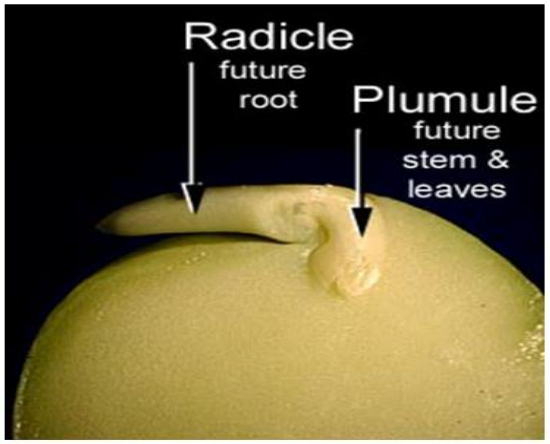
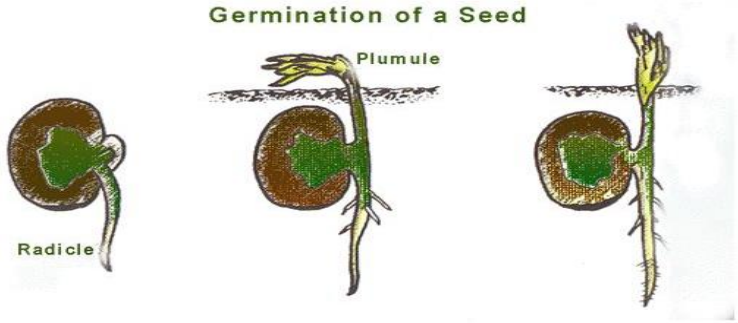
Stem Morphology

- The stem: the ascending axis of the plant which is represented in the seed by the plumule.
- grows upwards into the air in search of light.
- green in color and may be branched or unbranched.
- It bears leaves, flowers and fruits.
- A stem with its leaves is called **a shoot** and an entire stem with all its branches and leaves , is called a **shoot system**.

Early Stem Growth – the Plumule

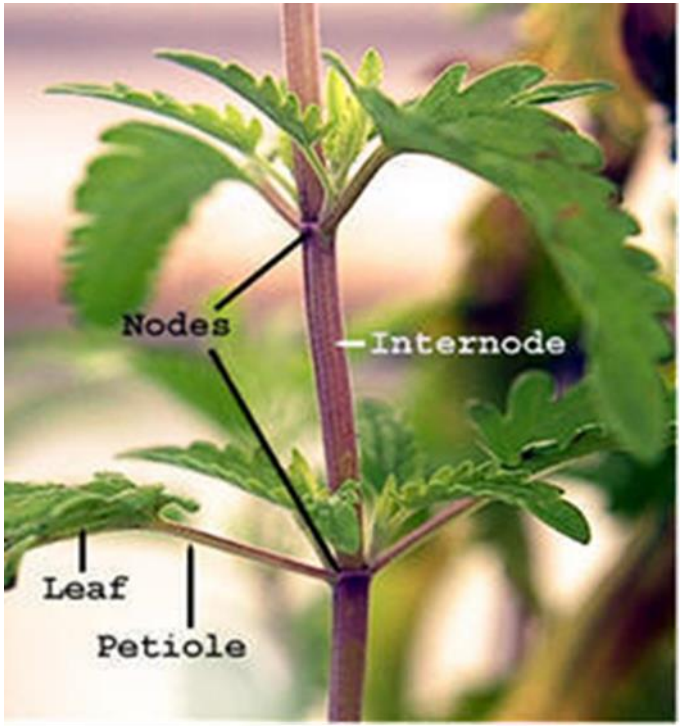




Nodes and internodes

- **Nodes**: distinct points of the stem where leaves are borne.
- **Internode**: leafless portions of the stem between two adjacent nodes.
- **Axil**: the upper angle between the leaf and stem.

