Pharmacognosy

CHAPTERWISE NOTES

Calcium Oxalate Crystals, Stomata and Trichomes

PHARMA

PHARMACOGNOSY

Calcium Oxalate Crystals, Stomata and Trichomes

CALCIUM OXALATE CRYSTALS

- Calcium oxalate crystals are considered as **excretory products of plant metabolism.**
- They occur in different forms and provide valuable information for identification of crude drugs in entire and powdered forms.
- In **pharmacognosy**, **calcium oxalate crystals** are often studied as part of the **microscopic identification of crude plant drugs**.
- These crystals are important **diagnostic features** used to help **identify plant materials**, especially in powdered or adulterated forms where macroscopic features are not visible.

Occurrence:

- Found in **parenchyma cells** of many plant tissues.
- Common in **leaves, stems, roots**, and **rhizomes**.

Type	Other Name(s)	Shape	Description
Raphides	Needle crystals	Needle-like	Slender, elongated, often pointed crystals, typically found in bundles within specialized idioblast cells. They are known to cause irritation upon contact with mucous membranes due to their sharp nature and sometimes associated irritating compounds.
Acicular	Fine needle crystals	Very thin, needle-shaped	Extremely slender and elongated crystals, often finer and more individual than raphides, though they can also be found in small groups. They are generally straight or slightly curved.
Prisms	Prismatic crystals	Rectangular, square, or polygonal	Angular, often sharp-edged crystals with a distinct geometric shape (e.g., cubic, tetragonal, rhombic). They typically occur singly within cells but can also be found in small, loose aggregations.

Styloids	Columnar crystals	Elongated, rod-like, often pointed	Thicker and usually longer than raphides, typically occurring singly within a cell. They are often pointed at one or both ends and may have a more robust, column-like appearance.
Rosettes	Rosette aggregates	Star-like, radial, or flower-like	Spherical or near-spherical aggregates of numerous smaller crystals (often oxalate prisms) arranged radially around a central point, giving them a flower-like or star-like appearance.
Druses	Cluster crystals	Spherical, globular, or mulberry-like	Rounded, often mulberry-shaped clusters composed of many tiny, interconnected crystals, which can be prismoidal, tetrahedral, or irregular. They appear as ball-like aggregates under the microscope.
Sand	Crystal sand	Fine granular, amorphous, or tiny crystalline	It appears as very fine, minute, often anhedral (lacking well-defined crystal faces) crystalline particles, resembling sand or powder. These are typically calcium oxalate, but their shape is less distinct than other forms.
Micro-sphenoidal	Pyramidal microcrystals	Tiny wedge/pyramidal	Very small, symmetrical, often bipyramidal or wedge-shaped crystals. These require high magnification to be observed clearly and are characteristic of certain plant families.

TYPES OF CALCIUM OXALATE CRYSTALS IN CRUDE DRUGS

S.No.	Type of Calcium Oxalate Crystal	Drug Name	Description / Form
1	**Rosette Crystals**	**Rhubarb (*Rheum spp.*)**	Variable size, 5–40% total ash due to calcium oxalate
		Cascara (*Rhamnus purshiana*)	6–45 µm, parenchymatous cells
		Jalap	Storage tissues; frequent rosette crystals.
		Stramonium (Rosettes, Cluster Crystals)	Mesophyll; cluster crystals distributed throughout tissues.
		Clove (Rosettes, Radiate Aggregate)	Hypanthium; radiate aggregates after KOH maceration.
2	**Cluster Crystals**	**Henbane (*Hyoscyamus niger*)**	Found in mesophyll cells
		Belladonna (*Atropa belladonna*)	Present in mesophyll (also called micro-sphenoidal)

