring out phlegm when you cough. *Stolon* = an underground horizontal stem (liquorice spreads through stolons).

7.5 Drug 3 — Digitalis

Point	Details
Biological source	Dried **leaves** of *Digitalis purpurea* L. (**purple foxglove**) and *Digitalis lanata* Ehrh. (**woolly foxglove**), family Scrophulariaceae (Plantaginaceae).
Common names	Foxglove
Distribution	Europe (native); cultivated in temperate India — Kashmir, Himachal Pradesh, Nilgiris.
Identifying characters	Ovate, wrinkled leaves with a crenate (rounded-toothed) margin; *D. lanata* leaves are distinctly **woolly/hairy** underneath — hence "lanata" (wool-like).
Chemical constituents	**Cardiac glycosides (cardenolides)** — **digoxin** (mainly from *D. lanata*), **digitoxin** (mainly from *D. purpurea*), gitoxin.
Specific tests	**Keller–Kiliani test** (reddish-brown ring + bluish-green layer — for the deoxy sugar), **Legal's test** (pink-red), **Baljet's test** (orange) — all for the unsaturated lactone of cardenolides.
Therapeutic uses	**Cardiotonic** — strengthens the failing heart in **congestive heart failure** and controls **atrial fibrillation**. **Critical caution: narrow therapeutic index** — the effective dose and the toxic dose are very close; overdose causes dangerous arrhythmias. Never used without a doctor's prescription and monitoring.
Commercial applications	Industrial manufacture of **digoxin tablets and injections** — one of the classic heart drugs of modern medicine.

Pharmacy relevance: Digoxin is the textbook example of a drug with a **narrow therapeutic index**. A pharmacist must counsel patients never to double a missed dose and to report nausea, vision changes (yellow vision) or irregular pulse — early signs of toxicity.

7.6 Comparison table — the three glycoside drugs

Feature	Senna	Liquorice	Digitalis
Glycoside type	Anthraquinone	Triterpenoid saponin	Cardiac (cardenolide)
Part used	Leaflets	Roots/stolons	Leaves
Main constituent	Sennosides A–D	Glycyrrhizin	Digoxin, digitoxin
Key test	Bornträger's (pink-red)	Foam test, sweetness	Keller–Kiliani (brown ring)
Main use	Laxative	Demulcent, expectorant	Cardiotonic (heart failure)
Caution	Griping on overuse	Pseudoaldosteronism	Narrow therapeutic index

7.7 Mnemonics

- "**S**enna **S**timulates **S**tool" (anthraquinone — **S** for **S**ennosides).
- "**L**iquorice is **L**ovely and sweet — but too much **L**owers potassium."
- "**D**igitalis for a **D**ying heart — but **D**angerously narrow dose range."

7.8 One-minute revision — Chapter 7

- Glycoside = sugar (glycone) + non-sugar (aglycone).
- Senna (*Cassia* spp., leaflets): sennosides — stimulant laxative; Bornträger's pink-red.
- Liquorice (*Glycyrrhiza glabra*, roots): glycyrrhizin — sweet demulcent/expectorant; caution pseudoaldosteronism.
- Digitalis (*D. purpurea/lanata*, leaves): digoxin/digitoxin — cardiotonic; narrow therapeutic index; Keller–Kiliani/Legal/Baljet tests.

7.9 Practice questions — Chapter 7

MCQs

1. Sennosides are: (a) Cardiac glycosides (b) Anthraquinone glycosides (c) Saponin glycosides (d) Cyanogenic glycosides
2. Glycyrrhizin is: (a) Bitter (b) Sweet (c) Sour (d) Tasteless
3. Digoxin is obtained mainly from: (a) Digitalis purpurea (b) Digitalis lanata (c) Cassia angustifolia (d) Glycyrrhiza glabra
4. The asymmetric leaflet base is characteristic of: (a) Senna (b) Digitalis (c) Liquorice (d) Vinca

Short answers

1. Define glycoside and name its two parts with the senna example.
2. Why is digitalis said to have a narrow therapeutic index?

Long answer

1. Describe the pharmacognostic study of digitalis under the standard headings, including its safety cautions.

Application-based

1. A patient taking digoxin reports nausea and yellowish vision. What should the pharmacist suspect and advise? (Answer: possible digoxin toxicity — advise immediate medical review, do not adjust the dose themselves.)