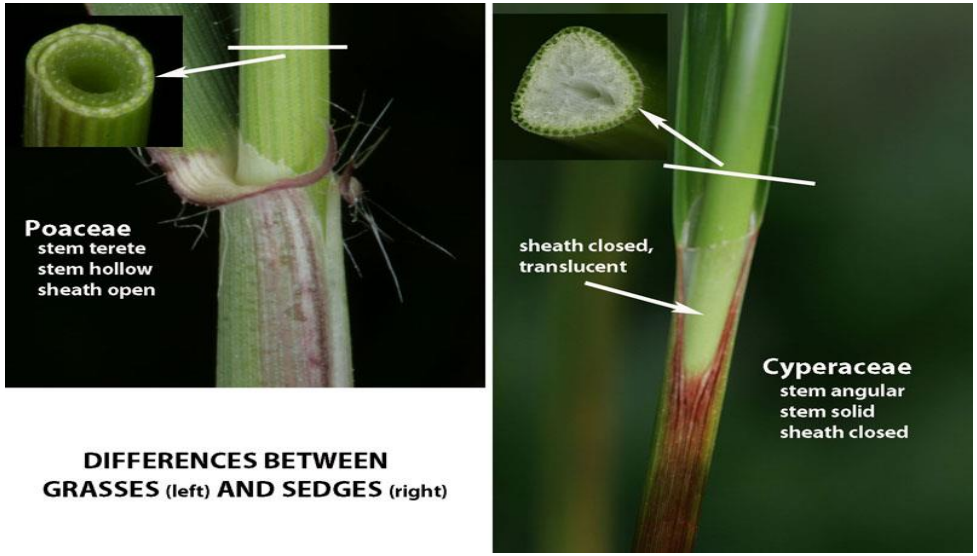
- The growing tip of the stem is **not** protected by a cap as in the root.



