

**ISAPGHULA +HUSK+LEAF+BARK  
+ROOT**

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# ISPAGHULA

**Synonyms :** Isapgol, Isabgol.

The origin of the word Isapgol lies in the Persian word ISAP which means the horse and Ghol means the ear. Thus, the literal meaning of word isapgol is the ear of the horse. The seeds, as well as, husk of the seeds, are used in medicine since 18<sup>th</sup> century. About 10 species of the drugs are available in India. Seeds are very small in size. A thousand seeds weigh about 1.5 g. Isapgol has high export potential value.

**Biological Source : (Fig. 9.4)**

Isapgol consists of dried seeds of the plant known as *Plantago ovata* Forskal, (Family : Plantaginaceae). In the pharmaceutical field, seeds, as well as the dried seed coats, known as Isapgol husk, are used.

**Geographical Distribution :**

The plant is cultivated largely in Gujarat, Punjab and South Rajasthan. The factory for preparation of husk is located at Sidhpur in North Gujarat. In Maharashtra, it is found to be grown successfully near Pune. About 30 thousand hectares of area is said to be under cultivation for the drug in India.

**Cultivation and Collection :**

Isapgol is a rabi crop and needs well-drained loamy soil, cool and dry weather. Heavy rains and cloudy weather at its maturity affect the yield adversely. The drug is cultivated by broadcasting method, in the month of November. About 6 to 12 kg seeds are needed per hectare. Irrigation is done 7 to 8 times at an interval of 8 to 10 days. Ammonium sulphate is found to be satisfactory fertilizer for the plant. The crop is harvested in March/April and the average yield of the seed per hectare is 7.4 quintals. It is collected by cutting the plant just above the ground, converting them to sheaves and drying. Thrashing is done and the thrashed material is winnowed and sieved to maintain quality.

The world demand for psyllium and isapgol seeds and husk is increasing (approx. 20,000 tons) and the main markets are U.S.A., France, West Germany and U.K. The total Indian export during 1990 – 91 was about Rs.61.5 crores.

### Organoleptic Characters : (Figs. 9.5 and 9.6)

Colour : Pinkish-grey or brown.

Odour : None

Taste : Mucilaginous, bland.

Size : 10 to 35 mm in length and 1 to 1.75 mm in width.

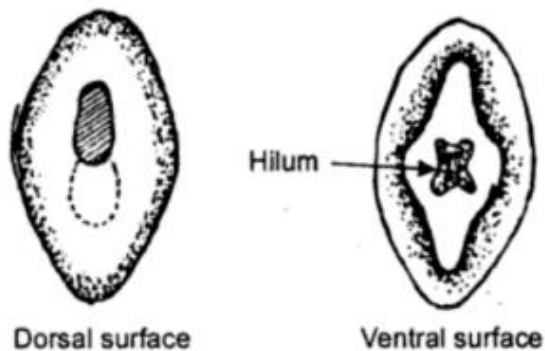
Shape : It is ovate cymbiform. One thousand seeds weigh about 1.5 g.

### Extra Features :

Seeds are hard, transparent and smooth with grey or reddish brown oval spot in the centre of the convex surface. Concave surface contains the hilum covered with thin membrane having two perforations.



Fig. 9.4 : Isapgol Plant



Dorsal surface

Ventral surface

Fig. 9.5 : Organoleptic Characters  
of Isapgol Seed



Fig. 9.6 : Isapgol Seeds

### **Isapgol Husk (Ispaghula Husk) :**

Isapgol seeds are processed to take out seed coats, commercially known as husk. The husk makes up about 25 to 27 per cent of the seed. The seeds are thoroughly dried and sieved to get rid of foreign organic matter. Seeds are crushed in flat stone grinders by passing several times through them, so as to cause the complete removal of the coating. The crushed material is then winnowed to separate the kernels and husk. Husk is sieved to get different grades and sizes. Thus, it consists of the epidermis and its adjacent layers removed from the dried seeds of *Plantago ovata*. Morphologically, it is in the form of pale buff ovate flakes with more or less lanceolate shape. The pieces are 1 to 2 mm in size.

### **Chemical Constituents :**

Isapgol husk and seeds contain mucilage which is present in the epidermis of the seed. Chemically, it consists of pentosan and aldobionic acid. The products of hydrolysis are xylose, arabinose, galacturonic acid and rhamnose. Fixed oil and proteins are other important constituents of the drug.

Swelling factor is supposed to be criterion of purity of the drug. Swelling factor of the drug is a quantitative swelling due to mucilage present in the drug. It is determined by putting 1 g of the drug in the measuring cylinder (25 ml capacity) in 20 ml water with occasional shaking. The volume occupied by the seeds after 24 hours of swelling is measured.

