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BP105T
INTRODUCTION TO PHARMACOGNOSY

UNIT IV — METABOLITES OF PLANT ORIGIN & TRADITIONAL SYSTEMS OF MEDICINE

Primary Metabolites — Carbohydrates, Proteins, Lipids • Secondary Metabolites — Alkaloids to Resins

Basic Principles of AYUSH & TCM • Dosage Forms in AYUSH Medicine

Role of Pharmacognosy in Allopathy and Traditional Systems

B.Pharm — Semester I

PCI Regulations, ER-2020 Syllabus

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1. Introduction to Plant Metabolites

- **Plant metabolites** are chemical compounds produced by plants during their normal **metabolic activities**.
- They are classified into **primary metabolites** and **secondary metabolites**.

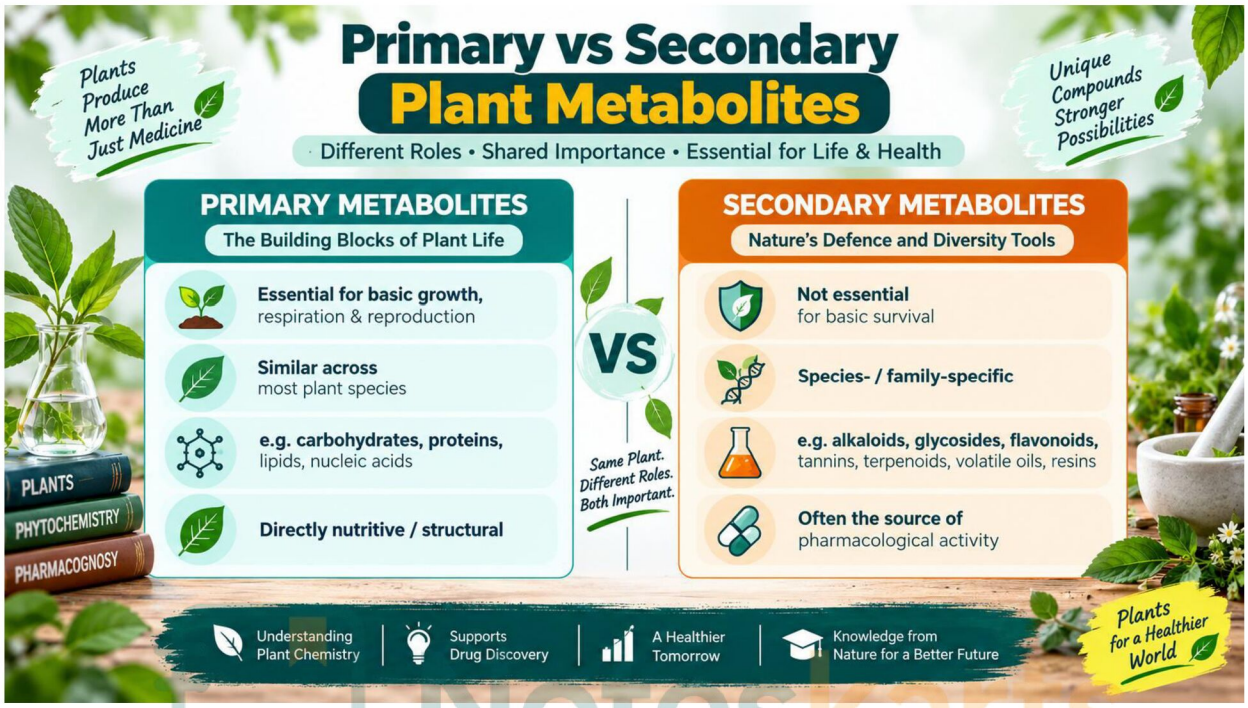

Figure 1.1 — Primary versus secondary plant metabolites.

1.1 Primary Metabolites

- **Primary metabolites** are compounds essential for the plant's growth, development, and survival.
- They are generally found in most plants because they perform basic life functions.
- **Examples**: carbohydrates, proteins, lipids, and nucleic acids.
- They mainly provide energy, nutrition, and structural support to the plant..

1.2 Secondary Metabolites

- **Secondary metabolites** are compounds that are not directly required for basic plant growth but help in defence and protection.
- They may protect plants from insects, diseases, UV light, and competing plants.
- They are often specific to certain plant species or families.
- Examples: alkaloids, glycosides, flavonoids, tannins, terpenoids, volatile oils, and resins.
- **Pharmacognostic importance:** Many secondary metabolites are responsible for the medicinal and pharmacological effects of crude drugs..

1.3 General Properties of Plant Metabolites

- **Biosynthetic origin:** secondary metabolites are built from primary metabolite precursors through defined biosynthetic pathways (e.g. the shikimic acid pathway for many phenolics, the mevalonate/MEP pathways for terpenoids, amino-acid-derived pathways for alkaloids).
- **Concentration varies** with genetic factors, growing conditions, plant age, and time of collection (Unit II, Section 3) — which is exactly why cultivation and collection practice affects a crude drug's potency.
- **Localisation** within the plant is often specific — a given metabolite may accumulate in latex, glandular hairs, resin ducts, or specific cell types, which is one reason morphological classification (Unit I) and microscopic evaluation (Unit III) remain useful even in a chemistry-focused field.
- **Structural diversity** is enormous even within one class — "alkaloid" or "glycoside" describes a broad structural principle, not one molecule, which is why Unit I's chemical classification system always needs a further level of subdivision to be genuinely informative.
- **Ecological role:** many secondary metabolites function as chemical defences (deterring herbivores, inhibiting competing microbes/plants) or as signalling molecules (attracting pollinators via scent/colour) — the same properties that make a compound ecologically useful to the plant are frequently what make it pharmacologically active in humans.