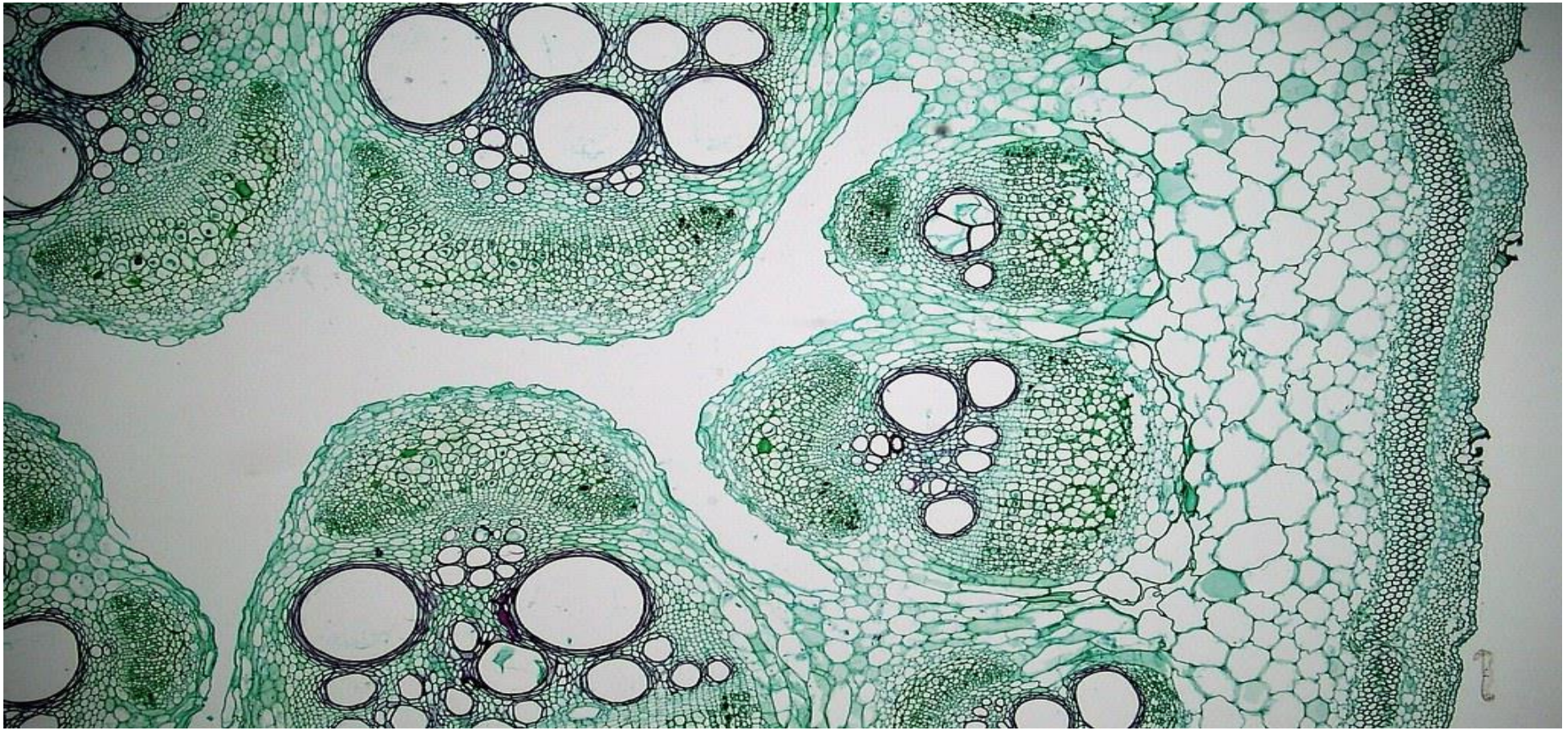
Internal appearance of stem

solid stem

Hollow stem



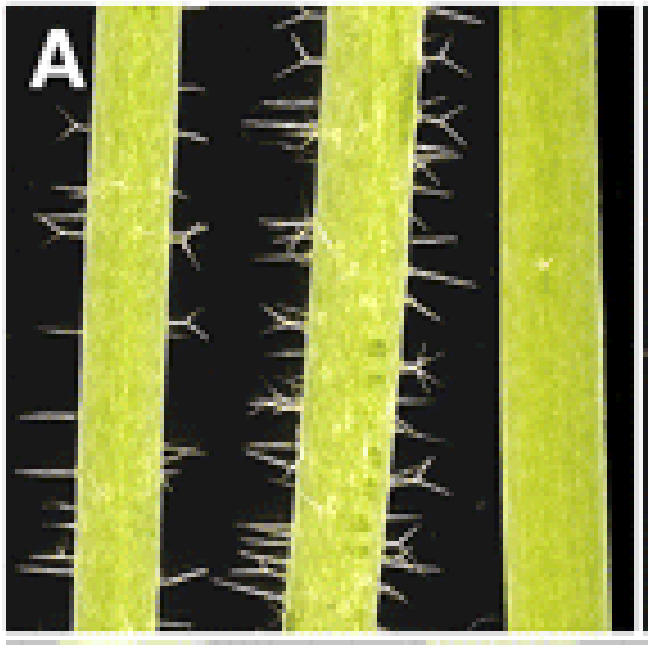
DIFFERENCES BETWEEN
GRASSES (left) AND SEDGES (right)



Cucurbita is a fast growing herb, which has **hollow stems and petioles**, so not much carbon resource is allocated to the production of lignified mechanical tissue. It is also a good example of a plant which has bicollateral vascular bundles with phloem outside (external) as well as inside (internal) to the xylem tissue.

Surface of stem

1. ***Glabrous surface:*** without hair or a similar growth; smooth.
2. ***Hairy:*** with hairs.



Arabidopsis
(glabrous and hairy)

Glabrous

Hairy

The stem bears sharp-pointed structures for protection in the following three types:

3. Prickly: sharp structures are ***irregular emergences in the cortex*** as in *Rosa*.

4. Thorny: sharp structures ***arise in the axil of leaves***, they are ***modified branches*** an are called thorns as in *Duranta*, *Citrus* , *Bougainvillea* and *Alhagi*. Thorns sometimes bear leaves and flowers

5. Spiny: When they are ***modified leaves***, they called spines e.g. *Opuntia*.

Alhagi

Rosa

Opuntia

Recap

- **Thorns** develop from shoot material.
- **Spines** are modified leaf structures.
- **Prickles** form from the plant's epidermis and cortex (outermost layers).

