Morphology of Flowering Plants

Introduction

Angiosperms or flowering plants (sometimes also referred to as phanerogams) are those vascular plants in which seeds are enclosed inside fruits.

They are the most dominant plants of the present day, comprising about 300,000 species. They occur in numerous habitats of the earth and show a great diversity of shape, size, and form.

TYPES OF PLANTS BASED ON HABITAT

- **Mesophytes:** Found growing well on land under medium, climatic conditions, e.g., Mustard.
- **Hydrophytes:** Found growing well in water, e.g., *Hydrilla.*
- **Xerophytes:** Found growing well in dry conditions, e.g., Cactus.
- **Epiphytes:** Found growing well on other plants e.g., Orchid.
- **Psammophytes:** Found growing well in sand, e.g., *Euphorbia.*
- **Halophytes:** Found growing well in saline habitats, e.g., *Rhizophora.*
- **Lithophytes:** Found growing well on rocks, e.g., ferns.
    - Most of the flowering plants are autotrophic in their mode of nutrition.
    - There are some which are parasitic (*Cuscuta*), saprophytic (*Monotrapa*) or insectivorous (*Utricularia*).

MORPHOLOGY AND ITS IMPORTANCE

- Study of morphology is essential for recognition and identification of plants.
- It provides important criteria for the classification of plants.
- Morphology gives information about the range of variations found in a species.
- Knowledge of morphology is necessary for studying various aspects of plant life like anatomy, physiology, ecology, genetics, etc.

Definition

Arboretum (L. *arbor*-tree): Often an outdoor place set for the display of living plants.

Gray Matter Alert!!!

Smallest angiospermic plant— *Wolffia* (0.1 mm)
Tallest Angiosperm— *Eucalyptus regnans* (height of certain specimens 130.5 m or 435 ft.)

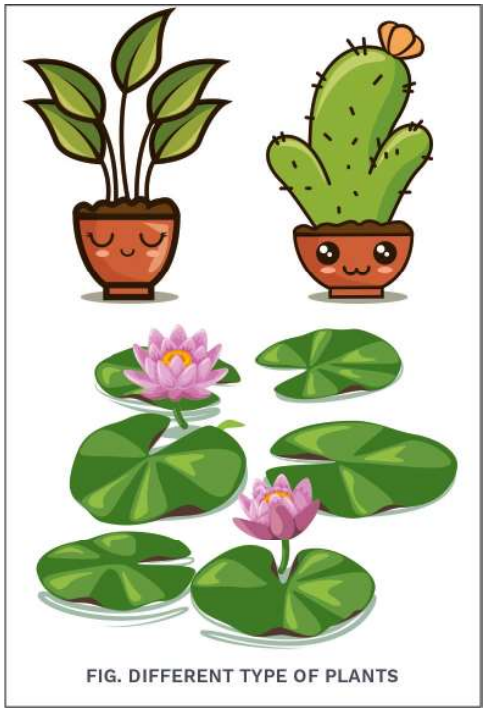


FIG. DIFFERENT TYPE OF PLANTS

Definition

Morphology: Branch of Biology that deals with the study of external features of an organism.

- It helps in the identification of deficiency and toxicity symptoms occurring in plants in response to shortage or excess of minerals.
- It helps in the study of morphological adaptations of plants to different types of habitats and enables horticulturists to adopt plants with morphological peculiarities for lawns, parks, gardens, etc.

FLOWERING PLANTS

Depending upon the **life span**, angiospermic plants are classified as:

Annuals
Biennials
Perennials

1. Annuals

- These plants complete their life cycle in a single growing season, varying from a few weeks to few months.
- During this period, they grow, bear flowers, produce seeds and fruits and then die.
- They pass the unfavourable periods in the form of seeds, e.g., wheat, rice, pea, mustard etc.

2. Biennials

- These plants complete their life cycle in two growing seasons.
- In the first season, they grow only vegetatively and store food in roots and underground stems.
- In the second season, they produce flowers, fruits and seeds, and then die. For example, cabbage, radish, turnip, etc., (grow in cold regions).

3. Perennials

- These plants continue to grow for more than two growing seasons to several years.
- They bear flowers and fruits during specific seasons.

Keywords

- Morphology
- Tap root system
- Primary root
- Secondary root
- Tertiary root
- Fibrous root system
- Adventitious root

Definition

Annual Plants: These plants complete their life cycle in a single growing season, varying from a few weeks to few months.

Definition

Biennial Plants: These plants complete their life cycle in two growing seasons.

Polycarpic Plants: Several perennial plants bear flowers and fruits every year *e.g.,* Mango, apple, lemon, etc.

Monocarpic Plants: Some perennial plants bear flowers and fruits only once, after a long period of vegetative growth, e.g., *Agave*, *Yucca,* etc.

Definition

Perennial Plants: These plants continue to grow for more than two growing seasons to several years.
They bear flowers and fruits during a specific season.

PARTS OF A FLOWERING PLANT

The plant body of an angiosperm or a flowering plant primarily consists of an axis, which is differentiated into:

- Root system
- Shoot system

ROOT SYSTEM

- The root system normally lies underground and consists of a main root and its branches.
- There is a most prominent root, which lies in the center and is called the primary root. It bears several lateral roots called secondary roots.
- The secondary roots are further branched into tertiary roots and finer rootlets. The tips of rootlets are covered with root caps.
- Behind the tips, there are few fine outgrowths called root hairs.

Main Functions of the Root System

- To anchor the plant in the ground.
- To absorb water and minerals from the soil.

SHOOT SYSTEM

The shoot system is normally aerial and consists of:

- **Main Stem**
- **Lateral branches**
- **Leaves**

Stem

- At intervals, the stem and its branches possess swollen areas called **nodes**.

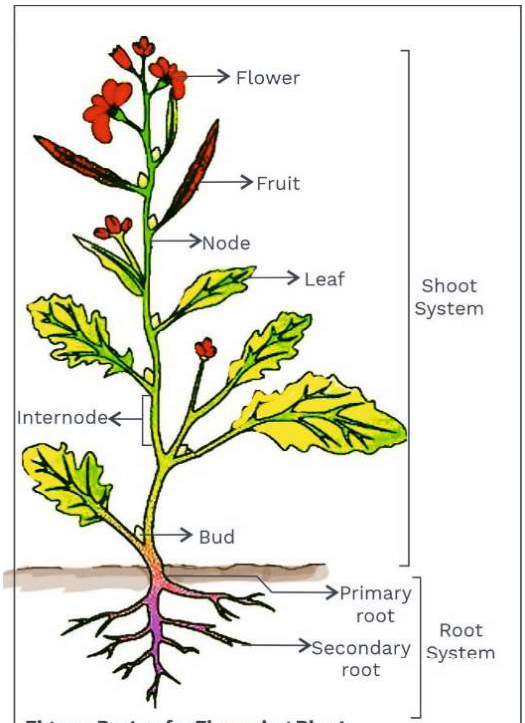


Figure: Parts of a Flowering Plant

- Part of the stem between two adjacent nodes is called **internode**.
- The leaves are borne in the region of nodes.
- The angle between the leaf and the upper part of stem is called **axil**.
- It bears an **axillary bud**, which later develops into a branch.
- A bud is also present at the tip of the stem or a branch called **terminal bud** or **apical bud**.
- Apical Bud is responsible for elongation of the stem or the branch.

Lateral Branches

These are structurally similar to the stem.

Leaf

The leaf is a green, expanded, lateral outgrowth, which develops on the stem or its branches at the region of a node.

Parts of a Leaf

- Leaf base
- Petiole
- Lamina or Leaf Blade

The leaf lamina is interspersed with numerous vascular strands called **veins**. The lamina is specialized for photosynthesis.

It is also the main site for transpiration and respiration.

VEGETATIVE ORGANS AND REPRODUCTIVE ORGANS OF A PLANT

- Root, stem, and leaves (vegetative organs)
- The flowers (reproductive organ)
- Fruits and seeds (associated with reproduction and continuity of the race)

MORPHOLOGY OF ROOT

The root is a non-green, non-photosynthetic, cylindrical, descending part of the plant that develops from the radicle of seed.

Keywords

- Vegetative Organs
- Nodes
- Internode
- Axillary bud
- Terminal bud
- Apical bud
- Veins

Rack your Brain

Of what importance is the study of leaf morphology for a physiologist?

Definition

Vegetative Organs: These organs are concerned with nutrition, growth, and help in the maintenance of the plant body.

Positively geotropic and hydrotropic that normally grows downwards into the soil.

Characteristics of the Root

- It does not bear nodes and internodes.
- It does not bear leaves and buds.
- It is non-green.
- A functional root is covered at the tip by a **root cap**.
- Near the tip, the root bear unicellular tubular **root hairs**.
- Endogenous in Origin: Root branches develop from the interior (usually pericycle) of the parent root.
- A root is neutral or negatively phototropic, and positively hydrotropic.
- The geotropic response is also positive for the main root.

THE REGIONS OF THE ROOT

A typical root possesses five parts or regions, however, there is no definite demarcation.

- **Root Cap**
  - It is a cap-like structure present at the tip of root.
  - The cells of the root cap secrete mucilage, which lubricates the passage of the root through the soil and help in easy penetration through the hard soil.
  - The cells of the root cap also possess starch grains, which are believed to be responsible for the perception of gravity.
  - The root cap also protects root meristem from friction between root and the soil particles.
- **Meristematic Region**
  - It is one to a few millimeters in length and lies partly within and partly beyond the root cap.
  - The cells of this zone divide actively and add new cells to the root and root cap.

Definition

Root: The root is a non-green, non-photosynthetic cylindrical, descending part of the plant that develops from the radicle of seed.

Rack your Brain

What will happen if the root tip of a developing primary root is cut off ?

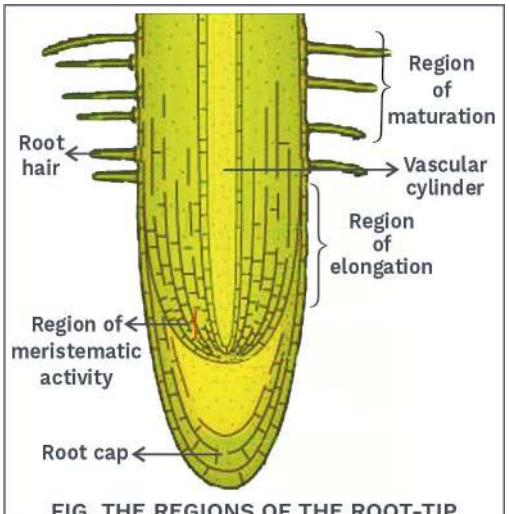


FIG. THE REGIONS OF THE ROOT-TIP

- Root meristem keeps on adding new cells and replacing the worn-out cells.

- **Region or Zone of Elongation**
  - It lies behind the meristematic zone and is about 4-8 mm in length.
  - The cells of this region are newly formed cells, which lose the power of division. They elongate rapidly and bring about an increase in the length of the root.
  - They also possess the power of absorption of water and mineral salts from the soil.
- **Region of root hair**
  - It lies above the region of elongation and bears a cluster of very fine tubular outgrowths called root hairs.
  - Root hairs are produced from the epiblema of the root.
  - The root hairs increase the exposed surface of the root for absorption. This zone also represents the zone of differentiation or maturation because different types of primary tissues differentiate or mature in this region.
  - As the root increases in length, the root hairs in older region get bruised and shed.
  - New root hair appears in the younger part of the zone of elongation.
- **Region or Zone of Maturation**
  - This region forms a major part of the root and no change occurs in the cells of this region.
  - It forms the permanent zone of the root and gives out lateral roots.
  - The outermost layer of this region has thick-walled cells and hence, does not help in absorption of water from the soil.

ROOT SYSTEM

The roots along with their branches, constitute the root system.