		Stramonium (*Datura stramonium*)	Abundant in mesophyll
		Roselle (*Hibiscus sabdariffa*)	Present in parenchymatous cells
		Podophyllum (*Podophyllum spp.*)	30–100 µm, ground tissue
		Oak Bark (*Quercus spp.*)	Found in cortex
		Wild Cherry Bark (*Prunus serotina*)	Seen in powdered bark
		Fennel (Minute Cluster Crystals)	Endosperm aleurone grains; very fine clusters under high magnification.
4	**Prismatic Crystals**	**Senna (*Cassia spp.*)**	10–20 µm
		Henbane (*Hyoscyamus niger*)	Present
		Stramonium (*Datura stramonium*)	Present
		Belladonna (*Atropa belladonna*)	Present
		Melilot (*Melilotus officinalis*)	Associated with vascular tissue
		Cascara (*Rhamnus purshiana*)	Found along with rosette crystals
		Quillaia Bark (*Quillaja saponaria*)	Up to 20 µm
		Wild Cherry Bark (*Prunus serotina*)	Present along with cluster crystals
		Liquorice	Scattered in parenchyma; visible under polarized light.
		Rauwolfia	Phloem parenchyma; diagnostic prisms present.
		Calumba	Thick-walled sclereids; embedded prisms.
		Quassia	Sclereid inclusions; prismatic crystals inside sclereids.

5	Micro -sphenoidal Crystals (Sandy Crystals)	**Belladonna (*Atropa belladonna*)**	Present in mesophyll
		Henbane (*Hyoscyamus niger*)	Present in mesophyll
		Stramonium (*Datura stramonium*)	Present in mesophyll
6	Raphides (Needle-shaped bundles)	**Squill (*Drimia maritima*)**	Large, 50–900 µm long
		Ipecacuanha (*Cephaëlis ipecacuanha*)	Present in cortex cells
7	Acicular Crystals	**Phytolacca**	Parenchyma; sharp acicular crystals differentiating from Solanaceae.
		Ipecacuanha (Single Acicular Crystals)	Parenchyma; slender needle-like crystals.
		Gentian (Single Acicular Crystals)	Parenchyma; straight needle crystals.
		Cinnamon (Single Acicular Crystals)	Parenchyma; simple acicular crystals.
		Squill (Bundles of Acicular Crystals)	Parenchyma; unique bundles of acicular crystals.
8	Miscellaneous	**Buchu (Spherocrystals)**	Leaf cells; flavonoid diosmin crystals, not oxalate.
		Verbascum, Digitalis, Linaria, Scrophularia, Picrorhiza (Solitary Crystals)	Scattered; sporadic solitary crystals microscopically.
		***Cannabis sativa* (Cystoliths)**	Epidermis; calcium carbonate cystoliths

TRICHOMES

Definition: Elongated outgrowths of epidermal cells, consisting of a foot embedded in the epidermis and a projecting body.

- **Location:** Found mainly on leaves, but also on seeds (e.g., Nux vomica, Andrographis) and fruits (e.g., Lady's finger, Cummin).
- Absent in some plants like Coca, Hemlock, etc.

Functions:

1. **Protection:** Prevents damage from insects and dust accumulation clogging stomata.
2. **Seed Dispersal:** Aids wind dispersal (e.g., Milkweed, Madar).
3. **Secretion:** Secretes volatile oils in plants like Peppermint, Rosemary, and Tulsi.

Types of Trichomes:

Type	Subtypes
1. Covering Trichomes	**a. Unicellular:** Linear, conical, warty (e.g., Tea, Senna), large, lignified (e.g., Nux vomica). **b. Multicellular Unbranched:** Biseriate (e.g., Calendula), Multiseriate (e.g., Male fern). **c. Multicellular Branched:** Stellate (e.g., Hamamelis), Peltate (e.g., Cascarilla), T-shaped (e.g., Pyrethrum).
2. Glandular Trichomes	**a. Unicellular:** Sessile (e.g., Piper betle). **b. Multicellular:** Various forms (e.g., Digitalis, Hyoscyamus, Mentha).