Viva

1. Which test distinguishes anthraquinone glycosides from cardiac glycosides? 2. What is Tinnevelly senna?

Chapter 8 — Phenylpropanoids and Flavonoids: Green Tea, Ginkgo, Flax Seed

8.1 Learning objectives

1. Define phenylpropanoids and flavonoids in simple words.
2. Give the pharmacognostic study of green tea, ginkgo and flax seed.
3. State the safety cautions for ginkgo.

8.2 The big idea: the plant's coloured protectors

Technical concept: Phenylpropanoids are built from a six-carbon ring plus a three-carbon chain (C6–C3); flavonoids are the largest group of plant pigments derived from them.

Simple explanation: These are the chemicals that give plants their yellow, orange and red colours — and they also act as the plant's sunscreen and bodyguards, protecting it from sunlight damage and germs. For humans, many of them are **antioxidants** (they neutralise harmful free radicals in the body).

Example: The yellow colour of many flowers and the health-giving catechins of green tea are flavonoids. The omega-3-rich oil of flax seed comes with lignans, which are phenylpropanoid relatives.

Analogy: If alkaloids are the plant's soldiers (attacking insects), flavonoids are its sunscreen lotion and multivitamins — protective and health-giving rather than poisonous.

Key takeaway: Phenylpropanoid/flavonoid = plant pigment + antioxidant protector. Tests: Shinoda (pink-red), alkaline reagent (yellow).

> **Terminology alert:** *Antioxidant* = a chemical that neutralises **free radicals** (unstable, damaging molecules) in the body. *Lignan* = two phenylpropanoid units joined together (found in flax seed).

8.3 Drug 1 — Green Tea

Point	Details
Biological source	Dried young **leaves** (unfermented) of *Camellia sinensis* (L.) Kuntze, family Theaceae.
Common names	Green tea, Hari chai
Distribution	Assam, Darjeeling, Nilgiris, Kangra; China and Japan. ("Unfermented" means the leaves are heated quickly after plucking so the natural enzymes cannot brown them — that keeps them green.)
Identifying characters	Green, rolled or twisted leaves; fresh grassy odour; astringent, slightly bitter taste.
Chemical constituents	**Catechins** — especially **epigallocatechin gallate (EGCG)** (flavonoid-type polyphenols), **caffeine**, theanine.
Specific tests	Ferric chloride (phenolics → dark colour); **Shinoda test** (pink-red — flavonoids); TLC of catechins.
Therapeutic uses	**Antioxidant**, mild **stimulant** (caffeine); traditionally for alertness and weight management (evidence described cautiously in exams).
Commercial applications	Huge beverage industry; green-tea extracts in nutraceuticals, cosmetics and "slimming" products.

8.4 Drug 2 — Ginkgo

Point	Details
Biological source	Dried **leaves** of *Ginkgo biloba* L., family Ginkgoaceae — a "living fossil" tree.
Common names	Maidenhair tree
Distribution	Native to China; cultivated in temperate India (Kashmir, Himachal Pradesh, Uttarakhand) and worldwide as an ornamental.
Identifying characters	Unmistakable **fan-shaped, bilobed leaves** (split into two lobes — "biloba" = two lobes); no other common tree has this leaf shape.
Chemical constituents	**Ginkgolides A, B, C** (diterpene lactones — unique to ginkgo), **bilobalide** (a sesquiterpene lactone), and **flavonoid glycosides** (quercetin, kaempferol derivatives).
Specific tests	TLC identification of ginkgolides and flavonoid glycosides (the standardised fingerprint described in Wagner & Bladt's atlas); Shinoda test for the flavonoids.
Therapeutic uses	Used for **peripheral circulation** and **cognitive/memory support** in standardised extracts. **Caution:** antiplatelet activity — increased **bleeding risk**, especially with blood thinners like warfarin/aspirin; stop before surgery.
Commercial applications	Standardised ginkgo extracts (EGb-type) in tablets/capsules — one of the world's best-selling herbal products.