TEST YOURSELF

1

2

3

4

5

6

7

8

9

10

Nature of stem

- Herbaceous: the stem is soft green and can be easily bent e.g. *Oryza* and *Trifolium*.
- Woody: stem stiff and hard, and can not be easily bent as in

1. Trees: with a well marked trunk, which grows for some distance above the ground before it branches e.g. Mango.
2. Shrubs: several stems branches of approximately equal size appear about the soil level e. g., rose, jasmine, cotton.

surviving unfavorable seasons, e.g. dark and cold winters.

- **Deciduous plants**: all the leaves usually fall at a time leaving the stem completely bare (e.g. *Morus*, *Poinciana*).
- **Evergreen plants**: the leaves do not fall at a time but are shed throughout the year, so that the plant is never bare e.g. Pine, Mango.

- **The annual plants:** live only for **one season** produce seeds and then die e.g. Pea and bean (**herbaceous**).
- **Biennials:** live for two growing seasons. e.g. Carrot, radish and beet that grow in cold countries (**herbaceous**).
- **Perennials:** are woody plants that live longer than two years.

Habit of stem

1- Reduced stems (dwarf):

- The axis is very much abbreviated and looks like a ***small green disc*** at the top of the root.
- The leaves appear to arise directly from the root, e.g. Carrot, Radish, Turnip and Onion.

2- Erect stem:

- They stand upright and do not require any extra support to expose themselves and their leaves to the sun's rays.
- These are of four types :

(a) **Excurrent:** the main axis tapers from the base to the apex and producing branches horizontally in acropetal succession (**pyramidal shape**), e . g. , *Eucalyptus*, *Pinus*.

(b) Deliquescent: after the main axis ceases to grow its axillary buds grow vigorously, producing branches. (**dome-shaped**) e.g. mango.

(c) Caudex: the main axis remains unbranched and terminates in a cluster of leaves e.g. , palms, coconut.

(d) Culm: The main axis is unbranched and closely jointed e.g., Bamboo.

Excurrent

Eucalyptus

Deliquescent

Mango

Caudex

Culm

3- Weak stems: not strong enough to become erect.

(a) Trailers: They lie prostrate on the soil and grow in a horizontal direction over the surface of the soil, e.g. *Portulaca*.

(b) Twiners: The aerial stem grows in a spiral fashion around a suitable support e.g. *Convolvulus*, *Ipomoea*.

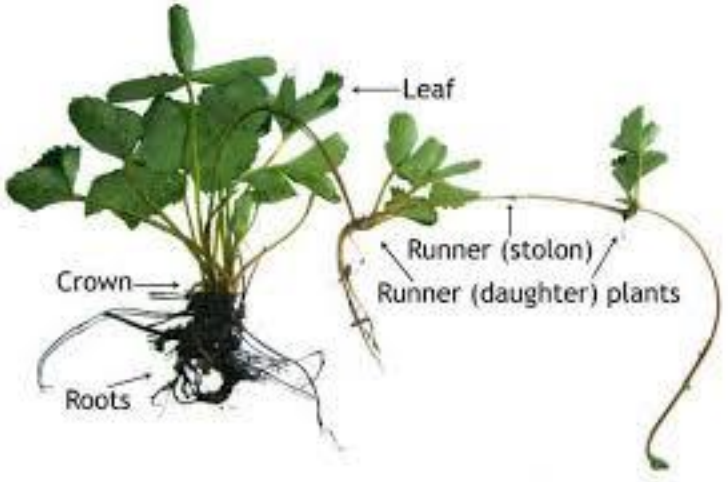
(c) Runners:

- A runner arises in the axil of a leaf at the level of the soil from the base of the parent plant and at intervals. it bears buds which form aerial shoots, and adventitious roots.
- Runners thus produce new plants without the help of seeds e.g. lawn grass and strawberry

(d) Offsets:

- An offset is a short and thick runner, e.g., water Hyacinth and *Pistia*.