Keywords

- Root cap
- Region of meristematic activity
- Region of elongation
- Region of maturation
- Root hairs

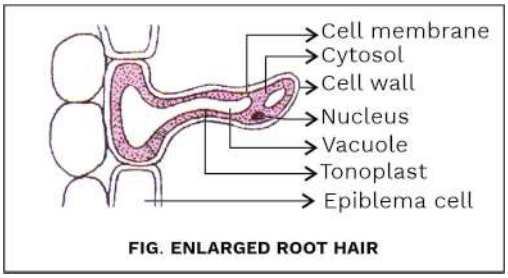


FIG. ENLARGED ROOT HAIR

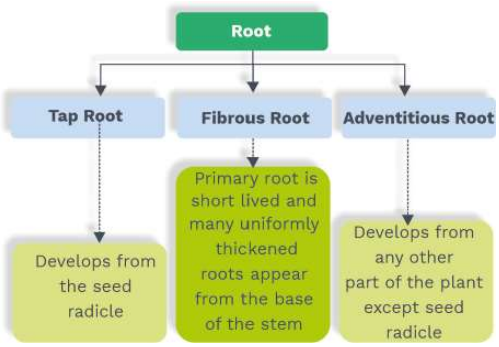
Rack your Brain

Roots in strict sense are present in which of the following ?

(1) Phanerogams only
(2) Cryptogams only
(3) Cryptogams and phanerogams both
(4) Thallophyta

TYPES OF ROOT SYSTEM

- Taproot System
- Fibrous Root System
- Adventitious Root System



1. Tap Root System

- Characteristic feature of most of the dicot plants.
- It develops from the radicle of the embryo of a seed.
- The first root is formed by the elongation of radicle and is called primary root.
- The primary root that persists throughout the life of the plant is termed as tap root.
- It grows continuously and produces lateral roots that are called as secondary roots.
- The secondary roots are further branched into tertiary roots and finer rootlets. The taproot and its branches together constitute a taproot system.

(a) Deep Feeder Root System or **Racemose Taproot System**

The taproot of perennial plants penetrates in the deeper layers of the soil, e.g., *Ficus sp.*

(b) Surface Feeder Root System or **Cymose Taproot System**

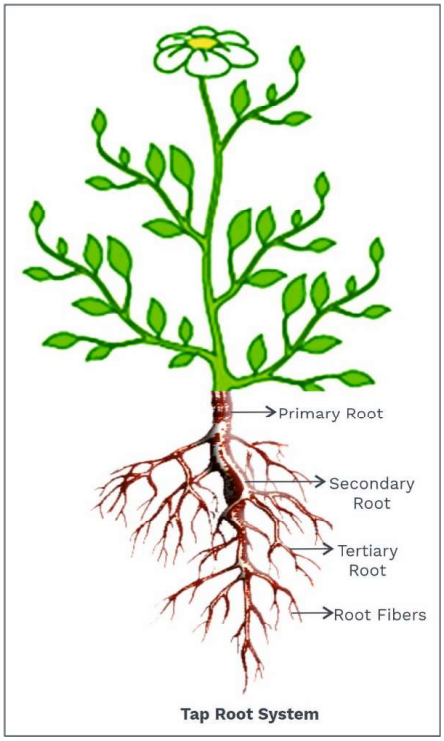
The taproot of some annual plants does not penetrate much and the secondary roots spread horizontally near the soil surface only.

Keywords

- Tap root system
- Fibrous root system
- Adventitious roots
- Pneumatophores
- Prop roots
- Stilt roots

Definition

Taproot System: Tap root develops from the radicle of the seed.
It has a main primary root that further gives rise to secondary and tertiary branches.



Tap Root System

2. Fibrous Root System

- Roots that consist a bunch of root fibres originating from the base of the stem constitute fibrous root system.
- In monocotyledonous plants, the primary root is short lived and replaced by many roots.
- Here, the primary root that originates from the radicle is short lived, as it terminates into the root fibres, e.g., wheat plant, grasses, etc.

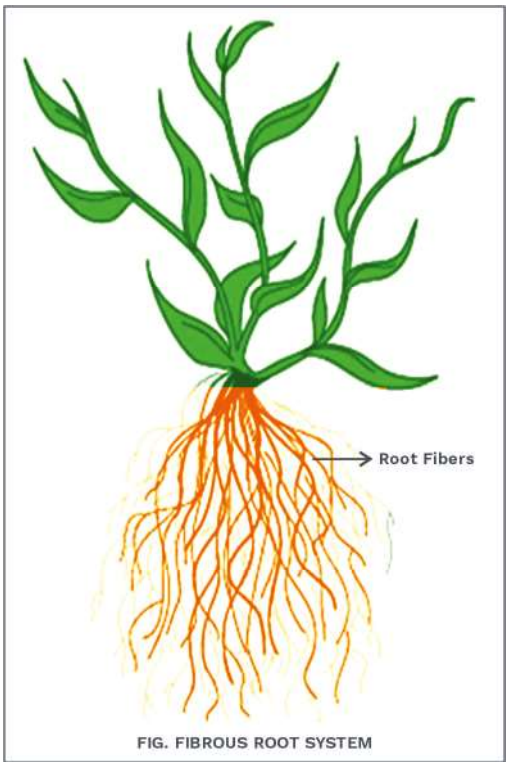


FIG. FIBROUS ROOT SYSTEM

3. Adventitious Root System

(L. *adventicius*–extraordinary)

- Roots that develop from any part of the plant other than the radicle.
- Adventitious roots may develop from the nodes or internodes of the stems, e.g., ***Monstera***.
- These arise from branches (**banyan**) or from the leaves (***Bryophyllum***).
- Several plants creeping on the ground, produce roots from nodes as in wood sorrel (***Oxalis*** *sp.*), grass, etc.
- These arise from branch cuttings of rose, sugarcane, tapioca, when put into the soil.
- Mostly adventitious roots do not penetrate deep into the soil, hence they are **surface feeders**. Adventitious roots are characteristic feature of monocot plants.

Rack your Brain

Rhizophora plant is able to survive in marshy areas. How ?

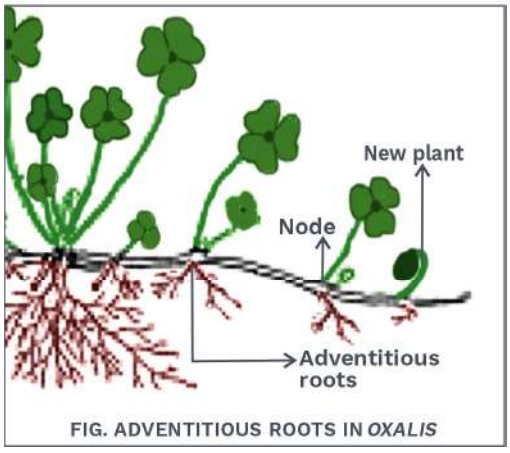


FIG. ADVENTITIOUS ROOTS IN *OXALIS*

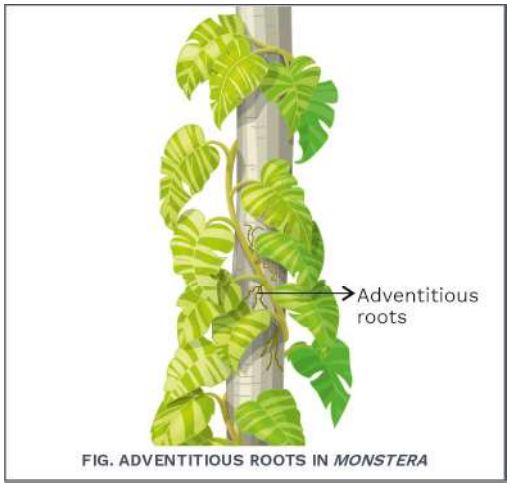


FIG. ADVENTITIOUS ROOTS IN *MONSTERA*

MODIFICATIONS OF ROOT

Modifications can be defined as morphological changes (shape, form, or structure) in an organ to perform certain special functions, other than or in addition to the normal functions.

The roots of some plants are modified to perform specialized functions.

Rack your Brain

Carrot is a root and not a stem. Comment.

MODIFICATIONS OF TAPROOT

1. Fleshy taproot

The taproots of some plants become swollen and fleshy due to the storage of food. Hypocotyl may also join the taproot in storing food.

The secondary and tertiary roots remain thin and fibrous.

Depending upon the shape, fleshy taproots are of the following types:

(i) Conical (Cone-shaped)

- The primary root is broad at the base and tapers gradually towards apex like a cone.
- Many thin, threads like secondary roots arise all along the conical root, e.g., Carrot (*Daucus carota*).

(ii) Fusiform (spindle shaped)

- The primary root is spindle shaped. It is almost uniformly thick except at the base and apex where it tapers.
- The basal part of the root is derived from hypocotyl.
- The root also bears a reduced discoid stem and radicle leaves (leaves arising from roots or appear to arise from roots). *e.g.,* Radish (*Raphanus sativus*).

(iii) Napiform (pitcher-shaped)

- Globular or top-shaped and tapers abruptly towards the apex.
- Bears a reduced discoid stem and radicle leaves.

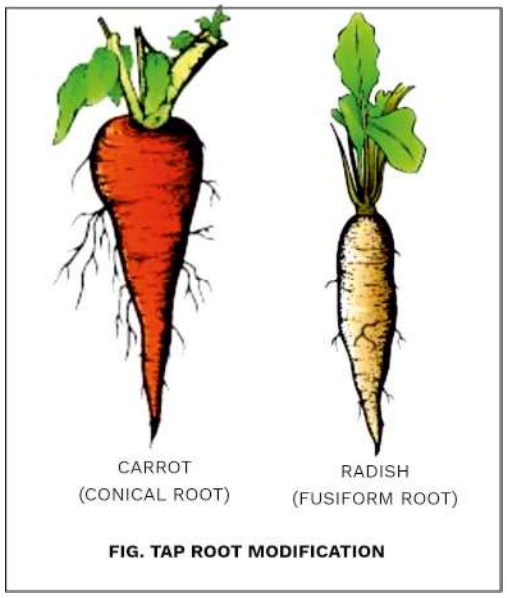


FIG. TAP ROOT MODIFICATION

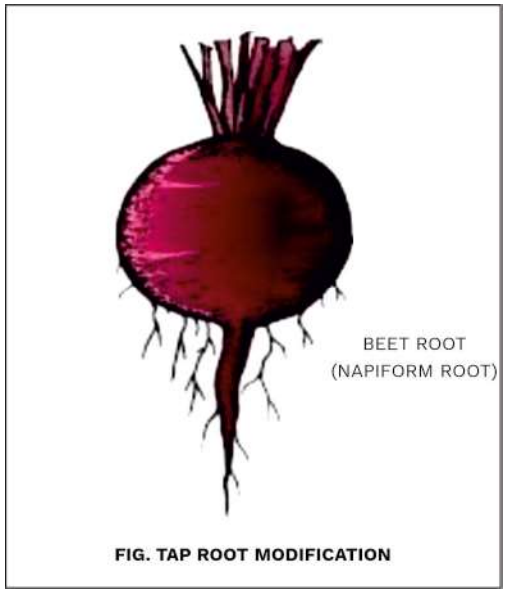


FIG. TAP ROOT MODIFICATION

- Basal part of the fleshy root is hypocotyl.
- For example, Turnip (*Brassica rapa*), beetroot (*Beta vulgaris*).

(iv) Tuberous roots (irregularly shaped)

- The primary root becomes thick and fleshy.
- No definite shape. *e.g.,* four o'clock plant (*Mirabilis jalapa).*

2. Pneumatophores or Respiratory Roots

- These are aerial roots or **aerophores** found in mangrove plants (plants growing in swamps near the seashores), e.g., *Rhizophora, Sonneratia, Heritiera* (vern. *Sundari*) etc.
- The underground secondary and tertiary roots of the plants come out of swamp for exchange of gases.
- They bear small pores called **lenticels** or **pneumatothodes** near their tips. The remaining surface of pneumatophores is covered with cork and the proximal submerged part bears many short absorbing roots.