8.5 Drug 3 — Flax Seed (Linseed)

Point	Details
Biological source	Dried **ripe seeds** of *Linum usitatissimum* L., family Linaceae.
Common names	Linseed, Alsi (Hindi)
Distribution	Madhya Pradesh, Maharashtra, Uttar Pradesh, Bihar; also Canada and other temperate countries.
Identifying characters	Small, flattened, ovoid, glossy **reddish-brown seeds**; mucilaginous (slimy) taste when chewed.
Chemical constituents	**Fixed oil** rich in **alpha-linolenic acid** (an omega-3 fatty acid), **mucilage** (swelling fibre), **lignans** (secoisolariciresinol diglucoside — phenylpropanoid dimers), protein.
Specific tests	**Swelling test** — seeds swell in water forming mucilage (characteristic); fixed-oil tests (grease spot — permanent, unlike volatile oils).
Therapeutic uses	**Bulk laxative** (the mucilage and fibre add bulk and soften stool), **demulcent** (soothes irritated gut lining).
Commercial applications	**Linseed oil** for paints and varnishes (it "dries" by oxidation); omega-3/flaxseed supplements; cattle feed.

Common confusion: Flax seed contains a **fixed oil** (non-evaporating, like cooking oil), not a volatile oil — so it belongs with phenylpropanoids/lignans in this chapter, not with Chapter 4's volatile oils. The mucilage test is its signature identification.

8.6 Comparison table

Feature	Green tea	Ginkgo	Flax seed
Part used	Leaves (unfermented)	Leaves	Seeds
Main constituents	Catechins (EGCG), caffeine	Ginkgolides, bilobalide, flavonoid glycosides	Alpha-linolenic acid, mucilage, lignans
Key test	Shinoda, TLC of catechins	TLC fingerprint	Swelling/mucilage test
Main use	Antioxidant, stimulant	Circulation, memory support	Bulk laxative, demulcent
Caution	Caffeine sensitivity	Bleeding risk with anticoagulants	Take with plenty of water

8.7 One-minute revision — Chapter 8

- Phenylpropanoid/flavonoid = plant pigment + antioxidant.
- Green tea (*Camellia sinensis*): EGCG catechins + caffeine — antioxidant, stimulant.
- Ginkgo (*Ginkgo biloba*, fan-shaped bilobed leaves): ginkgolides + bilobalide + flavonoid glycosides — circulation/memory; bleeding caution.
- Flax seed (*Linum usitatissimum*): omega-3 oil + mucilage + lignans — bulk laxative; swelling test.

8.8 Practice questions — Chapter 8

MCQs

1. EGCG is found in: (a) Ginkgo (b) Green tea (c) Flax seed (d) Senna
2. The bilobed fan-shaped leaf belongs to: (a) Camellia (b) Ginkgo (c) Linum (d) Cassia
3. The swelling test is characteristic of: (a) Green tea (b) Ginkgo (c) Flax seed (d) Clove
4. Ginkgo should be used cautiously with: (a) Antacids (b) Anticoagulants (c) Antidiabetics (d) Laxatives

Short answers

1. What are flavonoids? Give two identification tests.
2. Why is flax seed called a bulk laxative?

Long answer

1. Describe the pharmacognostic study of ginkgo under the standard headings, including its safety cautions.

Viva

1. What does "unfermented" mean for green tea? 2. Name the omega-3 acid in flax seed oil.

Chapter 9 — Iridoids, Other Terpenoids and Naphthoquinones: Gentian, Artemisia

9.1 Learning objectives

1. Define iridoids, terpenoids and naphthoquinones simply.
2. Give the pharmacognostic study of gentian and artemisia.
3. Explain why artemisinin was a breakthrough antimalarial.

9.2 The big idea: bitter defenders and special rings

Technical concept: Iridoids are bitter monoterpene-derived glycosides; terpenoids are built from five-carbon **isoprene** units; naphthoquinones contain a double-ring quinone structure.

Simple explanation: Many plants protect themselves with extreme **bitterness** — so bitter that one taste stops any animal from taking a second bite. Iridoids like gentiopicrin are among the most bitter substances known. Terpenoids are a huge family built like Lego from identical five-carbon bricks (isoprene units) — artemisinin, the world's most important antimalarial, is a terpenoid with a special oxygen bridge that kills the malaria parasite.

Example: Gentian root is so bitter it is used in tiny amounts to stimulate appetite — "bitter tonic." Artemisia leaves contain artemisinin, which earned a share of a Nobel Prize (2015, Tu Youyou) for transforming malaria treatment.

Analogy: If flavonoids are the plant's sunscreen, iridoids are its "do not eat" warning sign written in the bitterest ink possible.

Key takeaway: Iridoid = intensely bitter glycoside (gentian — bitter tonic). Special terpenoid = artemisinin (artemisia — antimalarial). Tests: bitterness value, TLC.