Pistia



strawberry

(e) Climbers: attach themselves to a support by special structures to climb up those supports step by step.:

i- Root-climbers: These plants climb with the help of adventitious roots, e.g. (*Cereus*).

ii- Hook –climbers: These plants climb on the support by means of curved hooks, e.g., *Artobotyris*.

iii- Thorn-climbers: These plants climb with the help of thorns e.g. *Bougainvillea*.

iv- Tendril-climbers: These plants climb on their support with the help of tendrils (slender, leafless coiling structures) .

Cereus

Artobotyris
(hook from the flower axis)

Vitis
tendrils

Bougainvillea
thorns

Modifications Of Stem

I- Modifications Of Aerial Stems:

Any structure that arises in the leaf axil is morphologically a stem structure whatever its outward form.

The following forms illustrate axillary stem structures that look unlike ordinary branches:

A. Stems thorns: the branches of the stem lose their growing points, and become hard, sharp and pointed. Their stem nature is evident from their axillary position, by the occasional production of leaves or flowers on them and their internal structure e.g. *Citrus*, *Alhagi* and *Bougainvillea*.

- The stem thorns:

- protect the plant against injury from grazing animals.
- prevent excessive loss of water from the aerial parts of the plant as the leaf structure is extremely reduced.

Citrus

Alhagi

B. Stem Tendrils: Some branches become modified into *thread-like structures sensitive to contact*. They ***coil*** round some support, and thereby help in raising up the part of the plant on which they are borne (**climbing**).

- In grape vine , the tendrils **do not arise in the axils of leaves, but** are borne **apposite to the foliage leaves** on a sympodial axis, as a result of cymose branching.
- Other examples of stem tendrils are found in cucurbitaceous plants like *Luffa* and Water-melon. In these plants the stem **tendril occupies axillary position**.

The main function of the stem tendrils is:

- climbing organs in the weak-stemmed plants enabling them to expose their leaves to the sun's rays.
- cut down water loss as no foliage leaves are borne on these modified branches.

C- Phylloclades: In certain plants the stem or its branches instead of being cylindrical become **flattened**. They are **green** in colour and look very much **like the Leaves**. The true leaves remain smaller scaly or are wanting or are modified into spines and their functions are taken up by the leaf-like stems.

In *Opuntia* , the phylloclades are **broad and flattened** and look **like thick succulent leaves**, but they bear flower and arise in the axils of scale leaves which fall off early leaving behind distinct scars at their base. The true leaves are small and aggregated as of **fine spines.**

Opuntia

In ***Asparagus*** , the main stem bears scale leaves, in the axils of which arise a group of lateral shoots. Of these, some develops into a normal branch while the others are modified into green needle-like cladodes.

In ***Ruscus***, the cladodes are so much leaf-like in appearance that they are easily mistaken for leaves. But a closer examination shows that each leaf-like cladode *arises in the axil of small linear scale leaf* and *bears on its surface reduced scale leaves with axillary floral buds*.

in *Ruscus* and *Asparagus*, the stem nature is evident from:

- axillary position.
- the occasional production of buds, scales and flowers on them.
- their branching.

Phylloclades of one internode are called claddodes as in *Asparagus*.

The chief functions of the phylloclades:

(i) storage of water and food.

(ii) cutting down of transpiration (why? And how?).

(iii) making of food material (photosynthesis, why?).

Cont. Modifications Of Stem

B. Underground or Subterranean Stems:

All underground or subterranean stems may be looked upon as **unusual** , since one of the primary functions of the normal stem is that of **displaying leaves to the light**.

Because of their **underground position** and **non-green** colour, they are often mistaken for roots from which they can, however, be readily *distinguished by the following characteristics* :

(a) Presence of nodes and internodes.

(b) presence of scale leaves at the nodes and buds in their axils.

(c) absence of protective root-cap at the tip.

(d) presence of a terminal bud.

(e) internal structure.

The function of underground stems:

- for food storage.
- means for vegetative propagation.
- perform another important function, i.e. **Perennation** (it is the ability of the plants to survive in periods unsuitable for aerial growth).

When there is intense cold , hot or frost outside, the aerial parts die. As the conditions under the soil do, not undergo extreme variation, the underground stem remains unaffected and gives out aerial shoots on the return of favorable conditions.