3. Nodulated taproots

- In some plants, secondary, tertiary and even primary roots bear many small irregular swellings called **root nodules** or **tubercles.**
- The root nodules contain millions of minute nitrogen fixing bacteria of the genus *Rhizobium* (e.g., *Rhizobium leguminosarum*).
- These bacteria pick up free atmospheric nitrogen and convert it into nitrogenous organic compounds. This phenomenon is called **nitrogen fixation**.
- Plants belonging to family Leguminosae, such as pea (*Pisum sativum*), gram, groundnut, etc.

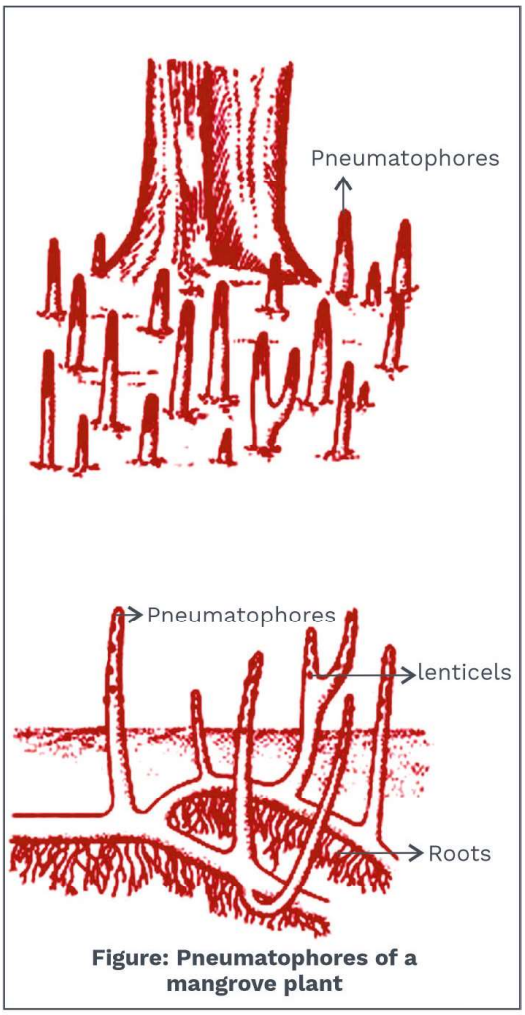


Figure: Pneumatophores of a mangrove plant

Gray Matter Alert!!!

Green manure: Legumes add nitrogenous compounds to the soil or increase the fertility of the soil as nitrogen fixing bacteria are in their root nodules, hence the roots are left over in the soil till the next harvest.

MODIFICATIONS OF ADVENTITIOUS ROOT

Storage adventitious roots: In some plants, adventitious roots become thick and fleshy due to the storage of food.

Depending upon the shape and the swollen part, adventitious roots are of following types:

(i) Tuberous Root or Root Tubers

- Such roots arise singly at the nodes of prostrate stem and are swollen without any definite shape.
- Also called root tubers, e.g., **Sweet potato** (*Ipomoea batatas* vern. *Shakarkandi*).

(ii) Fasciculated Roots

- These are swollen roots which arise in clusters or fascicles at the base of the stem, e.g., *Asparagus, Dahlia*.
- In ***Asparagus***, swollen *tubers* are borne on the normal roots at intervals. The root system is often referred to as 'crown'.

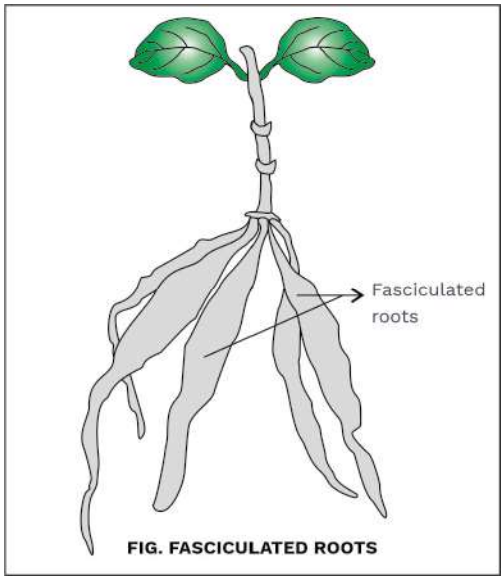


FIG. FASCICULATED ROOTS

Previous Year's Question

Pneumatophores are found in–

(1) The vegetation which is found in marshy and saline lake

(2) The vegetation which is found in acidic soil

(3) Xerophytes (4) Epiphytes

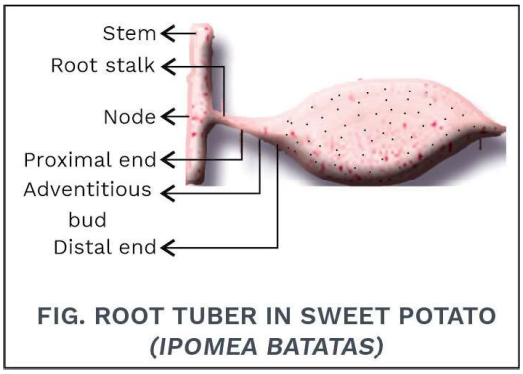


FIG. ROOT TUBER IN SWEET POTATO *(IPOMEA BATATAS)*

Definition

Reproductive Roots: Roots do not bear buds but the root tubers of sweet potato bear adventitious buds which give rise to new plants, hence they are also known as reproductive roots.

Roots Modified for Additional Support

(i) Prop or Pillar Roots

- Pillar-like adventitious roots that arise from branches of the trees like banyan tree (*Ficus benghalensis*).
- Initially, these roots are aerial and hygroscopic.
- As the roots reach the soil, they become thick and pillar-like and start absorbing water and minerals.
- In old plants, the main trunk may die, but the crown of the tree is supported and nourished by the prop roots.

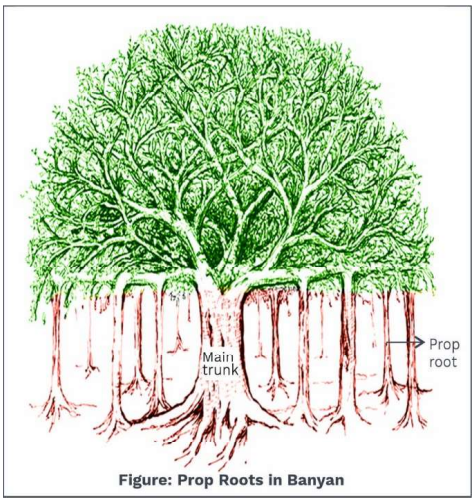


Figure: Prop Roots in Banyan

(ii) Stilt Root or Brace Roots

- These are short and thick supporting roots which develop obliquely from the basal nodes of the stem.
- These roots penetrate down into the soil and give support to the plant, e.g., maize (*Zea mays*), sugarcane (*Saccharum officinarum*), sorghum (*Sorghum vulgare*), screw pine (*Pandanus*), etc.
  In *Pandanus*, the stilt roots develop only from the lower surface of the obliquely bending stem. They bear much folded multiple caps at their tips.

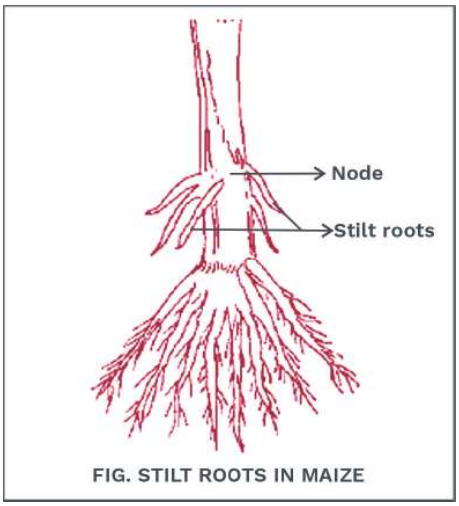


FIG. STILT ROOTS IN MAIZE

(iii) Clinging or Climbing Roots

- These are non-absorptive adventitious roots found in some climbers.
- These may arise from the nodes, e.g., *Pothos* (Money Plant), *Betel;* or from internodes *e.g., Ficus pimula* and both, e.g., Ivy.
- These roots either enter into crevices or cracks of the support or stick firmly to the support by secreting a cementing gummy substance.
- These help the climbers to climb up the support.

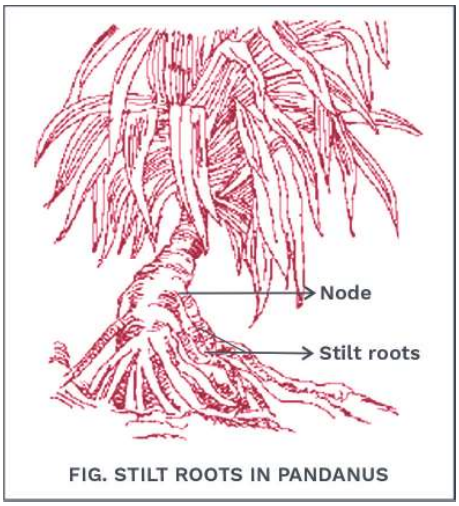


FIG. STILT ROOTS IN PANDANUS

Previous Year's Question

The plant which bears clinging roots is

(1) Screw pine (2) *Podostemon*

(3) *Trapa* (4) Orchid

ROOTS MODIFIED FOR VITAL FUNCTIONS

(i) Assimilatory or Photosynthetic Roots

- These are green roots, which are capable of photosynthesis, e.g., water chestnut (*Trapa*).
- In *Trapa,* some submerged roots are highly branched and green in colour to perform photosynthesis

(ii) Haustorial or Parasitic Roots

- These roots occur in parasitic plants that are achlorophyllous.
- These roots absorb nourishment by establishing contact with the vascular tissue of the host plant.
- Hence, also called as **sucking roots** or **suckers.** e.g., *Cuscuta* (Dodder Plant) has non-green stem and bears scale leaves. Dodder plant is a **total parasite** on hosts like *Acacia, Zizyphus, Citrus,* etc. and obtains both water and food from the host.

(iii) Hygroscopic or Epiphytic Roots

- These are adventitious roots found in some orchids (*Vanda*, *Vanilla,* etc.)
- Orchids grow as epiphytes upon the trunks or branches of the trees.
- The epiphytes develop aerial roots which hang freely in the air.
- Roots of orchids are whitish in colour and are covered with a specialized spongy tissue called **velamen.**
- Velamen helps the roots in absorbing atmospheric moisture.

(iv) Floating Roots or Root Floats

- These are inflated buoyant roots, spongy in texture due to abundant aerenchyma, arising at the nodes of some aquatic plants like *Jussiaea*.
- These roots grow out of water and keep the plant afloat.

Previous Year's Question

Prop roots are–
(1) Taproot
(2) Adventitious root
(3) Secondary root
(4) All

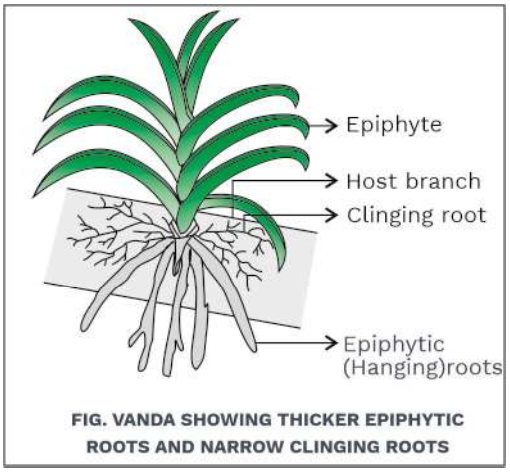


FIG. VANDA SHOWING THICKER EPIPHYTIC ROOTS AND NARROW CLINGING ROOTS

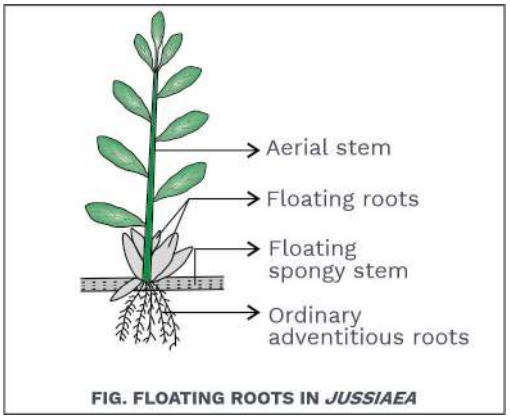


FIG. FLOATING ROOTS IN *JUSSIAEA*

- These also help in gaseous exchange for respiration.