> **Terminology alert:** *Bitter tonic* = a very bitter medicine taken in small doses to stimulate appetite and digestion. *Isoprene unit* = a five-carbon building block (C5); monoterpenes = 2 units (C10), sesquiterpenes = 3 units (C15) — artemisinin is a sesquiterpene lactone.

9.3 Drug 1 — Gentian

Point	Details
Biological source	Dried **roots and rhizomes** of *Gentiana lutea* L., family Gentianaceae.
Common names	Gentian, yellow gentian
Distribution	Mountain regions of Europe (Alps and others); India's requirement is largely imported — it is not a major Indian crop.
Identifying characters	Thick, cylindrical, brown roots; intensely **bitter** taste — even a tiny piece is unmistakably bitter.
Chemical constituents	**Gentiopicrin** (a secoiridoid glycoside — the main bitter principle) and **amarogentin** (one of the most bitter natural substances known).
Specific tests	**Bitterness value** determination (the official measure of how bitter it is); TLC of gentiopicrin.
Therapeutic uses	**Bitter tonic** — stimulates appetite and digestion; used in dyspepsia (indigestion).
Commercial applications	Bitter aperitifs and herbal tonics; flavouring of beverages.

9.4 Drug 2 — Artemisia (Sweet Wormwood)

Point	Details
Biological source	Dried **leaves and flowering tops** of *Artemisia annua* L., family Asteraceae (Compositae).
Common names	Sweet wormwood, Qinghao (Chinese)
Distribution	Native to China; cultivated in India in Kashmir, Himachal Pradesh and Uttarakhand (improved varieties developed by Indian research institutes).
Identifying characters	Finely divided, fern-like aromatic leaves; small yellowish flower heads.
Chemical constituents	**Artemisinin** — a **sesquiterpene lactone** containing a unique **endoperoxide bridge** (an –O–O– link), which is the key to its antimalarial action.
Specific tests	TLC identification of artemisinin; specific colour reactions for the endoperoxide group.
Therapeutic uses	**Antimalarial** — artemisinin and its derivatives (artemether, artesunate) are the backbone of **artemisinin-based combination therapies (ACTs)**, the global standard for falciparum malaria.
Commercial applications	Industrial extraction of artemisinin for antimalarial drug manufacture — one of the most important plant-derived drugs of modern times.

Pharmacy relevance: Artemisia is the perfect story for exams: a traditional Chinese fever herb → pure compound isolated → Nobel Prize (2015) → WHO-recommended malaria cure. It shows exactly why pharmacognosy matters to modern medicine.

India context: Malaria is still a public-health concern in parts of India, so a domestically cultivated source of artemisinin (Himalayan states) has genuine national importance.

9.5 Comparison table

Feature	Gentian	Artemisia
Part used	Roots/rhizomes	Leaves/flowering tops
Chemical type	Secoiridoid glycoside	Sesquiterpene lactone (endoperoxide)
Main constituent	Gentiopicrin, amarogentin	Artemisinin
Key test	Bitterness value	TLC of artemisinin
Main use	Bitter tonic	Antimalarial (ACTs)

9.6 One-minute revision — Chapter 9

- Iridoid = bitter glycoside; terpenoid = built from C5 isoprene units.
- Gentian (*Gentiana lutea*, roots): gentiopicrin + amarogentin — bitter tonic; bitterness value test.
- Artemisia (*Artemisia annua*, leaves): artemisinin (sesquiterpene endoperoxide) — antimalarial, ACTs; Nobel Prize 2015 connection.

9.7 Practice questions — Chapter 9

MCQs

1. Gentiopicrin is a: (a) Alkaloid (b) Secoiridoid glycoside (c) Tannin (d) Resin
2. Artemisinin contains a unique: (a) Nitrogen ring (b) Endoperoxide bridge (c) Sugar chain (d) Sulphur group
3. Gentian is used as a: (a) Laxative (b) Bitter tonic (c) Analgesic (d) Antitussive
4. ACTs are the standard treatment for: (a) Typhoid (b) Falciparum malaria (c) Tuberculosis (d) Diabetes

Short answers

1. What is an iridoid? Give one example with its use.
2. Why is the endoperoxide bridge of artemisinin important?

Long answer

1. Describe the pharmacognostic study of artemisia under the standard headings.

Viva

1. Which drug of this unit is linked to a Nobel Prize, and who received it? 2. What is bitterness value?

Combined References

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