Types of Trichomes

Category	Sub-Type	Structure & Description	Example(s)
Covering (non-glandular)	Unicellular	Linear, strongly waved, thick-walled	*Yerba santa*
		Linear, thick-walled, warty	*Damiana*
		Short, conical	*Tea*
		Short, conical, warty	*Senna*
		Large, conical, longitudinally striated	*Lobelia*
		Long, tubular, flattened, twisted	*Cotton*
		Lignified	*Nux vomica*, *Strophanthus*
		Short, sharp, pointed, curved, conical	*Cannabis*
		Stellate (star-shaped)	*Deutezia scabra*
Covering (non-glandular)	Multicellular Unbranched	Uniseriate, bicellular, conical	*Datura*
		Biseriate	*Calendula officinalis*
		Multiseriate	*Male fern*
Covering (non-glandular)	Multicellular Branched	Stellate (star-shaped)	*Hamamelis*, *Kamala*
		Peltate (shield-like)	*Cascarilla*
		Candelabra (branched)	*Rosemary*, *Verbascum thapsus*
		T-shaped	*Pyrethrum*

Glandular	Unicellular	Sessile (no stalk)	*Piper betel*, *Vasaka*
Glandular	Multicellular	Unicellular stalk, single spherical secreting cell	*Digitalis purpurea*
		Uniseriate multicellular stalk, single spherical cell	*Digitalis thapsi*
		Uniseriate stalk, bicellular head	*Digitalis purpurea*
		Multicellular uniseriate stalk, multicellular head	*Hyoscyamus*
		Biseriate stalk and biseriate secreting head	*Santonica*
		Short unicellular stalk, rosette of 2–8 club-shaped cells	*Mentha*
		Multiseriate, multicellular stalk, head with ~8 radiating club-shaped cells	*Cannabis*

S.No.	Important Drugs	Trichome Type & Description
1	Datura	**Covering**: Uniseriate, multicellular, warty, blunt apex. **Glandular**: Stalk (1 cell), multicellular head.
2	Hyoscyamus	**Covering**: Uniseriate, multicellular (2–4 cells). **Glandular**: Stalk (2–6 cells), ovoid multicellular head.
3	Duboisia	**Glandular** trichomes only.
4	Nux vomica	Thick-walled, bent, twisted, lignified covering trichomes.
5	Lobelia	Uni-cellular or uniseriate bicellular conical, lignified trichomes.
6	Tea	Thick-walled, uni-cellular, conical covering trichomes.
7	Senna	Non-lignified, unicellular trichomes.
8	Digitalis	**Covering**: Uniseriate (3–4 cells). **Glandular**: Short unicellular stalk, bicellular/unicellular head.
9	*D. lanata*	**Covering**: Non-glandular, 10–14 cells. **Glandular** trichomes present.
10	Strophanthus	Lignified covering trichomes.
11	Gokhru	Unicellular trichomes.
12	Anise	Conical epidermal trichomes.
13	Tulsi	**Covering**: Uniseriate, multicellular (up to 8 cells), bladder-shaped, 100–400 µm. **Glandular**: Unicellular stalk, spherical unicellular head.

14	Vasaka	**Covering**: Five-celled uniseriate. **Glandular** trichomes present.
15	Apamarga	Both covering and glandular trichomes present.
16	Vinca	Uni-cellular covering trichome.
17	Punarnava	**Glandular**: Multicellular uniseriate (9–12 cells).