(v) Reproductive Roots

- Some fleshy adventitious roots develop adventitious buds.
- Adventitious buds can grow into new plants under favourable conditions. Such roots are called reproductive roots. *e.g.,* Sweet potato, *Dahlia*, etc.

FUNCTIONS OF ROOTS

Roots perform two types of functions — **primary** and **secondary**.

A. Primary or Main Functions (Performed by all the roots)

- **Anchorage:** The roots fix the plant in the soil firmly and support the aerial shoot system.
- **Absorption:** The roots absorb water and mineral from the soil.
- **Translocation:** The absorbed water and minerals are translocated to the stem through the xylem of the root.
- **Synthesis of plant growth regulators**
- **Prevention of soil erosion:** Roots hold the soil particles firmly and prevent the soil from erosion.

B. Secondary or Accessary Functions: The secondary functions are specialized functions and are performed only by those roots which are modified accordingly.

- **Storage of food:** Some roots store food and become fleshy, e.g., carrot, radish, *Asparagus*, *Dahlia*, sweet potato, etc.
- **Additional support:** Some roots like prop roots and stilt roots provide additional support to the plant, e.g., *Ficus benghalensis*, *Zea mays* (Maize), *Pandanus,* etc.
- **Climbing:** Some weak stemmed plants climb up

Definition

Epiphyte: A plant that grows upon another plant only for shelter but is not a parasitem, e.g., orchid.

Rack your Brain

Maximum growth of roots occur in the region just behind the apex. Justify

Previous Year's Question

Root nodule is a modified structure of —
(1) Adventitious root
(2) Taproot
(3) Fibrous root
(4) Lateral root

a support with the help of clinging roots, e.g., *Pothos* (money plant), *Betel* etc.

- **Nitrogen fixation:** The roots of some leguminous plants (*e.g.,* pea, gram, groundnut, etc.) contain nitrogen-fixing bacteria in their nodules. These bacteria fix free atmospheric nitrogen. Thus, enrich the soil by adding nitrogen compounds.
- **Breathing:** Respiratory roots or pneumatophores of mangrove plants have lenticels that help in exchange of gases.
- **Moisture absorption and retention:** Hygroscopic roots of some orchids (e.g., *Vanda*) absorb moisture directly from the air.
- **Absorption of food:** In parasitic plants (e.g., *Cuscuta*), spine-like adventitious roots penetrate the host and obtain food and water from the latter.
- **Assimilation:** The green roots of *Tinospora*, water chestnut (*Trapa*) etc., carry out photosynthesis.
- **Floating:** The roots of some aquatic plants (e.g., *Jussiaea*) store air and function as floats.
- **Balancing:** Cluster of adventitious roots arising in free floating aquatic plants (e.g., *Pistia, Eichhornia* etc.) helps in balancing the plants over water, surface.
- **Reproduction.** The roots of some plants have adventitious buds (e.g., sweet potato) which help in reproduction.

THE STEM

A **stem** is the main structural axes of vascular plants, it supports leaves, flowers and fruits, transports water and dissolved substances between the roots and the shoots via xylem and phloem respectively, stores nutrients, and produces new structures from time to time.

Morphology of the Stem

- Stem develops from the plumule and epicotyl of the embryo.

Rack your Brain

Roots are not always geotropic. Justify

Gray Matter Alert!!!

Rootless Plants: Submerged aquatic plants like *Ceratophyllum*, *Myriophyllum*, *Utricularia,* etc. do not possess roots. They absorb water and minerals directly from the surfaces of stem and leaves.

Keywords

- Nodes
- Internodes
- Tendril
- Thorns

Definition

Stem: It is the main structural axes of vascular plants, it supports leaves, flowers and fruits. It develops from the seed plumule.

- It is generally an aerial and ascending part of the plant axis.
- Its apex bears a terminal bud for growth in length.
- It bears nodes and internodes.
- The stem nodes bear leaves.
- The young stem is green and is thus photosynthetic.
- In the mature state, it bears flowers and fruits.
- Stem branches and leaves develop exogenously.
- Stem exposes leaves, flowers and fruits to their most suitable position in the environment for optimum function.
- Hair, if present, is generally multicellular.
- Stem is positively phototropic and negatively geotropic.

BUDS

- A bud is a compacted underdeveloped shoot having a growing point, surrounded by closely placed immature leaves.
- As the bud grows, the internodes become longer and the leaves spread out, resulting in the formation of a young shoot.

Protection of Buds

- Buds when covered by a series of overlapping and protective bud scales are called covered or closed buds or winter buds, e.g., *Ficus religiosa* (Peepal) etc.
- Buds without protective scales are called naked buds found in herbaceous plants.
- The bud scales are often covered with hair or a coating of waxy, oily or resinous matter to prevent desiccation and injuries due to extremes of temperature.

Previous Year's Question

Lateral organs of the stem are —
(1) Endogenous in origin
(2) Exogenous in origin
(3) Both
(4) None of the above

FIG. WINTER BUDS IN PEEPAL TREE

Rack your Brain

Which type of buds are found in the axile of leaves ?

Vegetative buds, floral buds or mixed buds.

CLASSIFICATION OF BUDS

On the basis of —
(1) nature or structure (2) position

1. According to the nature or structure, buds are of the following types:
   - **Vegetative Buds:** Give rise to leafy shoots.
   - **Floral or Flower Buds:** Give rise to flowers or floral shoots.
   - **Mixed Buds:** Give rise to both vegetative shoots and flowers.
2. According to the origin and position, the buds are of following type:

Terminal or Apical Buds

- Occur at the tips of the main stem and its branches.
- Help in length-wise increase of stem and its branches.

Lateral Buds

- Present on the stem and branches at various places except apices.
- **Adventitious Buds:** Develop at places other than stem.
- **Foliar or epiphyllous:** Found on leaves e.g., *Bryophyllum, Begonia.*
- **Radical:** Found on roots, e.g., sweet potato
- **Cauline:** Found on the stem and its branches, at places other than nodes and apices, e.g., rose (*Rosa indica*).

Modifications of Buds

Tendrillar Buds

- Buds in some plants are modified into long spring-like threads called tendrils.
- They help the plant with weak stem in climbing over some support, e.g., gourds (cucumber, pumpkins, watermelon) and grapevines.

Bud Thorns

- Axillary buds of stems may also get modified into woody, straight and pointed thorns.
- They protect plants from browsing animals, to reduce.
- Transpiration and act as organ of defense against grazing, e.g., Citrus, *Bougainvillea*.

Bulbils and Turions

- **Bulbils:** These are specialized buds, which become fleshy due to the storage of food and take part in vegetative reproduction.
- Bulbils may be axillary (e.g., lily), on the leaf, e.g., hairy Bittercress (*Cardamine*), in place of flower on the floral axis (e.g., Onion, *Agave*) or base of the swollen roots (e.g., *Oxalis*).
- **Turions:** The fleshy buds found in many aquatic plants perform the function of perennation e.g., *Utricularia,* etc.

Primary or Main Functions of the stem

- Stem bears leaves, flowers and fruits.
- It conducts water and minerals from the roots to the leaves, flowers, and fruits.
- It also transports food, manufactured by the leaves to the roots, fruits and other storage organs of the plant.
- It adds new cells, tissues, and organs, which are required for the continued functioning of the plant.

Secondary or Accessory Functions

- A large number of plants **store food and water** in their underground stems like rhizomes (e.g., ginger), corms (e.g., *Colocasia*) and tubers (e.g., potato). The stem of sugarcane (*Saccharum officinarum*) stores sugar in it.
- The stems of several succulent plants (e.g., *Opuntia*) **store water.**
- The underground stems such as rhizomes, corms, tubers, etc. perform the function of perennation (*i.e.,* tiding over unfavourable growing period).
- In many plants, stems serve as a means of **vegetative propagation** as in the case of runner (e.g., grass), stolons (e.g., strawberry), offsets (e.g., *Eichhornia*) and underground stems (e.g., mint, Potato, etc.).
- The stems of some weak-stemmed plants may be modified into tendrils (e.g., *Passiflora*, Grapevine, etc.), thorns (e.g., *Bougainvillea*) and hooks (e.g., *Atrabotrys*) to help them in **climbing**.
- The stem of some plants is modified into thorns (*e.g., Duranta, Carissa,* etc.), phylloclades (e.g., *Opuntia*) and cladodes (e.g., *Ruscus, Asparagus*) to **reduce transpiration.**
- The stem thorns as in *Duranta, Bougainvillea, Carissa,* etc., act as organs of defence and protect the plant from browsing animals.
- The stem in younger state and when modified into phylloclades (e.g., *Opuntia*) and cladodes (*e.g.,*

Previous Year's Question

Which of the following is an underground stem?
(1) Ginger
(2) Sweet potato
(3) Radish
(4) Turnip

Rack your Brain

Potatoes are cultivated by their tubes. comment.

Ruscus, Asparagus, etc.), performs the function of **photosynthesis**.

- The stem when modified into a flower performs the function of **sexual reproduction.**

DIFFERENT FORMS OF STEM

- In most plants, stems grow above the soil surface. These are called **aerial** or **epiterranean** stems.
- The aerial stems of some plants trail or creep on the ground. They are called **sub-aerial** or **sub-epiterranean stems**.
- In some plants, the stems grow in the soil. Such stems are called **underground** or **subterranean stems.**
- The aerial stems or epiterranean stems are of three types:
  - Reduced
  - Erect
  - Weak

1. **Reduced stems:** The stem is reduced to a small disc above the base of the root. Nodes and internodes are not distinct, and leaves arise crowded together on the stems.

- Such leaves appear to arise directly from the root and are called **radical leaves**, e.g., radish, turnip, carrot, etc.
- A reduced discoid, flattened stem is found in some free-floating aquatic plants such as *Lemna, Spirodela, Wolffia,* etc.
- It is green and leafless and floats on the surface of the water.
- The underground structures called bulbs found in onion, garlic, etc., also possess a reduced and non-green stem.

Rack your Brain

Which part of the bulb stores food ?

2. **Erect stems:** These are the most common type of aerial stems. The stems are strong enough to remain erect or upright without any external support. The erect stem is of the following types:

- **Culm:** Erect, unbranched, cylindrical, hollow, nodes visible as rings and swollen. Stems are joined at nodes, e.g., bambino (family Gramineae).
- **Caudex:** Erect, unbranched, cylindrical stem. On the stem, scars of fallen leaves are visible, e.g., coconut date palm.