Swelling factor for seeds is 10 to 14.

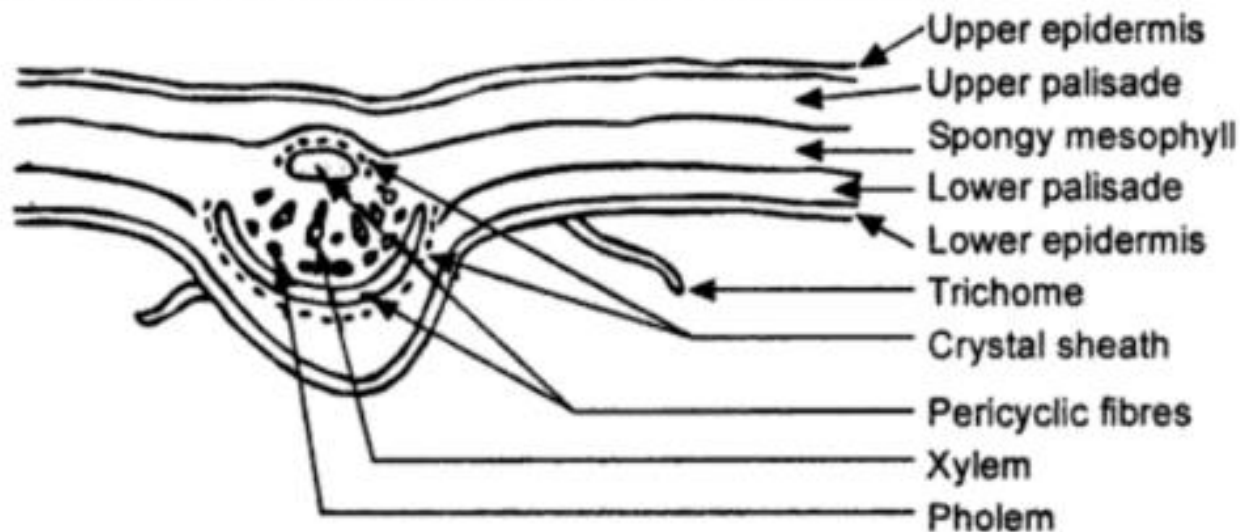
### Chemical Tests :

1. To dry seeds of Isapgol add one drop of Test solution of Chinese-ink, mucilage shows transparent, spherically dilated fragments on black background.
2. Being mucilage chemically, isapgol gives pink colour with the solution of ruthenium red.
3. To dry seeds add a drop of Thionine test solution, wait for 10 minutes, wash with alcohol mucilage turns violet-red.

The another common variety which is official in British Pharmacopoeia bears the synonym *Alexandrian senna* and botanically consists of the dried leaves of *Cassia acutifolia Delile*. **Alexandrian senna leaves** are pale greyish-green in colour, 7 to 12 mm in width and 20 to 40 mm in length. Leaflets are ovate-lanceolate with entire margin, papery in texture, thin and without transverse marking. Alexandrian senna is indigenous to tropical Africa and is cultivated in Sudan. It is exported through port of Alexandria.

### Microscopic Characters (Fig. 9.9) :

Senna represents typical histological characters of isobilateral leaves which include the following - The epidermis shows presence of unicellular, conical, thick-walled warty trichomes. The trichomes are slightly curved at their bases and are present on both the surfaces. The rubiaceous or paracytic stomata are present on epidermal surfaces. Palisade tissue is present on both the sides, consisting of rectangular cells, enclosing cluster-crystals of calcium oxalate. The spongy mesophyll and conducting tissues are represented by leaves as shown in the figure. A patch of sclerenchyma towards upper epidermis and above the xylem (also known as pericyclic fibres) is present. The presence of cluster sheath and sclerenchyma are characteristic of the senna leaves.



**Fig. 9.9 : T.S. of Senna Leaf-let**

The following are quantitative microscopic constants of Indian and Alexandrian senna leaves.

## I. LEAVES

There are several leaves, which find use in the practice of pharmacy. Leaves are flat, thin, green appendages to the stem, containing, supporting and conducting strands in their structures.

In pharmacognosy, the word leaf includes leaf, compound leaf and leaflets. Depending upon their biological sources, leaves, many a time, include the flowering tops. In certain cases, the minimum percentage of active constituents is specified. The basic difference between the leaf and the leaflet is as follows.