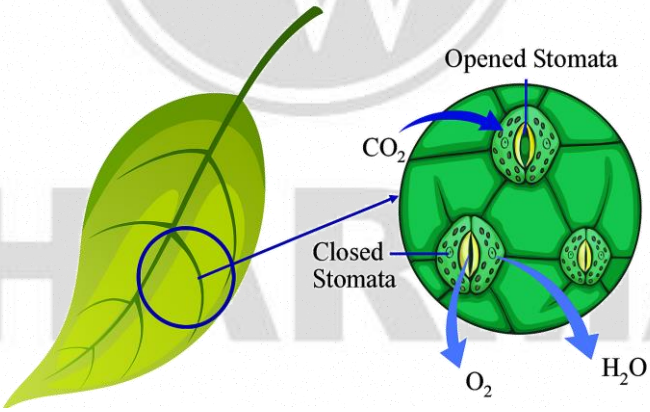
STOMATA

1. **Stomata are small openings in the epidermis of leaves, stems, flowers, and fruits.**
2. Surrounded by guard cells (kidney-shaped).
3. **The opening and guard cells together form the stoma.**
4. Neighboring cells (subsidiary cells) surround guard cells, often differing from other epidermal cells.

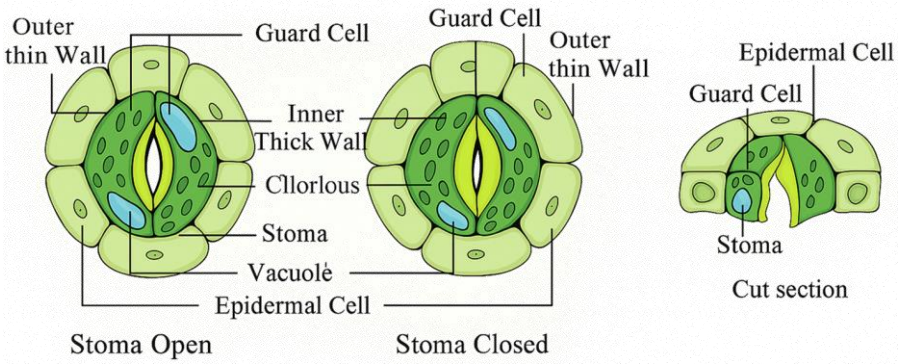
Functions of Stomata:

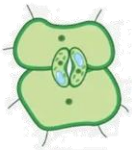
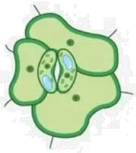
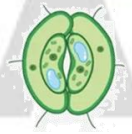
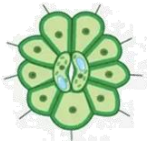
1. **Gas Exchange** – Allow CO_2 in for photosynthesis and release O_2.
2. **Transpiration** – Help in water vapor loss, cooling the plant.
3. **Water Regulation** – Control water loss by opening and closing.
4. **Temperature Control** – Cool the plant through transpiration.
5. **Nutrient Transport** – Support mineral uptake via transpiration stream.

Stomata



Part of Stomata



TYPES OF STOMATA IN CRUDE DRUGS			
S.No.	**Drug(s)**	**Type of Stomata**	**Characteristic Arrangement**
1.	**Tulsi, Peppermint, Spearmint, Vasaka**	**Diacytic (Caryophyllaceous)**	**Cross-celled** – 2 subsidiary cells at right angles to guard cells  Diacytic
2.	**Hyoscyamus, Chirata, Duboisia, Vinca, Belladonna, Datura herb, Stramonium**	**Anisocytic (Cruciferous)**	**Unequal-celled** – 3 subsidiary cells, one smaller than the others  Anisocytic
3.	**Digitalis, Oleander, Eucalyptus, Apamarga, Punarnava, Clove, Buchu, Lobelia, Rue, Colchicum**	**Anomocytic (Ranunculaceous)**	**Irregular-celled** – Surrounded by cells similar to epidermal cells  Anomocytic
4.	**Senna, Coca**	**Paracytic (Rubiaceous)**	**Parallel-celled** – 2 subsidiary cells parallel to guard cells  Paracytic
5.	–	**Actinocytic**	**Radiate-celled** – Guard cells surrounded by a ring of radiating subsidiary cells  Actinocytic
6.	**Belladonna, Stramonium, Brahmi**	**Anisocytic + Some Anomocytic**	**Mixed** – Unequal + Irregular cells
7.	**Datura herb**	**Paracytic + Anisocytic**	**Mixed** – Parallel + Unequal cells