The seven major secondary metabolite classes covered in this unit trace back to only a few core biosynthetic pathways:

Metabolite class	Main biosynthetic origin
Alkaloids	Amino acids (e.g. ornithine, lysine, tyrosine, tryptophan)
Glycosides	Variable aglycone origin + sugar conjugation (glycosylation)
Flavonoids	Shikimic acid pathway (aromatic ring) + acetate pathway
Tannins	Shikimic acid pathway (hydrolysable) or flavonoid polymerisation (condensed)
Terpenoids	Mevalonate pathway and/or MEP (non-mevalonate) pathway
Volatile oils	Mainly the terpenoid pathway (mono-/sesquiterpenes)
Resins	Mainly the terpenoid pathway, often alongside phenolic components

2. Primary Metabolites — Carbohydrates, Proteins and Lipids

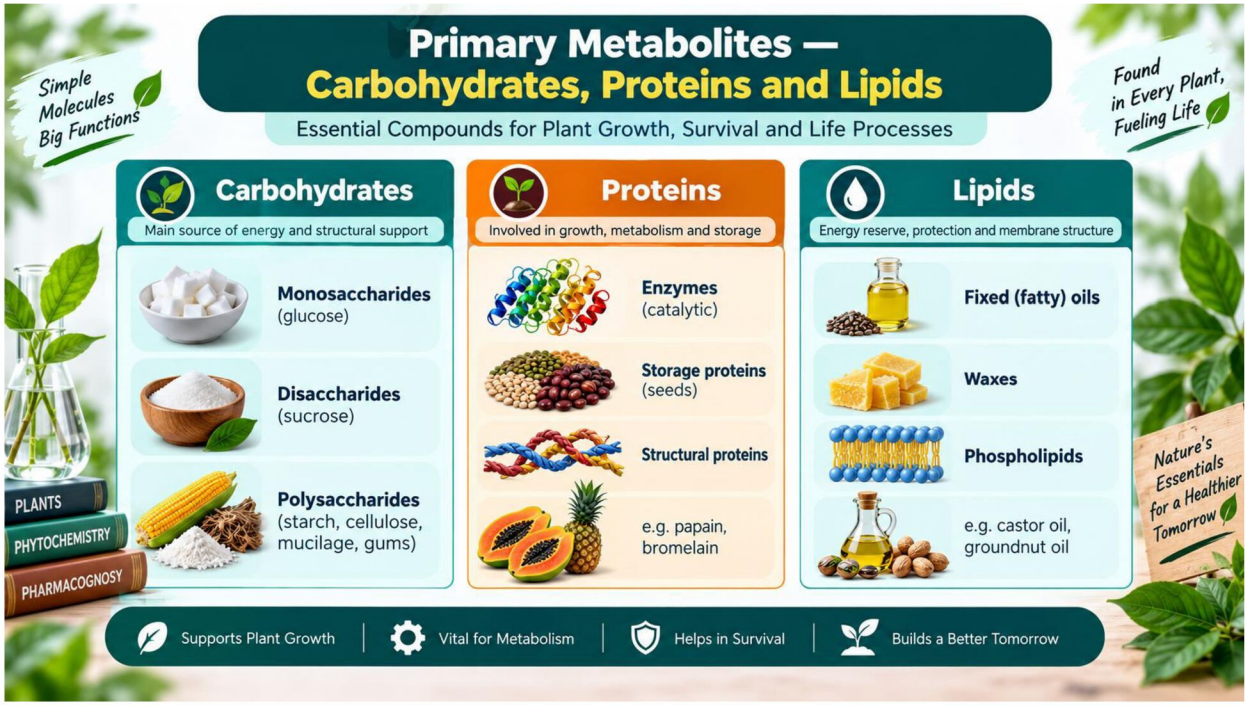

Figure 2.1 — The three major classes of primary metabolites, with examples.

2.1 Carbohydrates

2.1 Carbohydrates

Carbohydrates are one of the most abundant groups of organic compounds found in plants. They are mainly produced during **photosynthesis** and provide energy as well as structural support to plants. They are also important constituents of many crude drugs.

Types of Carbohydrates

1. Monosaccharides

- These are the **simplest form of carbohydrates** and cannot be broken down into smaller sugars.
- Examples include **glucose and fructose**.
- They act as building blocks for more complex carbohydrates and some glycosides.

2. Disaccharides

- These contain **two monosaccharide units** joined together.
- Example: **Sucrose**, which is made up of glucose and fructose.

3. Polysaccharides

- These are made up of **long chains of sugar units**.
- Important plant polysaccharides include:
  - **Starch:** The main **storage form of energy** in plants. It is commonly found in rice, wheat, maize, and potato.
  - **Cellulose:** A major **structural component of plant cell walls**. It provides strength and rigidity to plant tissues.

- **Mucilages:** Polysaccharides that **absorb and retain water**, becoming swollen and slippery. Isabgol (psyllium) is an important example.
- **Gums:** Plant substances that form viscous or gel-like solutions in water. Examples include **acacia and tragacanth**.

Pharmacognostic importance: They are evaluated using swelling index, viscosity, and extractive value.

2.2 Proteins

- **Enzymes** — catalytic proteins; some plant enzymes are themselves used pharmaceutically, e.g. **papain** (from papaya latex) and **bromelain** (from pineapple stem), both proteolytic enzymes used for wound debridement and anti-inflammatory action.
- **Storage proteins** — concentrated in seeds as a nutrient reserve for germination (e.g. legume seed proteins).
- **Structural proteins** — contribute to cell wall and membrane architecture.
- **Pharmacognostic relevance:** proteins can themselves be allergenic (relevant to herbal product safety) and are also the target of some quantitative colour-reaction tests used in crude drug evaluation.