**Table 4.2 : Difference between Leaf and Leaflet**

<b>Leaf</b>	<b>Leaflet</b>
1. In case of leaves, bud or branch is present in the axil.	It is absent in leaflets.
2. Leaves are arranged spirally and they are solitary in nature.	Leaflets are arranged in pairs.
3. Leaves lie in different planes.	Leaflets lie in the same plane.
4. Leaves are generally symmetrical at the bases, e.g. digitalis, belladonna, vasaka	Leaflets are asymmetrical at the bases, e.g. senna, neem, rose.

Apart from the normal characteristics i.e. their arrangement on the stems, their apices, margin, petiole, presence or absence of stipules etc., leaves are characterized by certain diagnostic structures. Most of these diagnostic characters are microscopic one, such as stomata and trichomes, stomatal index palisade ratio, vein islet number etc. All these characteristics shall be referred in detail under microscopic characters of the leaves.

### **Collection of Leaves :**

The procurement of leaves depend on several factors and varies from leaf to leaf. One should have thorough knowledge of chemical constituents of leaves and the chemical changes which might take place in normal atmospheric conditions. Medicinal leaves are collected during the flowering season of plants, when the plants reach maturity and they are photosynthetically most active. If the leaves contain volatile oil, irrespective of the other facts, they are generally collected when the plant is rich in volatile oil content. The

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weather and time of collection is also very important for procurement of drugs. Dry weather with minimum humidity is ideal in most of the cases for plucking the leaves. Digitalis leaves are collected in dry weather, generally in the afternoon. Coca leaves are collected, when they are nearly ready to fall from the stems. The discoloration of leaves is undesirable, while the leaves of substandard quality fetch less value in the market.



## Diagnostic Characters of Leaves :

Apart from shape, size and colour, leaves are characterized by several microscopic structures which help in their proper identification. Following are few diagnostic characters of common occurrence.

### [A] Stomata :

Epidermis of leaf shows different characteristics, e.g. cutical stomata, trichomes, water-pore, cell inclusions, etc. A Stoma is a minute epidermal opening with following characteristics.

- (i) A central pore .
- (ii) Two kidney shaped similar cells containing chloroplasts known as guard cells and varying number of subsidiary (epidermal) cells covering the guard cells.

Stomata perform two functions in the plant body. The primary and most important function of stomata is gaseous exchange and the secondary function is transpiration.

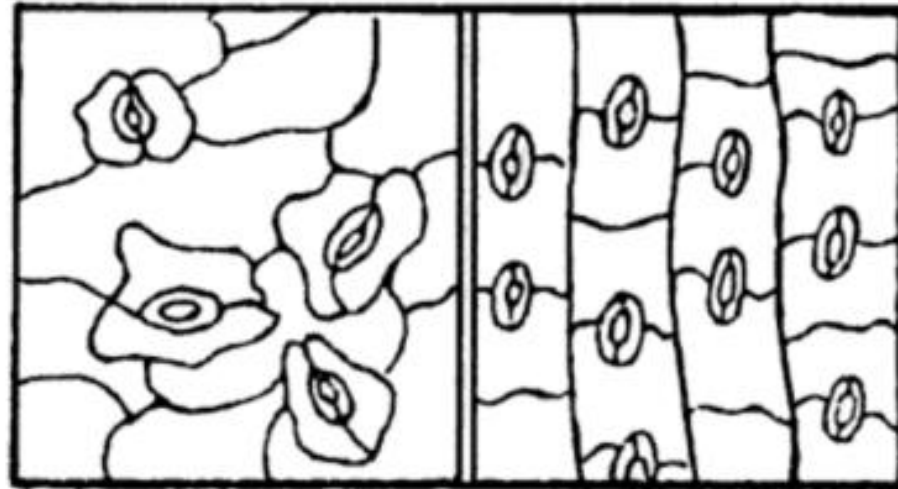
It is not essential that each plant must have stomata. The leaves of bryophytes and submerged leaves of aquatic parts do not contain stomata. Generally, stomata are present in green parts of the plant (mostly leaves), but absent in roots. Apart from the leaves, they are also present in the stems (ephedra), flowers (clove), and fruits (fennel). However, it is generally observed that stomata are abundantly present in dicot leaves. In some cases, they are present on the upper surface of leaves, while in others on lower surface only (coca and cherry). In some, the stomata are present on both surfaces of the leaves (senna, belladonna, datura etc.). The distribution of stomata between upper and lower epidermis in dicot leaves shows great variation.

**Types of Stomata :** Depending upon the type of the guard cells and arrangement of subsidiary cells, stomata are divided into four types.

1. Moss type.
2. Gymnospermous type.
3. Gramineous type.
4. Dicotyledonous type.

Out of these, fourth type of the stomata is of diagnostic significance. Dicotyledonous stomata are classified into following types depending upon the form and arrangement of subsidiary cells.