FIG. CULM STEM (BAMBOO)

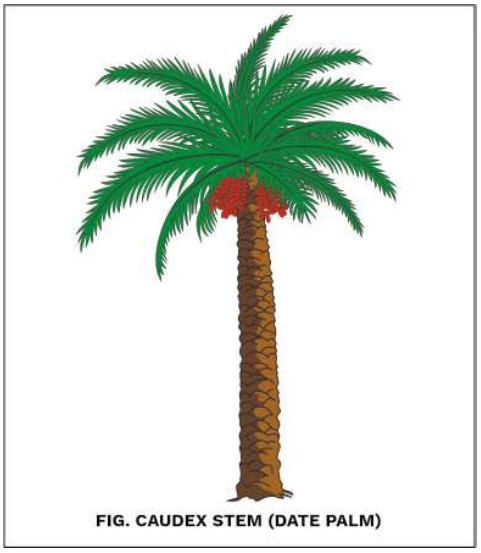


FIG. CAUDEX STEM (DATE PALM)

- **Excurrent:** The main stem is thicker than the branches, tapers towards the apical part, branching is acropetal. The appearance of the tree is just like a cone e.g., *Eucalyptus*, ashoka tree, etc.
- **Decurrent or deliquescent:** The main stem is short, and branching does not follow any definite manner and spread more laterally than vertically. At the stem top, the branches appear like a crown. The tree appears dome shaped, e.g., banyan (*Ficus benghalensis*)

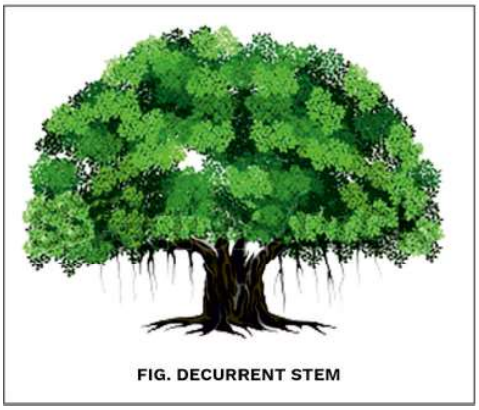


FIG. DECURRENT STEM

3. **Weak stems:** These are thin, delicate, and slender stems, which cannot stand erect. Therefore, they require support to expose their leaves and reproductive organs. The weak stems may climb up support or grow prostrate on the ground. Thus, they are of two types: **upright** and **prostrate**.
   A. **Upright weak stems:** These are weak stemmed plants, which climb up support to expose their foliage and reproductive organs. The upright weak stems are of two types: twiners and climbers.
      - **Twiners.** These have long, flexible, and sensitive stems. The stem can coil around support like a rope, e.g., *Dolichos lablab* (Bean)
      - **Climbers:** These have weak and flexible stems, which climb up a support with the help of certain clasping or clinging structures. Accordingly, climbers are of four types:
        - **Root climbers:** The stem cling to the support by adventitious roots, e.g., money plant *(Pothos)*
        - **Tendril climbers:** Tendrils are highly sensitive structures, specialized, thread-like structures, which can coil around a support, and help the weak stemmed shoot to climb up the support.
          When in contact with a support, the side of the tendril, which is opposite to that in contact grows more rapidly.
          This results in the coiling around the support and gives a firm grip for climbing.
        - **Scramblers or ramblers:** These are weak stemmed plants that climb up the support with the help of

Previous Year's Question

A thin spirally coiled structure sensitive to contact is—
(1) Stem
(2) Root
(3) Tendril
(4) Root hair

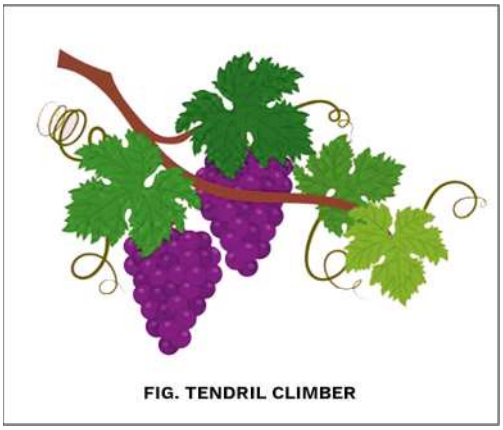


FIG. TENDRIL CLIMBER

thorns (e.g., *Bougainvillea*), prickles (e.g., *Rosa, Calanus*) etc.

- **Lianas.** These are woody twiners or climbers, e.g., *Phanera*.

B. Sub-aerial or sub-epiterranean stems (prostrate or weak stems):

These weak stems spread on the ground for exposing their leaves and reproductive organs.

Types of sub-aerial stems: Runners, suckers, stolon and Offsets.

- **Runners**
  - The sub-aerial weak stem and their slender lateral branches grow horizontally along the soil surface.
  - Adventitious roots arise from nodes and nodes bear new a tuft of leaves.
  - Runners serve as means of vegetative propagation.
  - The nodes bear scale leaves and axillary budsm, e.g., *Cynodon* (lawn grass).
- **Stolon**
  - They are elongated, horizontal or arched runners with long internodes like runners, these are slender axillary branches, which develop adventitious roots on coming in contact with the soil.
  - Each stolon has one or more nodes possessing scale leaves and axillary buds.
  - The axillary buds may either form a secondary stolon or may grow up as an erect short aerial stem.
  - Stolons also propagate vegetatively, e.g., jasmine, strawberry

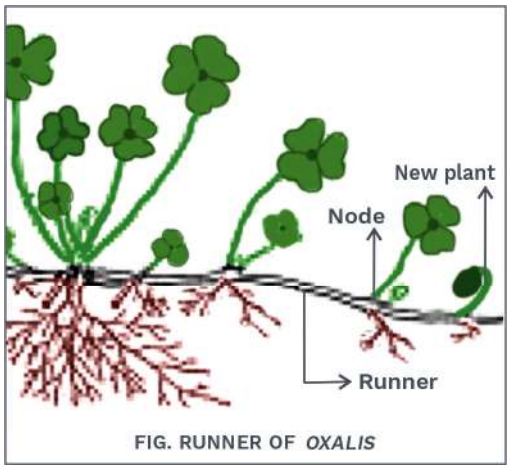


FIG. RUNNER OF *OXALIS*

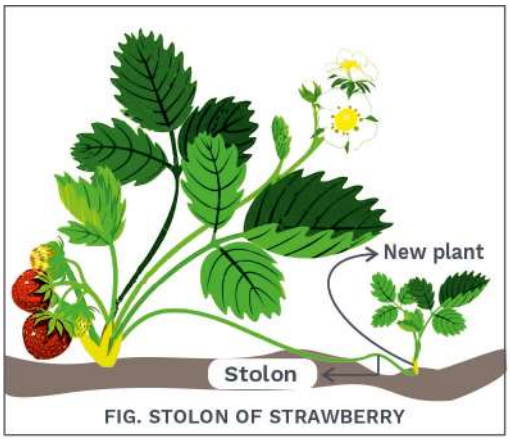


FIG. STOLON OF STRAWBERRY

- **Sucker**
  - These are sub-aerial, non-green branches that arise from the underground base of the aerial shoot or **crown** and runs parallel to the soil surface upto short distance then emerges out of the soil obliquely.
  - These sub-aerial branches are shorter and stouter than the runners.
  - Each sucker has one or more nodes with scale leaves and axillary buds. The axillary buds can also sprout into new shoots.
  - A sucker also bears adventitious roots at the nodes, e.g., *Chrysanthemum,* mint, etc.
- **Offset**
  - These are one internode long, stout, slender and condensed runner found in rosette plants at the ground or water level.
  - An offset arises from an axillary bud at the base of the cluster of leaves.
  - It runs horizontally and terminates in a bud at a short distance that develops into adventitious roots and a rosette (cluster) of leaves, e.g., *Pistia* (water lettuce), *Eichhornia* (water hyacinth), etc.

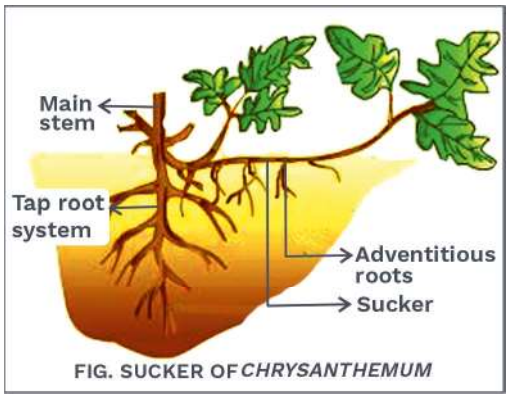


FIG. SUCKER OF *CHRYSANTHEMUM*

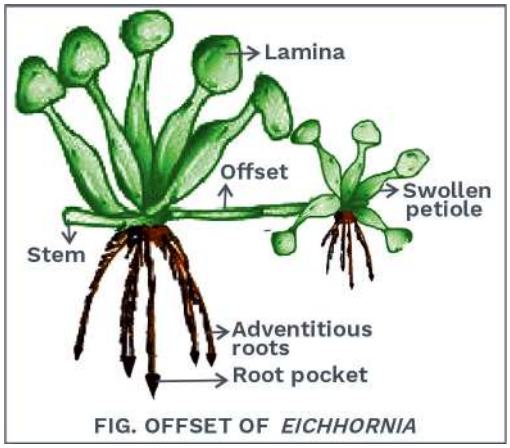


FIG. OFFSET OF *EICHHORNIA*

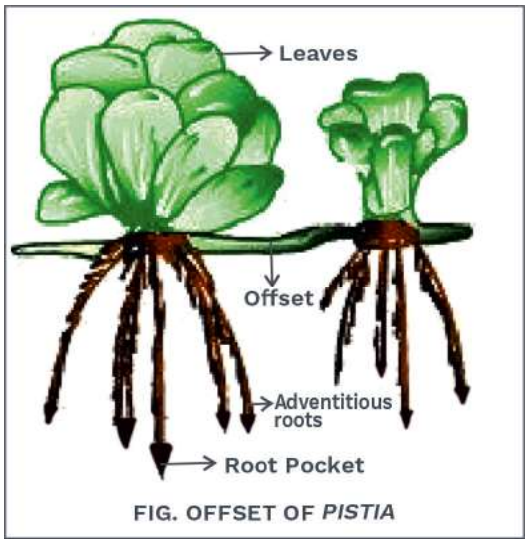


FIG. OFFSET OF *PISTIA*

Gray Matter Alert!!!

Trailers (Stragglers or Creepers): Spread without rooting, e.g., *Oxalis*.

UNDERGROUND OR SUB-TERRANEAN STEMS

- These stems lie below the soil surface.
- These are non-green, store food and are adapted for perennation (i.e., surviving unfavourable conditions)
- The underground stem sheds off aerial shoots or leaves at intervals during favourable seasons.
- The aerial shoots wither or die on the approach of unfavourable growth period, but the underground stems tide over this unfavourable period by remaining dormant.
- They resume their activity on the return of favourable conditions and develop new aerial shoots. Such stems can be used as '**seeds**' to produce new plants.

Rack your Brain

An exposed potato tuber during cultivation develops chlorophyll and turns green. Give reason.

How to differentiate between underground stem and a root?

Underground stems appear root like in their appearance, but they can be distinguished from roots by — (i) Absence of root caps; (ii) Absence of root hair; (iii) Presence of terminal bud; (iv) Presence of nodes and internodes; (v) Presence of foliage or scale leaves on the nodes; (vi) Presence of buds in the axils of scale leaves; (vii) Exogenous branching; (viii) Stem like internal structure.

TYPES OF UNDERGROUND STEMS

1. Stem tuber

- Fleshy, swollen, rounded or oblong distal portions of underground axillary or adventitious branches that arise from the underground basal nodes (present on tubers).
- Underground axillary or adventitious branches are termed as **stolons**.
- The tips of these branches become enlarged in the form of tubers, due to the accumulation of surplus food material manufactured by the aerial shoots.
- Stem tubers are covered over by corky skin having lenticels for aeration.
- Each tuber possesses several spirally arranged

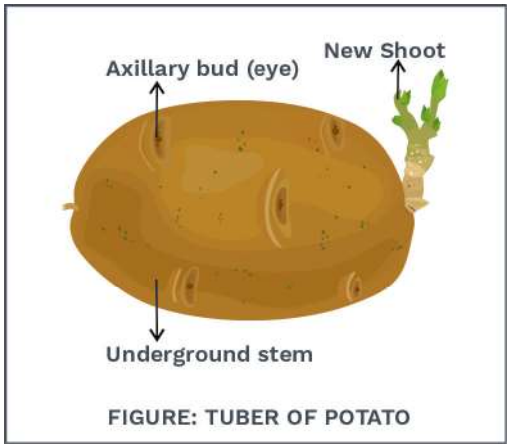


FIGURE: TUBER OF POTATO

depressions called eyes.

- Each eye represents a node that has a scale leaf in the form of a ridge. Each eye contains 1–3 dormant buds.
- The stem tuber lacks adventitious roots, e.g., potato (*Solanum tuberosum*), etc.