2.3 Lipids

- **Fixed (fatty) oils** — triglycerides of long-chain fatty acids, non-volatile, leave a permanent stain on paper (unlike volatile oils); e.g. castor oil, groundnut oil, sesame oil. Evaluated using the acid value and saponification value parameters (Unit III).
- **Waxes** — esters of long-chain fatty acids with long-chain alcohols (rather than glycerol); typically found as a protective coating on leaves/fruit surfaces (e.g. carnauba wax).
- **Phospholipids** — structural lipids central to cell membrane architecture.
- **Pharmacognostic relevance:** fixed oils are both crude drugs in their own right (e.g. castor oil as a laxative) and pharmaceutical excipients (vehicles for oily formulations, absorption bases).

3. Secondary Metabolites I — Alkaloids and Glycosides

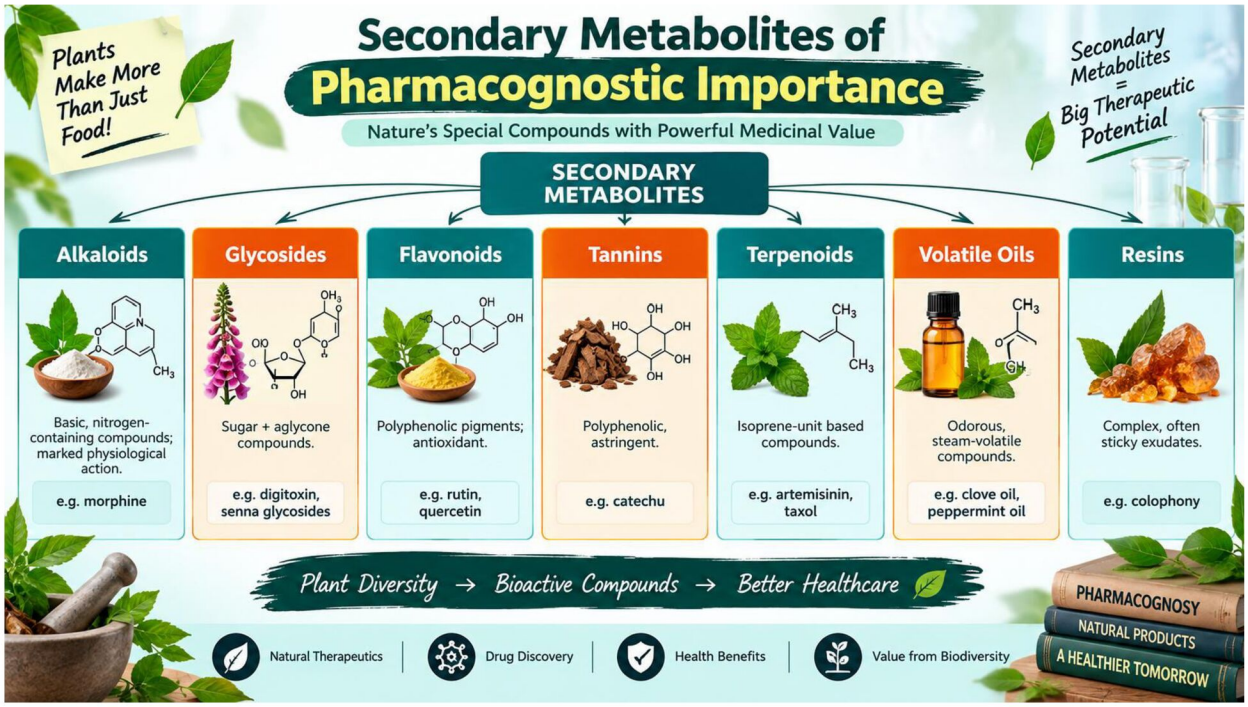

Figure 3.1 — The seven major classes of pharmacognostically important secondary metabolites.

3.1 Alkaloids

Alkaloids are naturally occurring **nitrogen-containing compounds**, mainly found in plants. They are usually **basic in nature** and often have strong effects on the human body, even in small amounts.

General Properties

- Usually have a **bitter taste**.
- Most are **colourless, crystalline solids**.
- Some alkaloids are **liquids**, such as **nicotine and coniine**.
- Free alkaloid bases are generally **insoluble in water** but soluble in organic solvents.
- Their **salts are usually soluble in water**, which is useful during extraction.

Classification and Examples

Alkaloids can be classified according to their **chemical ring structure**:

- **Tropane alkaloids:** Atropine, Hyoscine
- **Quinoline alkaloids:** Quinine
- **Isoquinoline alkaloids:** Morphine
- **Indole alkaloids:** Reserpine, Vincristine
- **Purine alkaloids:** Caffeine

Important Examples and Uses

Alkaloid	Main Use
Morphine	Analgesic
Quinine	Antimalarial
Atropine	Anticholinergic

Reserpine	Antihypertensive
Vincristine & Vinblastine	Anticancer

Detection

Alkaloids can be detected using common **precipitation tests**, such as:

- **Dragendorff's test**
- **Mayer's test**
- **Wagner's test**

In short: Alkaloids are **nitro**

Ring system	Example alkaloid	Therapeutic use
Tropane	Atropine, hyoscine	Anticholinergic
Quinoline	Quinine	Antimalarial (Unit I)
Isoquinoline	Morphine	Analgesic (Unit I)
Indole	Reserpine, vincristine	Antihypertensive; anticancer
Purine	Caffeine	CNS stimulant