**1. Paracytic or rubiaceous or parallel-celled stomata :** This type of stomata comprises two guard cells covered by two subsidiary cells, the long axes of which are parallel to that of stoma, e.g. coca and senna leaves (Fig. 4.1).



1. Paracytic

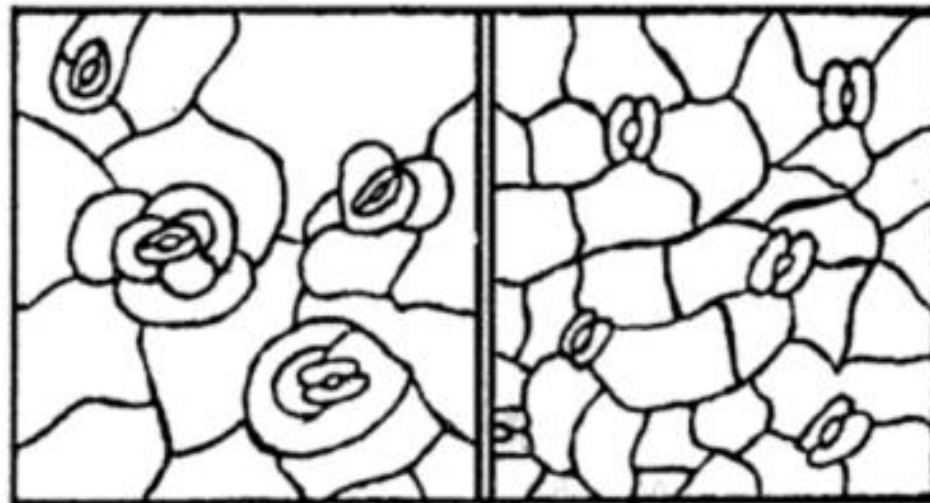
2. Diacytic

Fig. 4.1 : Types of Stomata

**2. Diacytic or caryophyllaceous or cross-celled stomata :** The guard cells are covered by two subsidiary cells, as in case of paracytic stomata, but the arrangement of subsidiary cells on the guard cell is at right angle to that of stoma, e.g. peppermint, spearmint, and vasaka.

**3. Anisocytic or cruciferous or unequal-celled stomata :** The number of guard cells is two, as in all other cases. But the guard cells are covered by three subsidiary cells, of which one is markedly smaller than the other two, e.g. belladonna, datura and stramonium (Fig. 4.2).

**4. Anomocytic or ranunculaceous or irregular-celled stomata :** In this type, stoma is surrounded by varying number of subsidiary cells resembling other epidermal cells, e.g. buchu, digitalis and lobelia (Fig. 4.2).



3. Anisocytic

4. Anomocytic

Fig. 4.2 : Types of Stomata

**[A] Covering trichomes :**

**(a) Unicellular :**

- |                                      |                          |
|--------------------------------------|--------------------------|
| 1. Lignified trichomes               | Nux-vomica, strophanthus |
| 2. Short, sharply pointed, curved    | Cannabis.                |
| 3. Large, conical, strongly shrunken | Lobelia.                 |
| 4. Short, conical, warty             | Senna.                   |
| 5. Short, conical, unicellular       | Tea, buchu.              |
| 6. Strongly waved, thick walled      | Yerba santa.             |

**(b) Multicellular, unbranched trichomes :**

**(I) Uniseriate :**

- |                              |             |
|------------------------------|-------------|
| 1. Bi-cellular, conical      | Datura .    |
| 2. Three celled long         | Stramonium. |
| 3. Three to four celled long | Digitalis.  |
| 4. Four to five celled long  | Belladonna. |
- (II) Biseriate** *Calendula officinalis.*

**(III) Multiseriate**

**(c) Multicellular, branched trichomes**

- |                       |   |
|-----------------------|---|
| 1. Stellate           | Hamamelis, <i>Helicteris isora</i>                      |
| 2. Peltate            | (Plate like arrangement of surrounded cells)<br>Humulus |
| 3. Candelabra         | (Uniseriate branched axis) <i>Verbascum thapsus.</i>    |
| 4. T shaped trichomes | Artemisia, pyrethrum                                    |

**[B] Glandular trichomes (Fig. 4.4) :**

These are characterised by the presence of glandular (spherical) cell at the top of the trichome. These are sub-classified as follows :

1. **Unicellular glandular trichomes** : The stalk is absent e.g. *Piper betel*, *Vasaka*.