Example

Potato: The stem tuber of potato contains reserve food in the form of starch. Stem tubers serve as a means of vegetative propagation. A piece of stem tuber having an eye can form a new plant. The tubers are cut into small pieces, having at least one or two eyes and are sown into the soil. The axillary buds present on these pieces (also called seeds) grow into aerial shoots, which then produce stolon and repeat the formation of tubers.

Previous Year's Question

What is the eye of potato?
(i) Axillary bud
(ii) Accessory bud
(iii) Adventitious bud
(iv) Apical bud

2. Rhizome

- It is fleshy, horizontally growing, perennial, underground stem which continues to grow for an indefinite period producing new leaves or shoots during favourable conditions.
- The aerial leaves or shoots wither or die on the approach of unfavourable conditions and are replaced by the new ones on the arrival of next favourable period.
- A rhizome bears nodes and internodes.
- The nodes bear scale leaves that protect axillary buds.
- It also bears adventitious roots on the nodes and on the lower side.
- Examples are *Zingiber officinale* (ginger), *Curcuma domestica* (turmeric, vern. Haldi), *Musa indica* (banana), ferns such as *Dryopteris*, *Pteris*, *Adiantum*.

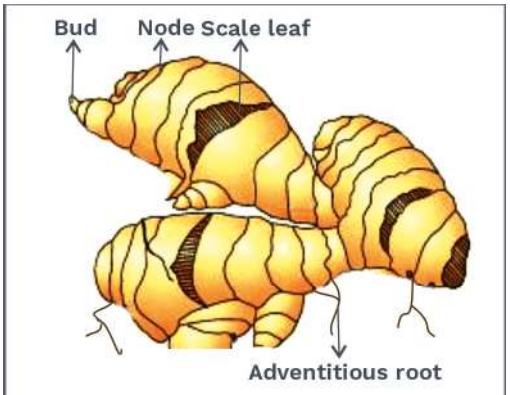


FIG. RHIZOME OF GINGER (UNDERGROUND STEM)

3. Corm

- It is a vertically growing, thick, fleshy usually unbranched spherical or sub-spherical underground stem.
- It bears several circular nodes with scales, which represent thin sheathing bases of fallen dead leaves.
- The nodes bear axillary buds. Many adventitious roots are also borne at the base of the corm.
- Corms take part in perennation.
- They develop aerial shoots from their buds during favourable period. The aerial shoots manufacture food and store the same in their bases, where new corms are formed. The new corms may appear either above (e.g., *Freesia*) or on the side (e.g., *Colocasia*) of the old ones.
- The aerial shoots die off during the unfavourable season.
- The old corms generally shrivel due to utilization of the stored food in forming the new aerial shoot in the next favourable season, e.g., *Crocus* (vern. Kesar), *Colocasia* (vern. *Kachalu*), *Amorphophallus* (elephant's foot, vern. *Zaminkand*)

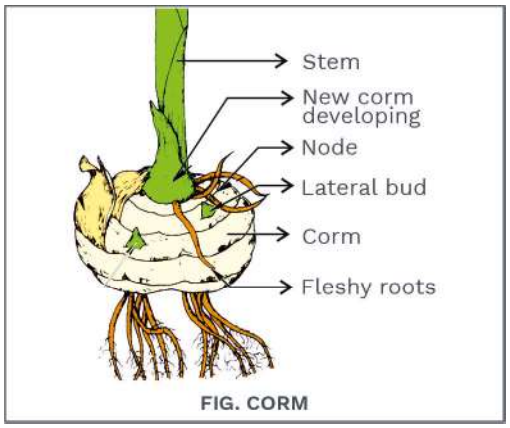


FIG. CORM

4. Bulb

- It is an underground spherical structure that possesses a reduced discoid stem and several fleshy, sheathing bases (usually called **scales**), enclosing a terminal bud. The base of the discoid stem bears fibrous adventitious roots.
- The whole structure takes the shape of a bulb. The terminal bud normally forms a leafless hollow floral axis called **scape**, that bears a terminal cluster of flowers.

Bulbs are of two types –Tunicate bulbs and non-tunicate bulbs (scaly bulbs).

- **Tunicate or laminate bulbs:** These have fleshy scales arranged concentrically. Each scale completely envelops the younger one

Previous Year's Questions

The new banana plant develops from—
(1) Rhizome
(2) Sucker
(3) Stolon
(4) Seed

within it. The outer scale becomes dry and membranous forming a protective covering called as **tunic**.

Types of tunicate bulbs

- **Simple tunicate bulb**

  In this type of bulb, the fleshy scales represent leaf bases in the outer region and scale leaves in the central part. The bulb is covered with a whitish or pinkish tunic, e.g., *Allium cepa* (onion), *Tulipa* (Tulips).

- **Compound tunicate bulb**

  (a) In this type, the fleshy scales represent axillary buds. Each axillary bud has its own tunic.

  (b) These fleshy buds are called bulblets or cloves.

  (c) The concentric rings of tunicate bulblets are in turn surrounded by overlapping tunics, e.g., *Allium sativum* (garlic)

  - **Atunicate or scaly imbricate bulbs**
    - These bulbs lack tunic or covering sheath.
    - The fleshy scales are narrow and overlap one another on the margins only.
    - Such a bulb is never a compact body, e.g., *Lilium sp.* (lily).

Keywords

- Caducous
- Phylloclade
- Axillary bud
- Rhizome
- Bulb
- Corm
- Tuber

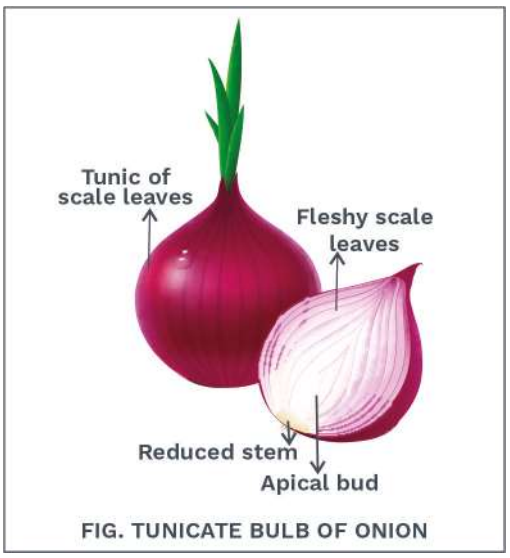


FIG. TUNICATE BULB OF ONION

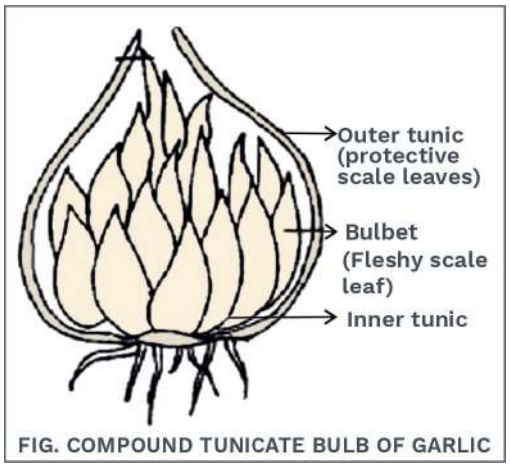


FIG. COMPOUND TUNICATE BULB OF GARLIC

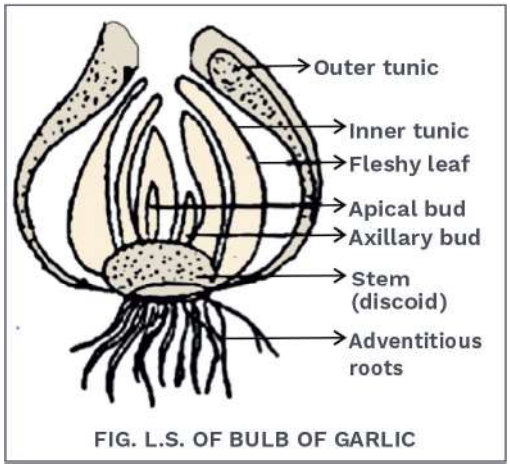


FIG. L.S. OF BULB OF GARLIC

MODIFICATIONS OF AERIAL STEMS

In some plants, stems undergo an extreme degree of modifications and depict specific appearances to perform certain special functions besides the normal functions.

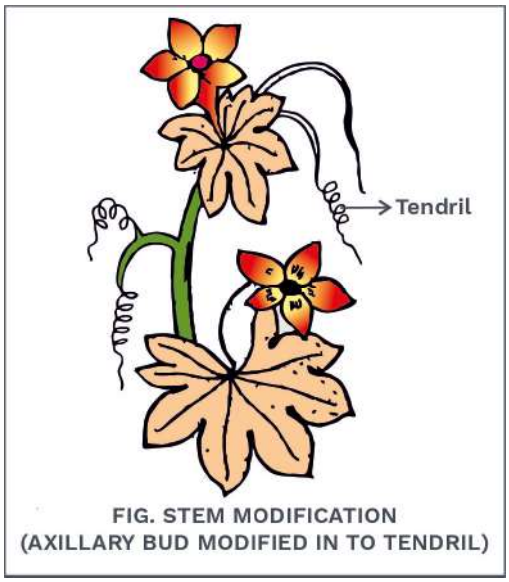


FIG. STEM MODIFICATION
(AXILLARY BUD MODIFIED IN TO TENDRIL)

How to recognize stem modification?

By observing the following:

- Position-axillary,
- Origin-exogenous,
- Presence of nodes and internodes,
- Occurrence of occasional branching,
- Presence of scale or reduced leaves,
- Formation of flowers,
- Internal structure (like that of a stem *viz*.
- types of vascular bundle, etc.)

TYPES OF AERIAL STEMS

1. Stem Tendrils

These are thin, thread-like sensitive, leafless spring-like structures, which coil around a support and help the plant in climbing.

Stem tendrils can be branch or unbranched.

Branched stem tendrils may bear scale leaves in the region of forking.

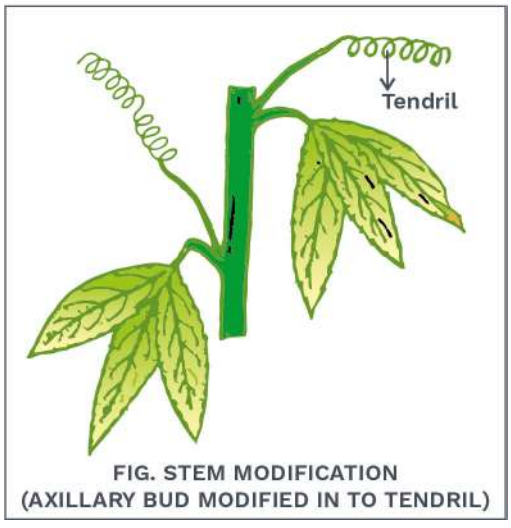


FIG. STEM MODIFICATION
(AXILLARY BUD MODIFIED IN TO TENDRIL)

Stem tendrils are of the following types:

- **Axillary bud tendril**— Axillary bud modifies into a tendril, e.g., *Passiflora* (passion flower), *Cucurbita* (vern. *Kaddoo*), *Luffa* (vern. *Tori*).
- **Apical bud tendril**—
  - The apical bud gets modified into a tendril.
  - The growth of the axis is continued by successive lateral axillary buds on either side of the axis.
  - Thus, a sympodial axis is formed, and the tendrils are opposite to leaves, e.g., *Vitis vinifera* (grapevine).

2. Stem Thorns

- These are modified axillary buds, which have lost the capacity for growth.
- These are stiff, woody, sharp and pointed.
- Reduce transpiration.
- Prevent browsing by animals.
- Stem thorns of *Bougainvillea* are curved and help in climbing.
- Examples are *Citrus, Bougainvillea* (glory of the garden), *Duranta*.