3.2 Glycosides

- **Definition:** compounds in which a sugar portion (the **glycone**) is joined, through a glycosidic bond, to a non-sugar portion (the **aglycone/genin**), which is usually the part responsible for the pharmacological activity.
- **General properties:** the glycosidic bond is hydrolysed by acid or by specific plant enzymes, releasing the free sugar and the aglycone — which is why processing/storage conditions (Unit II) that inadvertently trigger enzymatic hydrolysis can change a glycoside drug's potency.
- **Classified by the chemical nature of the aglycone:**
  - **Cardiac glycosides** — aglycone is a steroid; act on the heart. e.g. digoxin, digitoxin (Digitalis, Unit I).
  - **Anthraquinone glycosides** — aglycone is an anthraquinone derivative; stimulant laxative action. e.g. sennosides (Senna, Unit I).
  - **Cyanogenic glycosides** — release toxic hydrogen cyanide on hydrolysis. e.g. amygdalin (bitter almonds).
  - **Saponin glycosides** — surface-active, foam-producing, often haemolytic; directly linked to the foaming index and haemolytic index parameters (Unit III). e.g. glycyrrhizin (liquorice).
  - **Flavonoid glycosides** and **tannin-related glycosides** overlap with the classes covered in Section 4.

4. Secondary Metabolites II — Flavonoids and Tannins

4.1 Flavonoids

- **Definition:** a large class of polyphenolic plant pigments built on a common C6–C3–C6 carbon skeleton (two aromatic rings joined by a three-carbon bridge); one of the most widespread classes of plant secondary metabolites.
- **General properties:** typically yellow, orange, or red-blue pigments (responsible for much of the colour in flowers and fruit); generally water-soluble, especially as their glycosides; well known for **antioxidant** activity (scavenging free radicals).
- **Subclasses:** flavones, flavonols (e.g. quercetin, rutin), flavanones, isoflavones (e.g. genistein, with oestrogenic activity), anthocyanins (the pigments responsible for red/blue/purple colouration).
- **Pharmacological relevance:** antioxidant, anti-inflammatory, vasoprotective (e.g. rutin used for capillary fragility), and increasingly studied for cardioprotective and anticancer potential.
- **Detection:** Shinoda test (magnesium + concentrated HCl, producing a pink/red colour) is a standard qualitative test for flavonoids.

Flavonoid subclass	Example	Notable property
Flavones	Apigenin, luteolin	Common in leaves and flowers
Flavonols	Quercetin, rutin	Vasoprotective; capillary-strengthening
Flavanones	Hesperidin, naringin	Common in citrus fruit
Isoflavones	Genistein, daidzein	Oestrogenic (phytoestrogen) activity
Anthocyanins	Cyanidin, delphinidin	Red/blue/purple plant pigments

4.2 Tannins

- **Definition:** complex polyphenolic compounds capable of **precipitating proteins** — the property responsible for both their astringent taste and their traditional use in leather tanning (the origin of the name).
- **Classified into two main groups:**
  - **Hydrolysable tannins** — esters of a sugar (usually glucose) with gallic acid or ellagic acid; hydrolysed by acids or enzymes into their component parts. e.g. tannic acid.
  - **Condensed tannins (proanthocyanidins)** — polymers of flavonoid units, resistant to hydrolysis; more common than hydrolysable tannins in nature. e.g. catechin-derived tannins in Catechu.

- **General properties:** astringent taste; precipitate gelatin and alkaloids from solution; give a blue-black or green-black colour with ferric chloride (a standard qualitative test).
- **Pharmacological/pharmaceutical relevance:** astringent (used topically on wounds/mucous membranes to reduce secretions and promote healing), antidiarrhoeal, and antioxidant; also a recognised interference in phytochemical extraction, since tannins can precipitate other constituents (including alkaloids) out of solution.
- **Examples:** Catechu (Acacia catechu), pomegranate rind, tea (Camellia sinensis).

5. Secondary Metabolites III — Terpenoids, Volatile Oils and Resins

5.1 Terpenoids

- **Definition:** the largest and most structurally diverse class of plant secondary metabolites, built from repeating five-carbon **isoprene units**, biosynthesised via the mevalonate and/or MEP (non-mevalonate) pathways.
- **Classified by the number of isoprene units:**
  - **Monoterpenes** (2 units, C10) — major components of many volatile oils, e.g. menthol, limonene.
  - **Sesquiterpenes** (3 units, C15) — e.g. artemisinin (Unit I).
  - **Diterpenes** (4 units, C20) — e.g. taxol (Unit I).
  - **Triterpenes/steroids** (6 units, C30) — include steroidal saponins and the aglycones of cardiac glycosides (Section 3).
  - **Tetraterpenes** (8 units, C40) — e.g. carotenoids (plant pigments, provitamin A).
- **Pharmacognostic relevance:** terpenoids account for some of pharmacognosy's most important modern drugs (taxol, artemisinin, Unit I) as well as classical volatile-oil components (Section 5.2).

Terpenoid class	Carbon count	Example
Monoterpenes	C10	Menthol, limonene, camphor
Sesquiterpenes	C15	Artemisinin
Diterpenes	C20	Taxol, forskolin
Triterpenes / steroids	C30	Steroidal saponins, cardiac glycoside aglycones
Tetraterpenes	C40	Carotenoids (β-carotene)

5.2 Volatile (Essential) Oils

- **Definition:** odorous, volatile (steam-distillable) oily liquids responsible for the characteristic smell of many plants; chemically a mixture of terpenoids (mainly mono- and sesquiterpenes) and sometimes aromatic (phenylpropanoid) compounds.
- **General properties:** volatile at room temperature (unlike fixed oils); leave no permanent stain on paper; generally soluble in organic solvents, poorly soluble in water; obtained mainly by steam distillation, expression (for citrus peel oils), or solvent extraction.
- **Examples:** clove oil (eugenol — dental analgesic/antiseptic), peppermint oil (menthol — carminative), eucalyptus oil (eucalyptol — decongestant), lemongrass oil (citral).
- **Pharmacological/commercial relevance:** carminative, antiseptic, counter-irritant, and flavouring/fragrance uses; also the constituent class targeted by the WHO guideline's specific volatile-oil-content determination (Unit III, Section 1.1).