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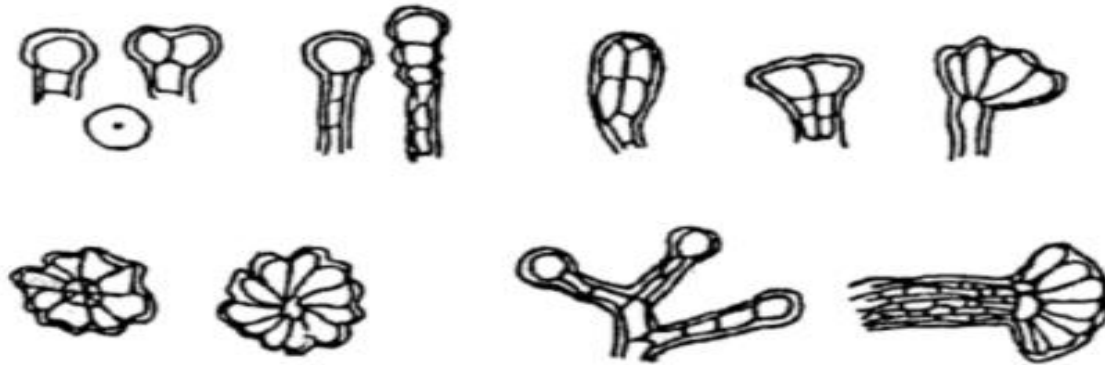


Fig. 4.4 (a) : Glandular Trichomes - Multicellular

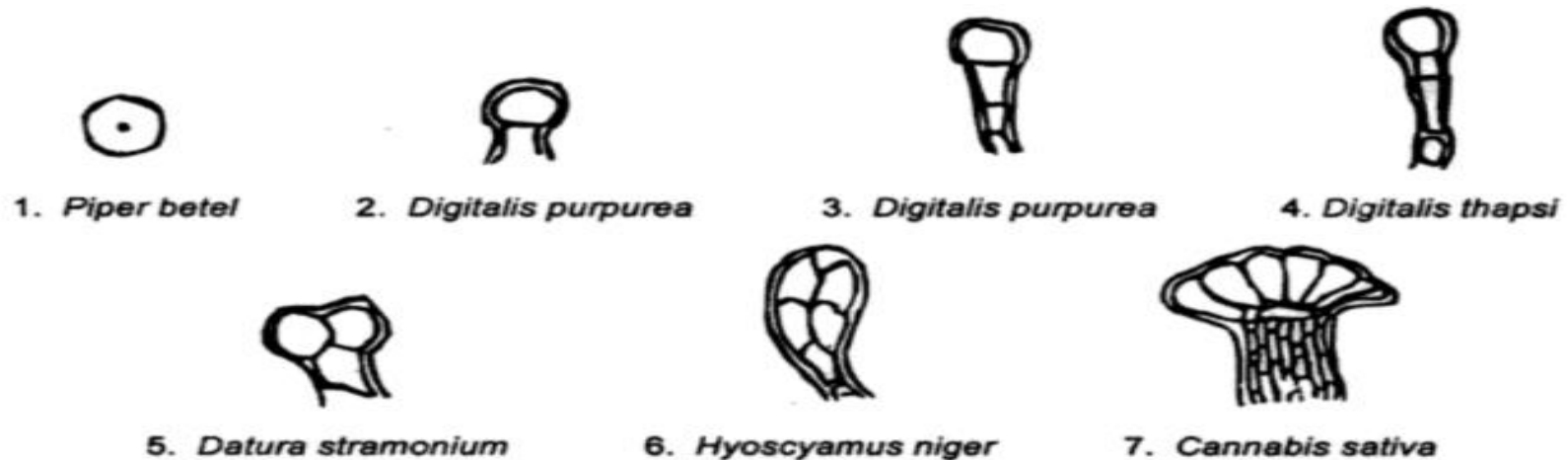


Fig. 4.4 (b) : Examples of Glandular Trichomes - Multicellular

2. **Multicellular glandular trichomes** :

1. Trichomes with unicellular head and unicellular stalk, e.g. *Digitalis purpurea*.
2. Unicellular head and uniseriate multicellular stalk, e.g. *Digitalis thapsi*, belladonna etc.
3. Multicellular head, multicellular, biseriate stalk, e.g. Santonica and plants of Compositae, such as sunflower etc.
4. Unicellular stalk and biseriate head, e.g. *Digitalis purpurea*.

5. Short stalk with secreting head formed of rosette or club shaped cells, e.g. *Mentha species*.
6. Trichomes with multicellular, multiseriate, cylindrical stalk and a rosette of secretary cells, e.g. *Cannabis sativa*.
7. Multicellular multiseriate head and multicellular uniseriate stalk, e.g. Indian hemp and tobacco.