Previous Year's Question

The prickles of rose are—
(1) Modified leaves
(2) Modified stipules
(3) Exogenous in origin
(4) Endogenous in origin

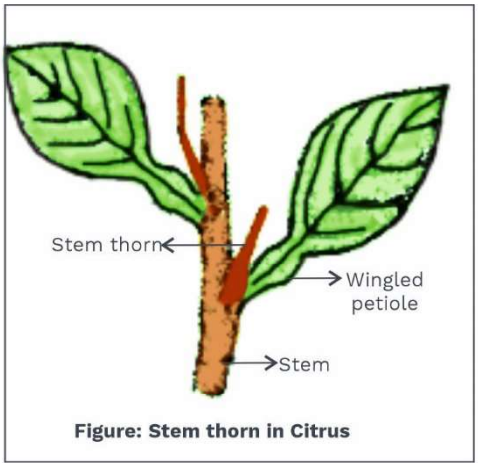


Figure: Stem thorn in Citrus

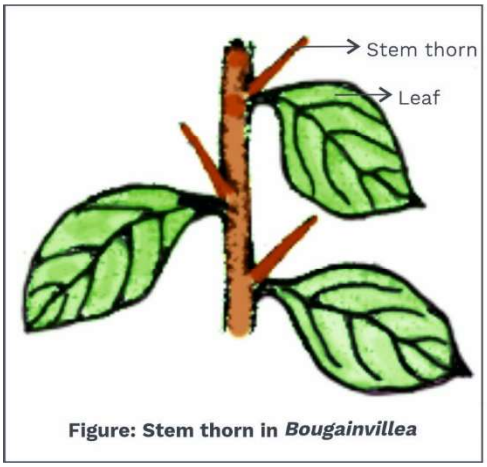


Figure: Stem thorn in *Bougainvillea*

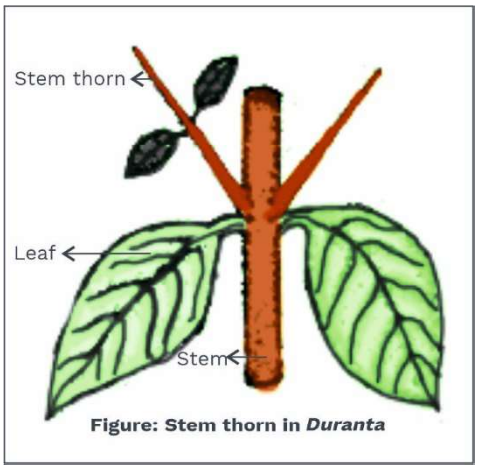


Figure: Stem thorn in *Duranta*

Rack your Brain

How are thorns different from spines ?

3. Phylloclade

- These are green flattened or cylindrical stem or branches, which appear leaf like, and have taken over the function of photosynthesis in the absence of normal green leaves.
- The true leaves are **Caducous** (fall off soon after their appearance) or reduced to scales or spines to reduce transpiration.
- Phylloclades are succulent due to storage of water, food and are of unlimited growth. Phylloclades are characteristics of some xerophytic plants such as *Opuntia*, *Euphorbia royleana,* cacti, etc.

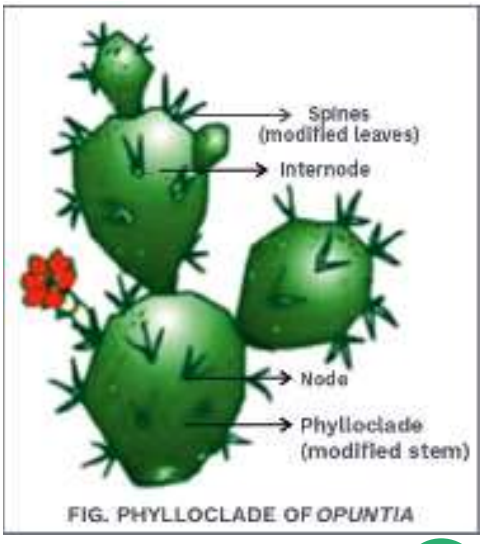


FIG. PHYLLOCLADE OF *OPUNTIA*

Previous Year's Question

Phylloclade is found in—
(1) *Opuntia* (2) Cactus
(3) *Acacia* (4) Both (1) & (2)

Examples of Phylloclade

Opuntia

- It is flattened, succulent leaf-like and develops in the axil of a caducous leaf, which falls and leaves behind a scar.
- A phylloclade bears raised areas (called **areoles**) that are nodes and bear leaf scars, one or two large spines and several stiff hairs called **bristles** or **glochidia**.
- The spines are modified leaves of suppressed axillary branches and prevent transpiration.

Euphorbia royleana

- Thick, angular and contain milky gates.
- It bears caducous leaves at the nodes during the favourable growth period.
- The stipules are modified into spines.

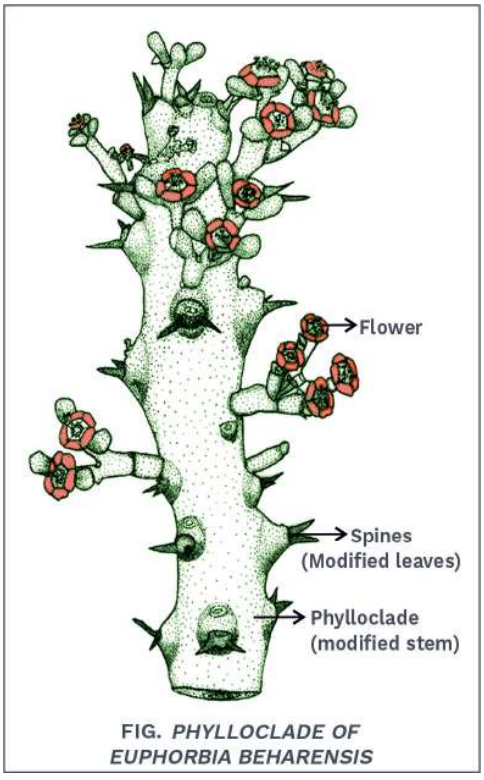


FIG. *PHYLLOCLADE OF EUPHORBIA BEHARENSIS*

4. Cladodes (*Cladophylls*):

- These are green cylindrical or flattened stem branches of limited growth (usually one internode long).
- They have taken over the function of photosynthesis from leaves.
- The true leaves are reduced to scales and spines

to reduce transpiration.

- The cladodes arise in the axils of scaly or spiny leaves at the nodes on the normal stem, e.g., *Ruscus* (butcher's broom), *Asparagus*, etc.

Example of Cladode

Ruscus

- The cladodes of *Ruscus* are green, leathery and leaf like.
- They are borne singly in the axil of scale leaves.
- A floral bud with a basal scale leaf develops in the middle of a cladode, which is one internode long.
- They develop in clusters in the axil of scale or spine leaves. Each cluster represents a suppressed, cymosely divided branch.

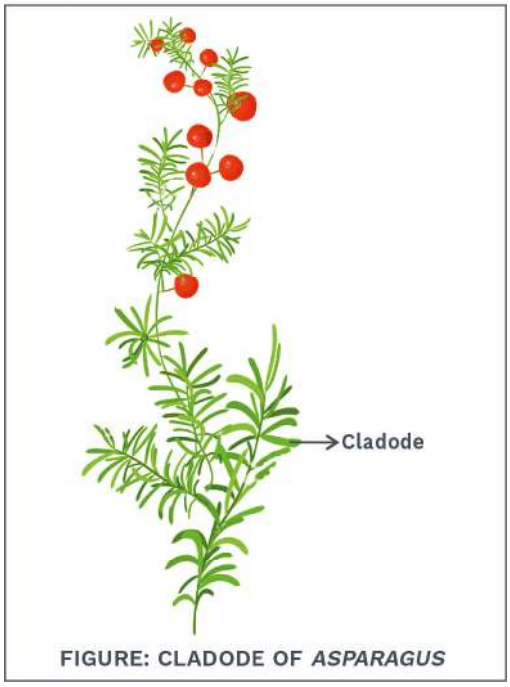


FIGURE: CLADODE OF *ASPARAGUS*

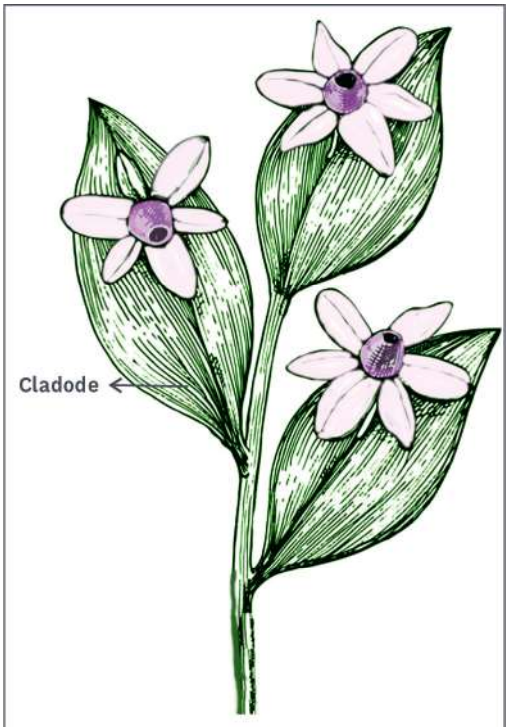


FIG. CLADODES OF *RUSCUS*

Rack your Brain

How is a cladode different from a phyllode ?

MORPHOLOGY OF LEAF

- Leaf is a flattened, lateral outgrowth, which is borne exogenously on the node of a stem or its branches and bears bud in its axil.
- Typically, it is green in colour due to the presence of chlorophyll and is the chief photosynthetic organ of the plant.
- All the green leaves of a plant are collectively called **foliage**.

Characteristics of a leaf

- The leaf is a dissimilar lateral outgrowth of the stem.
- It is borne on the node of the stem in acropetal order.
- It is exogenous in origin.
- It often bears axillary bud.
- The leaf does not bear an apical bud or regular growing point.
- A leaf is differentiated into three parts—leaf base, petiole and lamina.
- The leaf base may possess two lateral outgrowths called stipules.
- The lamina is traversed by prominent streaks called **veins**.

Parts of a leaf

(i) leaf base or hypopodium,
(ii) petiole or mesopodium and
(iii) lamina or leaf blade or epipodium.♦

1. Leaf Base (Hypopodium)

- Leaf base is the lowermost part of the leaf, by which the leaf is joined to the node of the stem or its branch.
- Usually, it protects a small bud in its axil.
- Leaf base is often indistinguishable from the petiole. In many leguminous plants, it is swollen. The swollen leaf base is called **pulvinus**.
- It is responsible for sleep or shock movements of certain plants (e.g., *Mumosa pudica*).

Definition

Leaf: Lateral, flattened outgrowth found attached on nodal areas of the stem and is exogenous in origin.

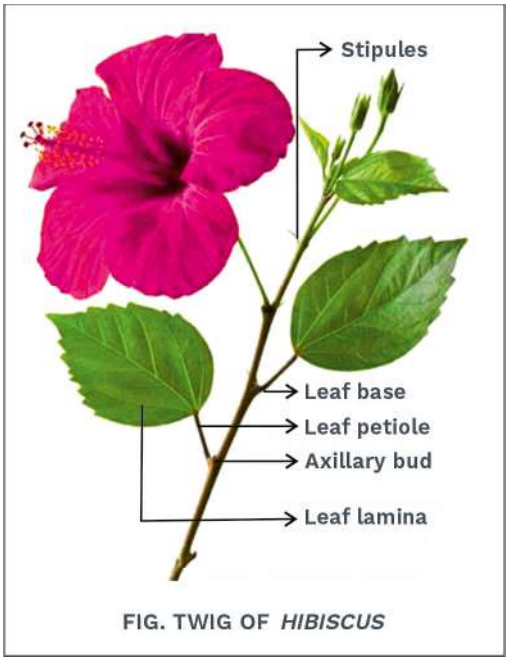


FIG. TWIG OF *HIBISCUS*

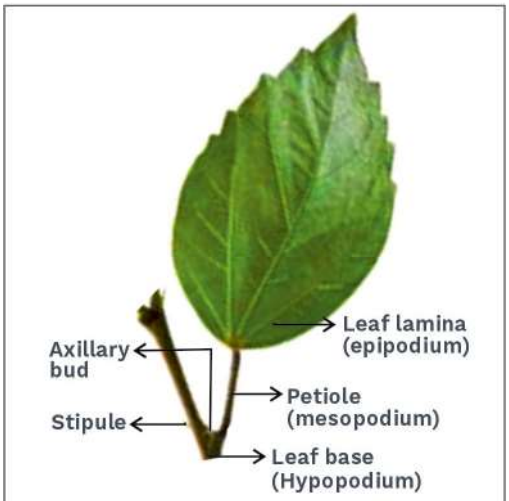


FIG. PARTS OF LEAF

- In several monocot plants (e.g., cereals, grasses, etc.) the leaf base is broadened. It clasps and forms a sheath like structure around the stem at the node. Such a leaf base is called a **sheathing leaf base**.
- When the leaf base surrounds the stem partially, it is called **semi amplexicaul.**
- When the leaf base surrounds the stem, it is called **amplexicaul.**

Stipules: In many plants, the leaf base possesses two lateral outgrowths, called stipules. They protect leaf primordia.