5.3 Resins

- **Definition:** complex, amorphous mixtures of terpenoids and related compounds, typically exuded by a plant (often through specialised ducts) in response to injury, and hardening on exposure to air.
- **General properties:** insoluble in water, soluble in alcohol and other organic solvents; often occur mixed with volatile oils (**oleoresins**, e.g. turpentine) or with gums (**gum-resins**, e.g. myrrh, guggul).
- **Examples:** colophony (rosin, from pine oleoresin), asafoetida (a gum-resin), guggul (Commiphora wightii gum-resin, used in Ayurveda for hyperlipidaemia).
- **Pharmacognostic/pharmaceutical relevance:** used historically as antiseptics, expectorants, and in traditional formulations; also of industrial importance (varnishes, adhesives) beyond pharmacy.

6. Traditional Systems of Medicine — Basic Principles

Alongside modern allopathic medicine, several traditional systems remain in active, large-scale clinical use worldwide, each built on its own theoretical framework for understanding health and disease. **AYUSH** is the Indian government's umbrella term for Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homoeopathy.

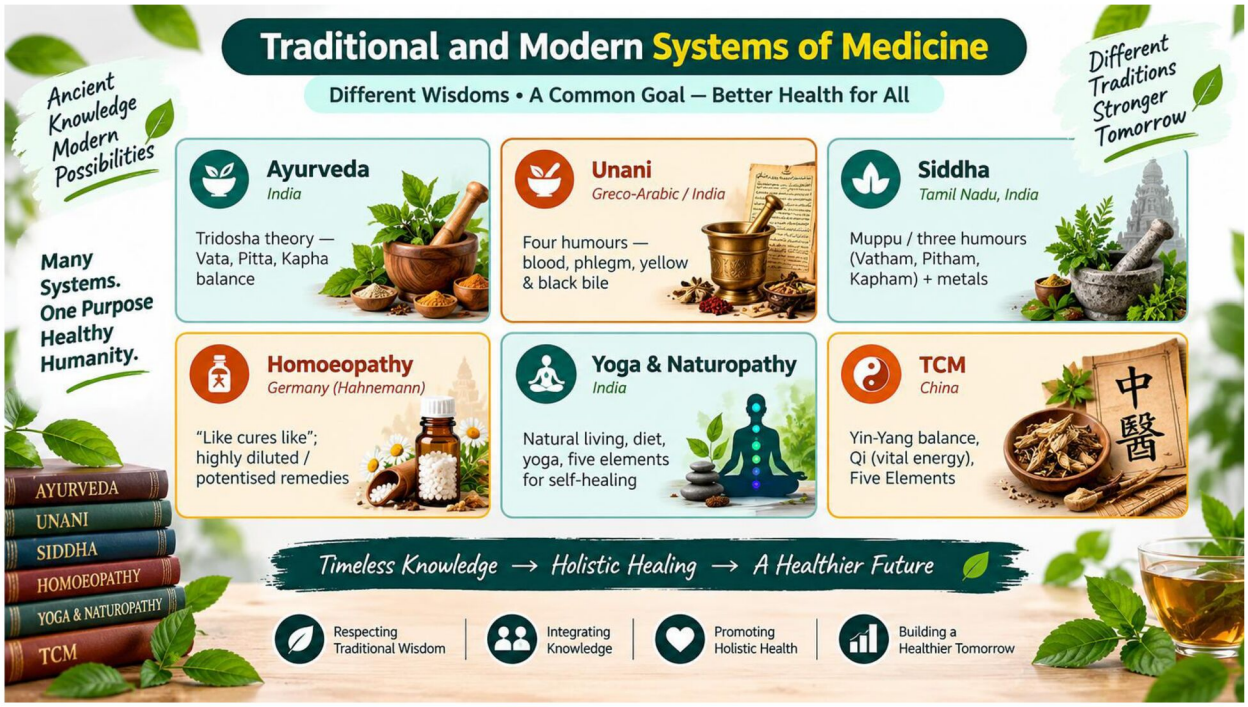

Figure 6.1 — Six systems of medicine and their core theoretical principle.

6.1 Ayurveda

- **Origin: Ayurveda is an ancient Indian system of medicine described in texts such as the Charaka Samhita and Sushruta Samhita.**
- **Tridosha Theory: Health depends on the balance of three doshas:**
    - **Vata – controls movement and nervous functions.**
    - **Pitta – controls digestion and metabolism.**
    - **Kapha – provides structure, stability, and lubrication.**
- **Panchamahabhuta Theory: According to Ayurveda, everything is made up of five elements:**
  Earth, Water, Fire, Air, and Space.
- **Treatment: Treatment is generally individualised and aims to restore the balance of doshas through diet, medicines, lifestyle changes, and Panchakarma procedures.**

6.2 Unani

Origin: Developed from **ancient Greek medicine** and later developed by **Arab and Persian physicians**. It became an important traditional system in India.

- **Core principle:** Based on the balance of four humours:
    - **Dam** – Blood
    - **Balgham** – Phlegm
    - **Safra** – Yellow bile

- **Sauda** – Black bile

- **Treatment:** Uses **diet, lifestyle changes, herbal/mineral medicines, and regimenal therapies** to restore balance.

6.3 Siddha

- Origin: **Tamil Nadu**, South India; one of the oldest systems, attributed to the *Siddhars*.
- **Core principle:** built on a similar three-humour framework to Ayurveda — **Vatham, Pitham, Kapham** (collectively *Muppu*) — but with its own distinct classical texts and pharmacological tradition.
- **Distinctive feature:** particularly strong emphasis on **metal and mineral preparations** (extensively purified and processed), alongside herbal drugs.