**[C] Hydathode or special types of trichomes :**

These are the organs of absorption or secretion of water developed in certain plants e.g. *Piper betel*, London pride etc.

**Emergences (Prickles) :**

Emergences are also small outgrowths on the epidermal walls of the aerial parts of the plants. They are epidermal and sub-epidermal in origin. They may be present on the stems or fruits like trichomes. Emergences are not microscopic structures. They are hard many a times, stout in nature and meant for plant protection.

## **II. BARKS**

*The secondary external tissues lying outside the cambium in stem or root of dicotyledonous plants, are known as the bark.*

Botanically, bark is also known as periderm. Periderm consists of three layers viz., cork (phellem) ; cork-cambium (phellogen) and secondary cortex (phelloderm). Commercially, barks consist of all the tissues outside the cambium. A young bark includes epidermis, cortex, pericycle and phloem. Barks are obtained from the plants by making longitudinal and transverse incisions through the outer layers followed by peeling. Barks may be obtained from stems or roots. Due to the excessive growth produced by the cambium and cork cambium, the external tissues get tangentially stretched or torn and hence, the epidermis is not found in the barks.

### **Characteristics of Barks :**

Barks exhibit several morphological and microscopical characters. The morphological characters need special attention, as they help in identification of the barks.



## Shapes in Barks :

The shape or form of the bark is dependent upon the method adopted for its preparation. It also depends on the type of incision made and the extent of any subsequent shrinkage of the tissues. When the bark is removed from the large trees and dried under pressure, the flats are produced, e.g. quillaia and arjuna. When the bark is removed from the small branches due to shrinkage of the soft tissues, it tends to curve forming concavity on the inner side, yielding *curved* pieces, e.g. wild cherry and cassia. If the concavity is on the outer side of the bark, it is described as *recurved*, e.g. kurchi. When the shrinkage of the tissues is to a greater extent and it forms deep trough or channel, it is called a *channelled bark*, e.g. ashoka, *Cinchona ledgeriana* and cassia. In some cases, one edge of a bark covers the other to form *quill*, e.g. cascara and cinnamon. If both the edges of the bark roll independently forming quill, it is described as *double quill* e.g. Java cinnamon. In some cases, one quill of a bark is put inside other quill to form a *compound quill*, e.g. cinnamon. Compound quill is a man-made shape of bark. It reduces the exposure of bark to atmospheric conditions and also saves the space in transport (Fig. 4.5).

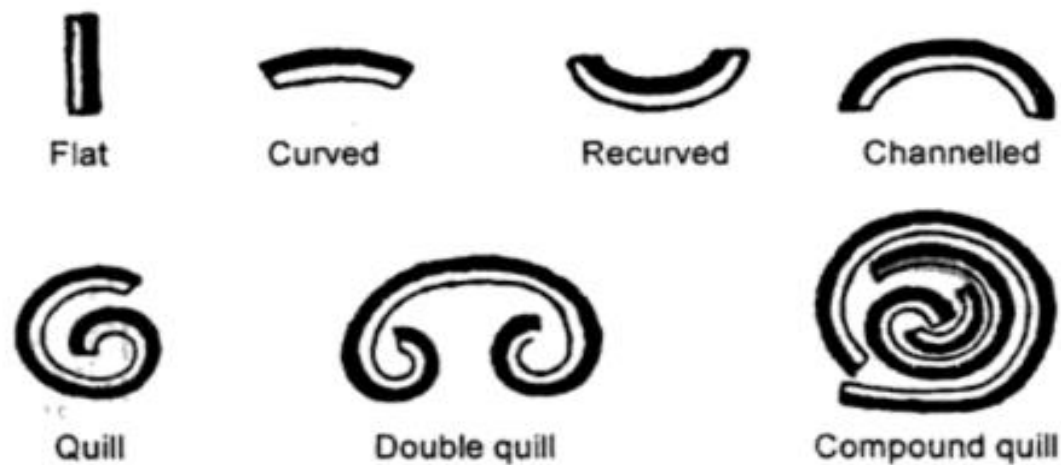


Fig. 4.5 : Shapes in Barks

## Fractures in Bark :

The appearance shown by the transversely broken surfaces of the bark is known as *fracture*. It is, sometimes, useful in identification of barks. The types of the fractures are as follows.