The underground stems are classified into five principal kinds :

1. Suckers
2. Rhizomes
3. corms
4. bulbs
5. tubers.

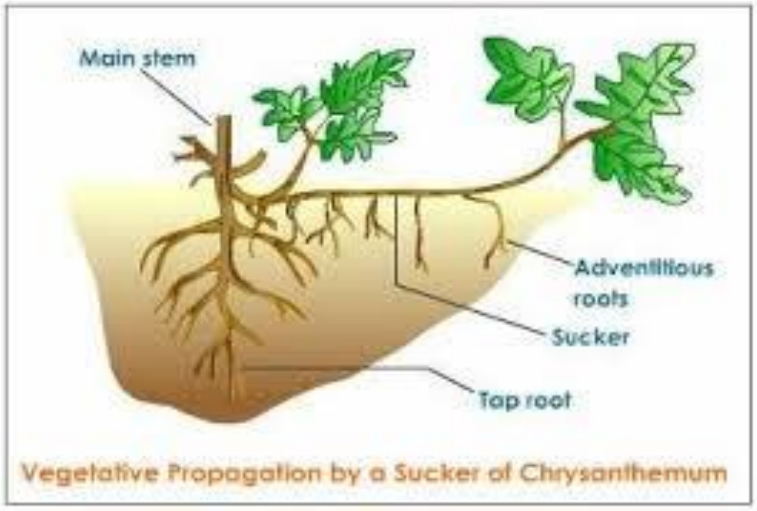
A. Suckers:

- It is merely an underground runner.
- After growing horizontally under the soil for some distance, it comes out into the air producing a leafy shoot with adventitious roots arising from the base, and can form a new plant.
- The suckers are pink or white and are often mistaken for roots from which they can be distinguished by:

  (a) their axillary position

  (b) the presence of scale leaves and axillary buds at the nodes.

  Familiar examples are *Chrysanthemum* and mint.



Vegetative Propagation by a Sucker of Chrysanthemum

B. Rhizome:

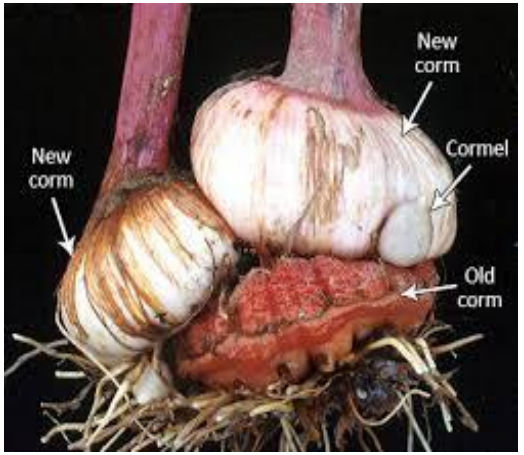
A rhizome is generally a food-laden, thick or elongated stem, growing beneath the surface of the soil. It bears distinct nodes and internodes, At each node are found adventitious roots below and a brownish scale leaf with an axillary bud above. The axillary buds may develop into aerial shoots at the cost of the reserve food material.

Functions of Rhizomes:

- enable the plant *survive* winter.
- help in *vegetative propagation* by its branches which can grow into independent plants (after of older part decay or during ploughing) .
- *Prennation*: These aerial shoots die in their turn on the approach of the unfavorable season and are replaced by new ones in the next favorable season . Thus, the surface of the rhizomes is marked by scar showing the points of attachment of the aerial shoots of the previous years.

Weeds with rhizomes are difficult, to eradicate because when they are pulled up, fragments of their rhizome often remain undetected in the soil and develop into new plants .