6.4 Homoeopathy

- Origin: developed in **Germany** by **Samuel Hahnemann** in the late 18th century.
- **Core principle — "Like cures like" (Law of Similars):** a substance that produces symptoms in a healthy person can, in a highly diluted form, treat similar symptoms in a sick person.
- **Potentisation:** remedies are prepared by serial dilution and vigorous shaking (succussion), a process homoeopathy holds increases potency even as the material concentration falls, often to the point where little or no original substance remains — a claim outside conventional pharmacological explanation and a point of ongoing scientific debate.

6.5 Yoga and Naturopathy

- Origin: **India**; Yoga has ancient roots in Indian philosophy, while modern Naturopathy draws on both Indian and Western natural-healing traditions.
- **Core principle:** the body has an inherent capacity to heal itself when supported by natural means — correct diet, physical postures and breathing (yoga), exposure to natural elements, fasting, and lifestyle modification, rather than pharmacological intervention.

6.6 Traditional Chinese Medicine (TCM)

- Origin: **China**, with a documented history spanning over two thousand years.
- **Core principle — Yin-Yang balance:** health depends on the dynamic balance of two opposing but complementary forces, Yin (cool, passive, substantive) and Yang (warm, active, functional); disease reflects an imbalance between them.

- **Qi (vital energy)** is believed to flow through the body along channels called **meridians**; blockage or imbalance of Qi flow is associated with illness — the theoretical basis for acupuncture as well as herbal therapy.
- **Five Elements (Wu Xing) theory:** Wood, Fire, Earth, Metal, and Water are used as a framework linking organs, emotions, seasons, and treatments in an interdependent system.
- **Treatment approach:** herbal formulas (usually multi-ingredient), acupuncture, moxibustion, and dietary/lifestyle therapy, aimed at restoring Yin-Yang and Qi balance.

A side-by-side comparison makes the six frameworks easier to hold in memory together:

System	Origin	Core theoretical framework	Key treatment tools
Ayurveda	India	Tridosha (Vata, Pitta, Kapha)	Herbal/mineral formulations, diet, Panchakarma
Unani	Greco-Arabic / India	Four humours (Mizaj)	Herbal/mineral drugs, regimenal therapy
Siddha	Tamil Nadu, India	Muppu (three humours)	Herbal + extensively processed metal/mineral drugs
Homoeopathy	Germany	Law of Similars; potentisation	Highly diluted single remedies
Yoga & Naturopathy	India	Innate self-healing capacity	Diet, yoga, natural elements, fasting
TCM	China	Yin-Yang; Qi; Five Elements	Herbal formulas, acupuncture, moxibustion

6.7 Safety and Standardisation Considerations

- "Natural" and "safe" are not automatically synonymous — traditional systems use pharmacologically potent materials, including processed metals/minerals (Bhasma, Rasayoga, Section 7), which carry a real heavy-metal-toxicity risk if not correctly and completely processed.
- Multi-ingredient classical formulations are harder to standardise chemically than a single isolated compound, since "potency" may depend on the combined action of many constituents rather than one measurable marker.
- Batch-to-batch consistency depends on the same cultivation, collection, and processing factors covered in Unit II, and the same quality-control methods covered in Unit III, applied specifically to these traditional raw materials and finished products.
- These considerations are precisely why Section 8 treats scientific validation and quality control as a central, ongoing role for pharmacognosy within AYUSH and TCM, not a one-time historical task.

6.8 Global Recognition — ICD-11 Traditional Medicine Module

- The **WHO's ICD-11** (11th revision of the International Classification of Diseases) includes, for the first time, a dedicated chapter for traditional medicine conditions.
- **Module 1** (East Asian traditional medicine, including TCM) took effect in **January 2022**.
- **Module 2** (Ayurveda, Siddha, and Unani), developed with India's Ministry of AYUSH, was released in **2025**.
- **Significance:** this gives traditional-medicine diagnoses a standardised international code for the first time, enabling more systematic global research, data collection, and health-system integration — without implying WHO endorsement of any specific treatment's efficacy, which continues to require the kind of scientific validation discussed in Section 8.

7. Types of Dosage Forms in AYUSH Medicines

AYUSH medicines are prepared in different **dosage forms** depending on the drug, its active constituents, therapeutic use, and required shelf life.