When fractured surface is smooth, it is described as a short fracture (cinnamon and kurchi). If the exposed surface exhibits small rounded appearance, it is described as a *granular* fracture (wild cherry and cassia). If, the broken surface shows the presence of uneven projecting points, it is described as *splintery* fracture, as seen in cinnamon. The presence of numerous fibres on the transversely broken surface is described as a fibrous fracture (cinchona). If the exposed surface shows the arrangements of layers one over the other, it is described as a *laminated* fracture, as observed in quillaia.

The various characters shown by the barks on the outer, as well as inner surface are also diagnostically important. Amongst these, the colour, condition and presence of several growths like lichens, mosses etc., are characteristic to each bark. The presence of lenticels and development of cracks are additional characters of bark. Outer surface of the bark shows presence of cracks and fissures, which are due to lack of elasticity or due to increase in girth of the trees. *Fissures* are usually deep. *Wrinkles*, which are seen on outer surface of the bark, result due to shrinkage of inside soft tissues. *Furrows* are troughs between wrinkles. Inner surface of bark shows characteristics such as *striations*, which are longitudinal and parallel lines. Transverse wrinkles present on inner surface are described as *corrugations*.

## Methods of Collecting Barks :

Barks are collected in a season when they contain maximum concentration of active constituent. Cinnamon is collected in rainy season, while wild cherry is collected in autumn. Following are the methods of collecting barks.

**1. Felling method :** This is a very old method of collecting barks. The tree is cut at base and bark is peeled out. This method is not used at present commercially, since it causes total destruction of trees.

**2. Uprooting method :** In this case, the roots of plant are dug out of soil and bark is stripped off from roots and branches. This method is applied for collection of root bark of cinchona in Java.

**3. Coppicing method :** In this method, the plant is allowed to grow for a definite period and then it is cut off at specific distance from soil. The stumps, which remain in ground are allowed to send shoots, which develop further independently yielding aerial parts. These new parts are cut off and bark is collected from shoots. As compared to other methods of collection of bark, this technique is more economical and less time-consuming. It is, therefore, the method of choice for collecting barks commercially. Cascara and cinnamon are collected by this method.

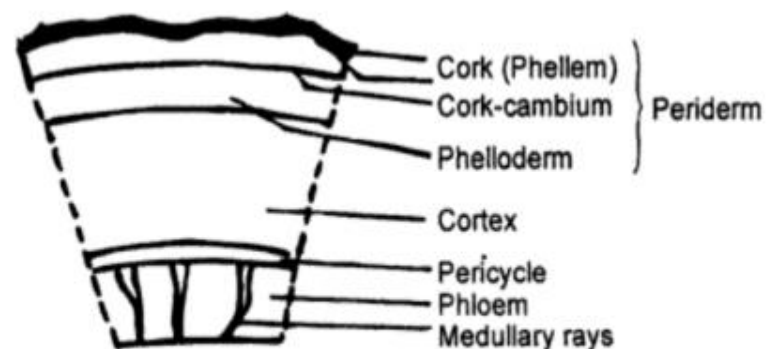


Fig. 4.6 : Microscopic Structure of Bark

## Microscopic characters of Barks :

General microscopic characteristics of barks are represented in Fig. 4.6. Depending upon several factors such as exfoliation of bark or special technique of preparation of bark for market as in case of cinnamon, histological structures may vary from bark to bark.

## VII. SEEDS

The seed is a fertilized ovule.

It represents a condensed form of life and it is a characteristic of phanerogams. Parenchymatous body of the ovule known as nucellus, contains embryo-sac surrounded by integuments (coatings). In the embryo-sac itself fertilization takes place giving rise to embryo. Thus, seeds are characterised by the presence of three parts known as embryo, endosperm and seed-coat. Endosperm is the nutritive tissue nourishing the embryo. Endosperm may or may not be present in the seeds. Therefore, seeds are classified as follows :

1. Endospermic or albuminous seeds.
2. Non-endospermic or exalbuminous seeds.
3. Perispermic seeds.

**1. Endospermic or albuminous seeds :** A part of the endosperm remains until the germination of seed and is partly absorbed by embryo. It shows distinct presence of endosperm, e.g. colchicum, isapgol, linseed, nux-vomica, strophanthus etc.

**2. Non-endospermic or exalbuminous seeds :** During the development of seed, the endosperm is fully absorbed by embryo and endosperm is not represented in the natural seeds, e.g. sunflower, tamarind, cotton, soyabean etc.

**3. Perispermic seeds :** Herein, the nucleus develops to such an extent that it forms a big storage tissue and seeds are found to contain embryo, endosperm, perisperm, and seed coat; e.g. pepper, cardamom, nutmeg etc.

Seeds are characterised by the following structures :

(a) **Hilum :** This is the point of attachment of seed to stalk.