C- Corm: *- it is a short solid underground stem which has become thickened and fleshy due to good storage.*

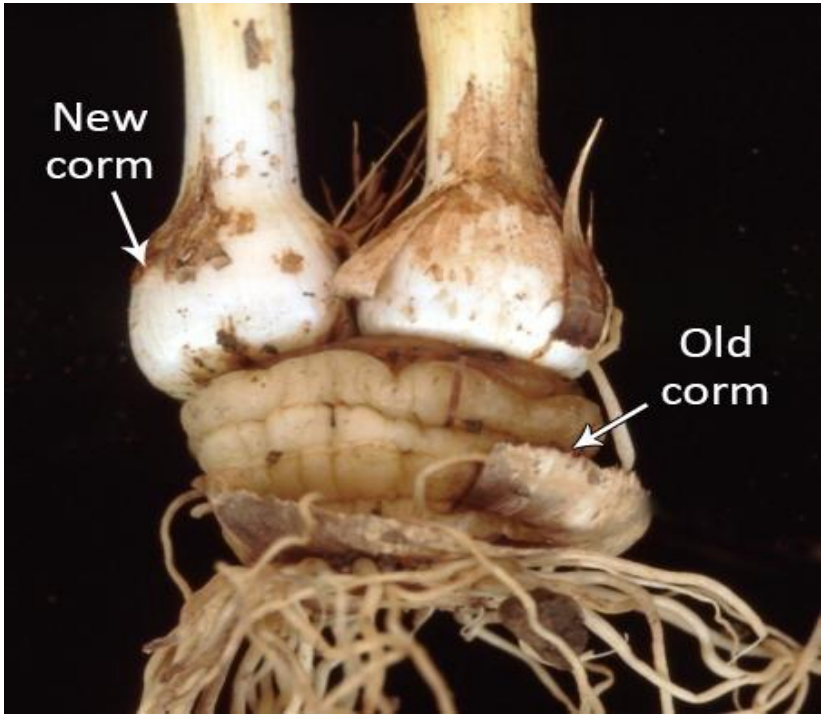


- It bears a number of thin brown sheathing scale leaves, in the axils of which are formed one or more buds.
- When the unfavorable season approaches, the aerial portions die off and the corm serves for presentation and gives rise to a new corm in the following year.
- usually the daughter corms separate and produce new plants.

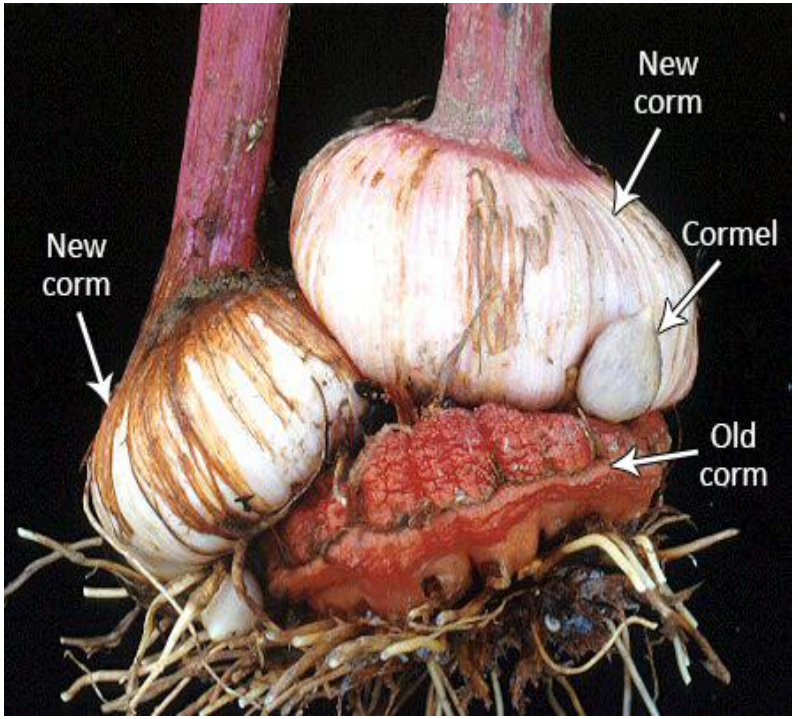
In *Colocasia,* the massive spherical corm is covered with a large number of thin brown sheathing scale leaves, which bear a number of buds laterally, The new corms arise from the old corms by the growth of the lateral buds.

A corm of a garden *Gladiolus*, with developing cormels.