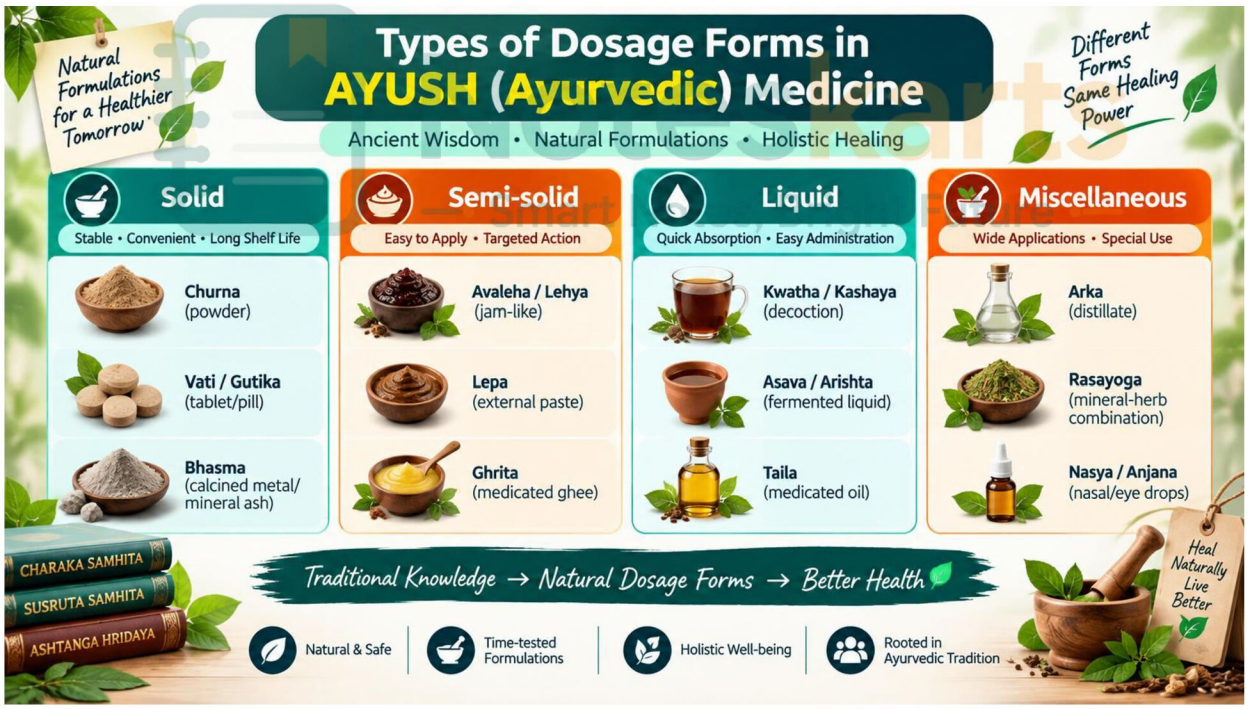

Figure 7.1 — The major categories of AYUSH (Ayurvedic) dosage forms.

7.1 Solid Dosage Forms

- **Churna** — fine powder of one or more drugs. e.g. Triphala Churna (used for digestion/detoxification).
- **Vati / Gutika** — tablets or pills, made by binding powdered drugs with a suitable excipient. e.g. Chandraprabha Vati (urinary disorders).

- **Bhasma** — a calcined (incinerated) metal or mineral ash, prepared through repeated purification and incineration cycles; used in very small doses. e.g. Swarna Bhasma (gold ash, used as a rasayana/rejuvenative).

7.2 Semi-Solid Dosage Forms

- **Avaleha / Lehya** – A thick, jam-like herbal preparation made using **decoctions or juices** along with sugar, jaggery, or ghee.
  Example: Chyawanprash.
- **Lepa** – A **medicated paste** applied externally to the skin.
  Example: Sandalwood paste.
- **Ghrita** – **Medicated ghee** prepared by processing ghee with herbal juices or decoctions. It may be used internally or externally.
  Example: Brahmi Ghrita..

7.3 Liquid Dosage Forms

- **Kwatha / Kashaya** – A **decoction** prepared by boiling coarse herbal material in water and reducing the volume. Usually used fresh.
  Example: Dashamoola Kwatha.
- **Asava / Arishta** – **Fermented herbal preparations** made using herbal juice or decoction with sugar or jaggery. The fermentation produces a small amount of alcohol, which helps in **preservation and extraction**.
  Example: Ashwagandharishta.
- **Taila** – **Medicated oil** prepared by processing oil with herbal juices or decoctions. It can be used **internally or externally**.
  Example: Mahanarayana Taila.

7.4 Miscellaneous Dosage Forms

- **Arka** — a distillate obtained by distilling a fresh herb with water, similar in concept to an aromatic water.
- **Rasayoga** — formulations combining processed minerals/metals with herbal drugs.
- **Nasya** — medicated drops or preparations administered nasally.
- **Anjana** — medicated preparations applied to the eye.

Exam framing: classical dosage-form selection was itself a pharmaceutical decision — water-soluble constituents call for a Kashaya, fat-soluble constituents call for a Taila/Ghrita, and constituents needing long shelf life and enhanced bioavailability call for an Asava/Arishta — showing that Ayurvedic pharmaceutics anticipated, in its own framework, some of the same solubility and stability considerations modern pharmaceutics addresses through formulation science.

A consolidated reference across all four categories:

Category	Dosage form	Classical example
Solid	Churna / Vati-Gutika / Bhasma	Triphala Churna / Chandraprabha Vati / Swarna Bhasma
Semi-solid	Avaleha-Lehya / Lepa / Ghrita	Chyawanprash / Sandalwood Lepa / Brahmi Ghrita
Liquid	Kwatha-Kashaya / Asava-Arishta / Taila	Dashamoola Kwatha / Ashwagandharishta / Mahanarayana Taila
Miscellaneous	Arka / Rasayoga / Nasya / Anjana	Distilled aromatic waters / mineral-herb combinations

8. Role of Pharmacognosy in Allopathy and Traditional Systems

Pharmacognosy is the connecting discipline between traditional plant-based medicine and modern pharmaceutical science — it supplies both with the same underlying tools: correct identification, chemical characterisation, quality control, and safety evaluation of natural drugs.