(b) **Micropyle :** It is the minute opening of the tubular structure, wherefrom water is provided for the germination of seeds.

(c) **Raphe :** Raphe is described as longitudinal marking of adherent stalk of anatropous ovule.

## Special Features of Seeds :

In some instances, apart from regular growth of seeds, additional growth is visible in the form of appendages.

1. **Aril** : Succulent growth from hilum covering the entire seeds, as observed in nutmeg (mace).

2. **Arillode** : Outgrowth originating from micropyle and covering the seeds, as seen in cardamom.

3. **Arista (awn)** : Stiff-bristle-like appendage with many flowering glumes of grasses, as found in strophanthus.

4. **Caruncle** : It is warty outgrowth from micropyle; e.g. castor, croton, viola.

5. **Strophiole** : Enlarged funicle, e.g. *Datura fastuosa* and colchicum seed.

6. **Hairs** : *Gossypium* and *Calotropis* are the examples of this type of outgrowth.

These appendages are found to perform special functions, at times. For example, hairs and awns of seeds help their dispersal.

## **VIII. UNDERGROUND DRUGS**

Underground part of the plant may be either root or it may be a underground or sub-aerial modification of stem.

The functions performed by modified stem or root are basically different, but taking into consideration their occurrence as underground parts of the plants, irrespective of their function, they can be put together for sake of convenience and study.

### **Roots :**

The roots are characterised by their downward growth into the soil. They do not have nodes and inter-nodes. Branching of roots arises from pericyclic tissues. The roots are covered by root caps or root heads.

Commercially, there is no clear demarcation between roots and rhizomes. Rhizomes studied in pharmacognosy may contain good proportion of root or even the roots may contain large amount of rhizomes. Hence, the roots, rhizomes and other underground parts of the plant are described together.

After collecting roots and rhizomes, it is necessary to prepare them carefully for market. The roots and rhizomes, have to undergo several operations for their preparation for market, which include proper washing, drying and even in certain cases scrapping and coating.

Underground modifications of stem are of the following types :

1. Rhizome,
2. Tuber,
3. Bulb, and
4. Corm.

All these parts can be distinguished from aerial parts and other underground parts of the plant by their specific characteristics.

**1. Rhizome :** The rhizomes grow horizontally under soil. They are thick, fleshy and characterised by presence of nodes, inter-nodes and scale leaves. They also possess bud in the axil of scale leaves. Adventitious roots may also be present on lower surface of rhizomes. The rhizomes may be branched and serve as storage organs. The examples of rhizomes are ginger, dioscorea, turmeric, rhubarb, male fern etc.

**2. Tuber :** The tubers are characterized by presence of ' eyes ' from vegetative buds, which grow further and develop into a new plant. Adventitious roots are absent in tubers. Tubers are swollen underground structures of plant. Tubers are organs of storage, as well as, of propagation. The examples of tubers are potato, jalap, aconite, dioscorea.

**3. Bulb :** The bulb is a specialized underground shoot. The food material is stored in fleshy scales, which overlap the stem. The buds are present in axils of the scales and few of them develop in spring season at the expense of stored food material in the bulb. The reserve food material formed by leaves is stored at their bases and new bulbs are produced in subsequent year. The bulb is an organ of perennation and also vegetative propagation. The examples of bulb are garlic, onion, squill and *Gloriosa*.

**4. Corm :** The corms are also underground modification of stems. Generally, they are stout and grow in vertical direction. They bear bud in the axil of the scale leaves and these buds then develop further to form new plant. Adventitious roots are present at the base of the corm. The growth of corm is sympodial. The examples of corm are saffron and colchicum.

## **Sub-aerial modifications of stems :** These include -

1. Runner,
2. Stolon,
3. Offset, and
4. Sucker.

**1. Runner :** The runners have the speciality of creeping on ground and rooting at nodes. Auxillary buds are also present in case of runner. Strawberry and pennywort are examples of runners.

**2. Stolon :** The stolons are lateral branches arising from base of the stems, which grow horizontally. They are characterized by presence of nodes and inter-nodes. Few branches growing above the ground develop into a new plant. The examples of stolons are glycyrrhiza, arrow root and jasmine.

**3. Offsets :** These are originated from axil of the leaf as short and thick horizontal branches. They are also characterized by presence of rosette type of leaves and a cluster of roots at their bottom. Offsets are shorter and stouter than runner, e.g. aloe, valerian and agave.

**4. Sucker :** The suckers are lateral branches developed from underground stems. Suckers grow obliquely upwards and give rise to a shoot, which develop further into new plant. They are characterized by presence of scale leaves. Examples of the suckers are *Mentha* species pineapple, banana etc.