Colocasia



Crocus



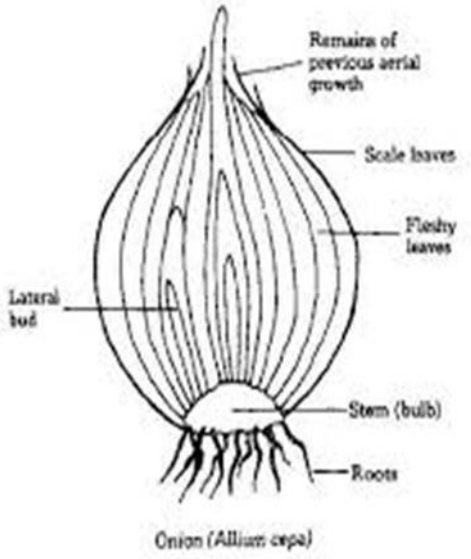
Gladiolus

Some species like *Crocus* and *Gladiolus*, produce a corm that is an annual structure (old corm) replaced with a new corm each year.

4- Bulb: the main stem is very short and covered by numerous thickened, overlapping leaves or leaf bases (usually called scales), the whole structure being a bulb.
The short reduced stem is disc shaped and bears at its bottom a number of adventitious roots.

- Familiar examples of bulbs are **onion**, **garlic lily** and **Narcissus**.
- Axillary buds frequently develop in the axils of the fleshy scales. These develop into new bulbs or, when separated from the parent bulb, develop into new plants. Bulbs thus serve both for food storage and vegetative propagation.

- **It is a corm if** the stem stores food and becomes fleshy and the leaves are reduced. Moreover, a new bulb is formed inside the old one whereas the new corm develops outside the old corm.
- The bulb **differs from the corm in that** the stem in this case is reduced and the bulb is formed by the food-laden scales. It is a modified shoot rather than a modified stem.

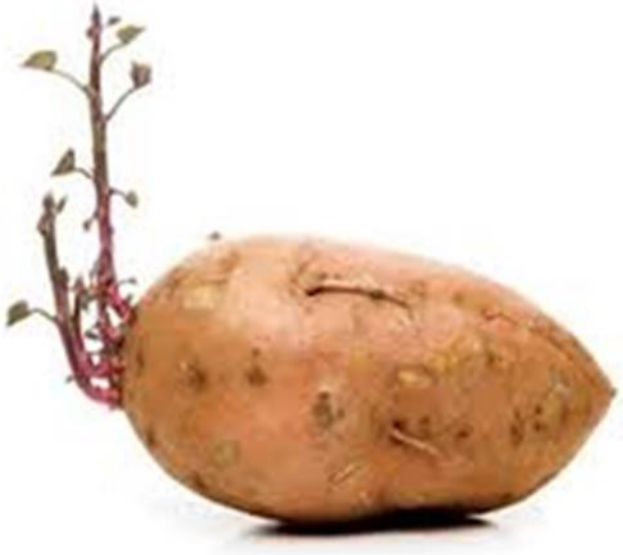


Onion (*Allium cepa*)

5- Tuber: A stem tuber is a much enlarged and swollen end of an underground branch which becomes filled with stored food. The best known example of a tuber is the common potato. It is a swollen round, oval or elongated fleshy structure.
It bears a number of lateral buds in the so-called " eyes “.

- Under magnifying lens **an eye is seen to consist of** a ridge bearing a minute scale leaf, in the axil, of which arise usually three minutes buds. The eye marks the position of a node and the part of the tuber between one eye and the next is the internode.

- When a potato tuber or a piece of it bearing one or more eyes is placed in the soil, the buds from the eyes sprout and form green plants. Thus the tuber serves both for **food storage** and **vegetative propagation**.



- Unlike the other underground forms of stem, tubers usually do not bear adventitious roots .

Root tubers should not be confused with the potato tuber:

Tubers: is a stem structure, has internodes and nodes with scale leaves and axillary buds, and also a terminal bud.

The root tuber: is a modified tap root or an adventitious root arising from any part of the stem as in the sweet potato ; it shows **no internodes and nodes** and **bears no scaeles or buds** ; although adventitious buds without scale leaves are present in the sweet potato.

- Moreover the potato tuber resembles the stem in - **internal structure** while a root tuber resembles the root in internal structure.