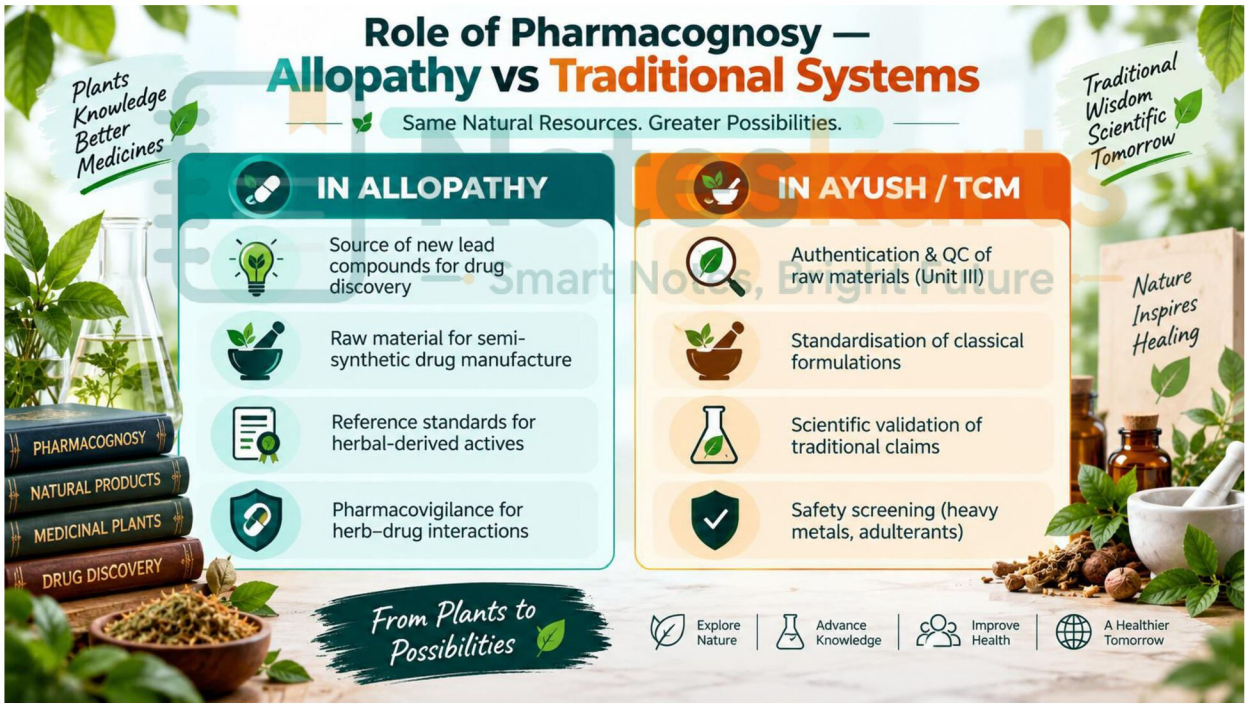

Figure 8.1 — The role of pharmacognosy in allopathy compared with AYUSH/TCM.

8.1 Role in Allopathy (Modern Medicine)

- **Source of new lead compounds** — natural products remain a major starting point for drug discovery (Unit I); pharmacognosy identifies and characterises promising constituents from traditional-use plants.
- **Raw material for semi-synthetic manufacture** — many allopathic drugs are chemically modified natural products (e.g. aspirin from salicin, semi-synthetic

penicillins, Unit I); pharmacognosy supplies and standardises the natural starting material.

- **Reference standards** — provides authenticated marker compounds and reference materials used in the chemical assay of herbal-derived actives (Unit III).
- **Pharmacovigilance** — pharmacognostic knowledge of plant constituents underpins the study of herb–drug interactions (e.g. St. John's Wort inducing hepatic enzymes and reducing the effectiveness of certain allopathic drugs), which is increasingly important as patients combine herbal and allopathic treatment.
- **Worked example — St. John's Wort (Hypericum perforatum):** a widely self-administered herbal antidepressant that induces the liver enzyme CYP3A4 and the drug transporter P-glycoprotein.
- This can significantly lower blood levels of several allopathic drugs taken alongside it — including some oral contraceptives, anticoagulants, and immunosuppressants — with real clinical consequences if the interaction is not recognised.
- This example illustrates exactly why pharmacognostic constituent knowledge matters to allopathic prescribing, not just to herbal-product manufacturing.

8.2 Role in AYUSH and TCM

- **Authentication and quality control of raw material** — applying the organoleptic, microscopic, physicochemical, and DNA-based methods of Unit III to confirm identity and detect adulteration in AYUSH/TCM raw drugs, which are just as vulnerable to substitution and contamination as any other crude drug.
- **Standardisation of classical formulations** — defining reproducible quality parameters (marker-compound content, physicochemical limits) for multi-ingredient formulations that were historically standardised only by traditional preparation method, not by numeric specification.
- **Scientific validation** — investigating the chemical basis and pharmacological plausibility of traditional therapeutic claims, helping bridge traditional theoretical frameworks (dosha, humoral, Yin-Yang) with the constituent-and-mechanism framework of modern pharmacology.
- **Safety screening** — testing for heavy metals (particularly relevant for Bhasma/Rasayoga preparations, Section 7, and some TCM mineral ingredients), microbial contamination, and correct botanical identity, addressing a recurring public-health concern with some traditional metal-containing formulations.
- **Supporting global integration** — the pharmacognostic evidence base built through these activities supports the kind of international recognition reflected in the WHO ICD-11 traditional medicine modules (Section 6.8), by giving traditional systems a shared quality and safety language with modern pharmaceutical regulation.

8.3 Challenges in Integrating Traditional and Modern Systems

- **Different evidence paradigms** — allopathic medicine relies primarily on randomised controlled trials targeting a single mechanism; traditional systems often use individualised, multi-ingredient treatment that is harder to evaluate with the same trial design, without this meaning the treatment is necessarily ineffective.
- **Standardisation gap** — many classical formulations were never designed with a numeric potency specification in mind, so retrofitting modern quality standards (Unit III) onto centuries-old preparation methods is genuinely difficult, not merely a matter of paperwork.
- **Regulatory divergence** — different countries classify herbal/traditional products differently (as drugs, dietary supplements, or a separate category), which complicates international trade and safety comparison (Unit II, Section 4).
- **Terminology mismatch** — concepts like "dosha imbalance" or "Qi stagnation" do not map neatly onto allopathic diagnostic categories, which is exactly the gap the WHO ICD-11 traditional medicine modules (Section 6.8) are intended to start closing.
- Pharmacognosy sits at the centre of resolving each of these challenges, because identification, standardisation, and safety testing are prerequisites for meaningful evidence generation in any system.