- The stipules vary in size and form and can be free or fused.
- The fused stipules cover and protect leaves in the bud e.g., *Ficus* (banyan tree, rubber tree).
- In pea and wild pea, the stipules are large and green to take part in photosynthesis. They are called **foliaceous stipules**.
- In *Acacia* and *Zizyphus,* the stipules are modified into spines to reduce transpiration. They also protect the plant from grazing animals. Such stipules are called **spiny stipules**.
- In *Smilax*, the stipules are modified into tendrils to help the plant in climbing. They are called **tendrillar stipules.**

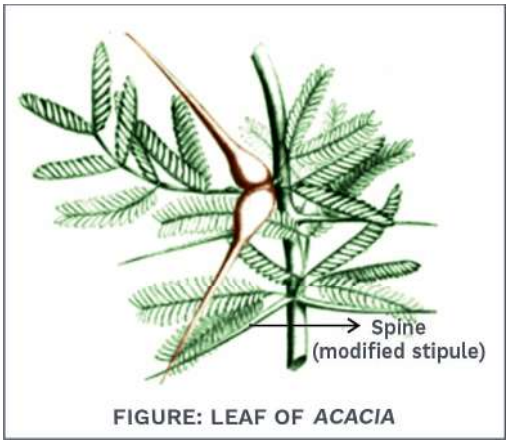


FIGURE: LEAF OF *ACACIA*

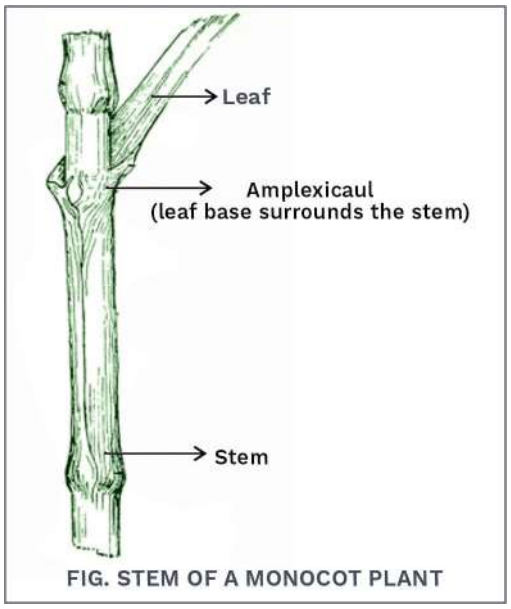


FIG. STEM OF A MONOCOT PLANT

Gray Matter Alert!!!

Broadest Leaf—*Victoria regia* (diameter 1.5—1.8m)
Longest Leaf—*Raphia vinifera* (10 - 15m)

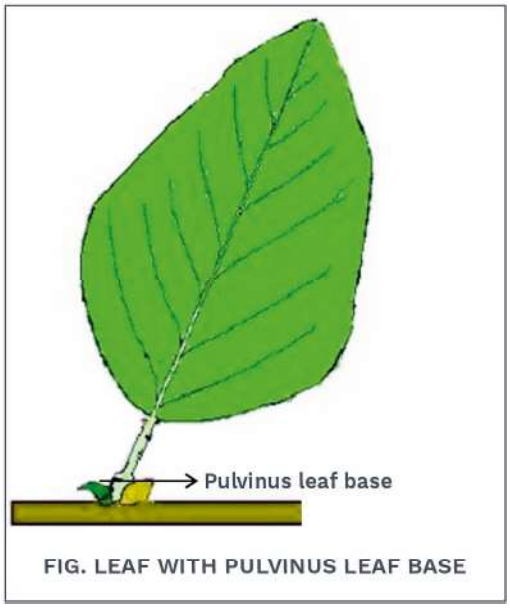


FIG. LEAF WITH PULVINUS LEAF BASE

Keywo

- Hypo
- Meso
- Epipo
- Pulvi
- Ampl
- Stipu
- Axilla
- Semi

2. Petiole (Mesopodium)

- It is a cylindrical or sub-cylindrical stalk of the leaf.
- It raises the lamina above the stem to provide maximum exposure.
- In some plants, the leaves are without petioles, such leaves are called sessile leaves.
- The leaves with petioles are called petiolate leaves.

3. Lamina (leaf blade or Epipodium)

- It is green, expanded portion of the leaf.
- It is the main site of photosynthesis and also helps in exchange of gases.
- Lamina is interspersed with a number of veins and veinlets.
- The veins and veinlets contain vascular tissues for the transport of water and food. They also provide rigidity to the lamina and keep the latter expanded.
- There are one or more prominent veins in the lamina. They are called **midribs** or **mid-veins**.

Previous Year's Question

The broad part of a leaf is —
(1) Leaf base
(2) Petiole
(3) Lamina
(4) All

Definition

Heterophylly: A condition where a plant has different leaf forms at different stages in its life cycle.

Types of Leaves

Leaf Duration: Based on the life span, leaves are of three types:

- **Caducous** (Fugacious): Leaves falling down soon after their appearance, e.g., *Opuntia.*
- **Deciduous** (Annual): Leaves falling off simultaneously at the end of growing season, leaving the plant leafless. The phenomenon is called **leaf fall**, e.g., Mulberry, Poplar etc.
- **Persistent** (Evergreen): Leaves live for more than one season. They fall down individually at different times. Plants with persistent leaves are called evergreen, e.g., *Nerium, Pinus* etc.

Venation

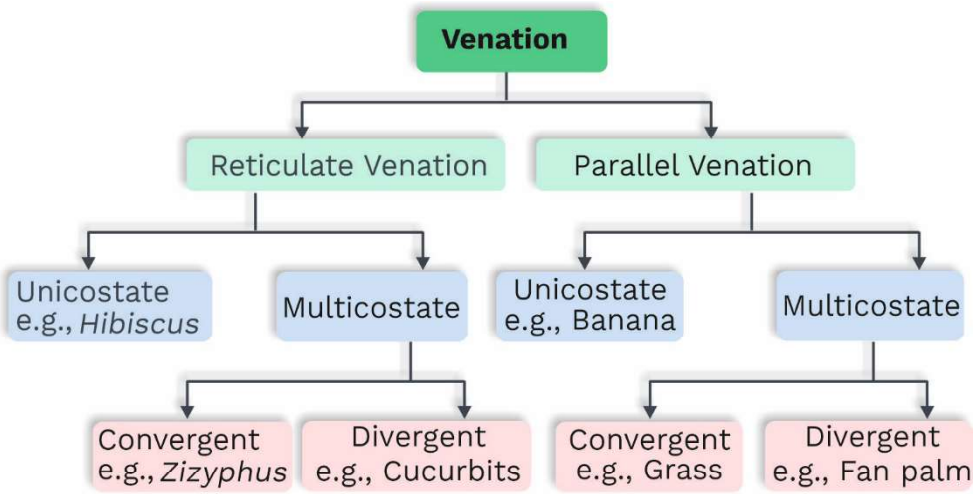
The arrangement of veins and veinlets in the lamina of a leaf is called venation.

- The veins are the conducting channels for water, minerals and organic food.
- Veins also provide firmness to the lamina and keep it expanded.

Keywords

- Venation
- Reticulate venation
- Parallel venation
- Furcate venation

- The lamina has one or more prominent veins termed as midribs, which arise from the petiole.
- Midrib (prominent/main vein) gives rise to lateral veins that traverse the entire lamina.
- The veins and veinlets are more prominent on the undersurface of the lamina in dorsiventral leaves.



Types of Venation — Reticulate, Parallel and Furcate.

- **Reticulate Venation**
- The veins arising from the midrib, branch and re-branch to form a network of veins, this network is reticulate venation.
- It is a characteristic feature of the leaves of dicot plants.
- Exception: *Calophyllum, Corymbium, Eryngium.*
- Based on the number of main veins or midribs in the lamina, reticulate venation has two sub-types:

(i) Pinnate or Unicostate Reticulate Venation

- The lamina has a single principal vein or midrib extending from base to the apex.
- It produces lateral veins.
- Lateral veins branch and re-branch into veinlets forming a network-like structure, e.g., leaf of Banyan, Mango, etc.

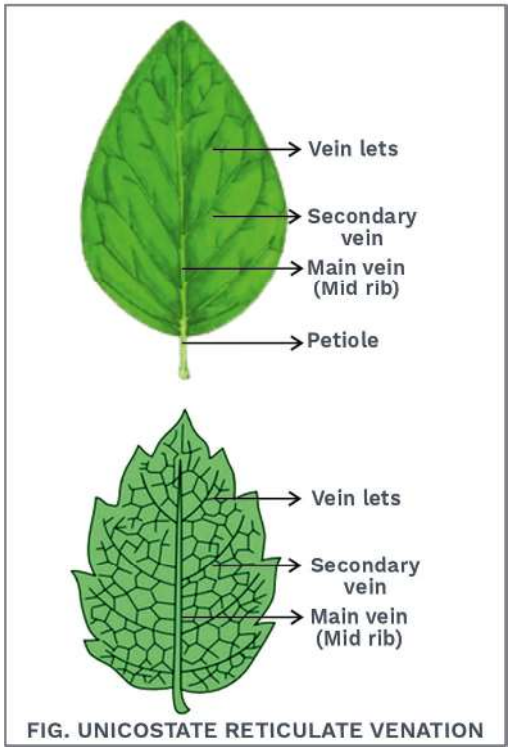


FIG. UNICOSTATE RETICULATE VENATION

(ii) Palmate or Multicostate Reticulate Venation:

- The lamina has more than one prominent or principal veins arising from the tip of the petiole and reaching either the apex or margin of the lamina.
- They give rise to lateral veins and further to veinlets.
- Multicostate reticulate venation has two forms:
- **Convergent:** The principal veins converge towards the apex of the lamina, e.g., *Zizyphus* (*Ber*)
- **Divergent:** The principal veins diverge towards the margin, e.g., Castor.

Previous Year's Question

Which type of leaf arrangement is found in *Hibiscus* ?
(1) Alternate
(2) Spiral
(3) Opposite
(4) Whorled

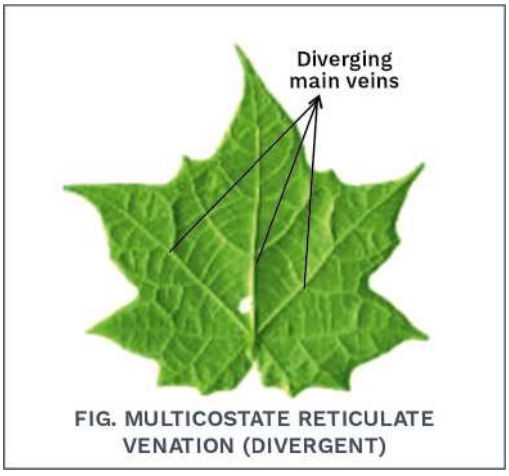


FIG. MULTICOSTATE RETICULATE VENATION (DIVERGENT)

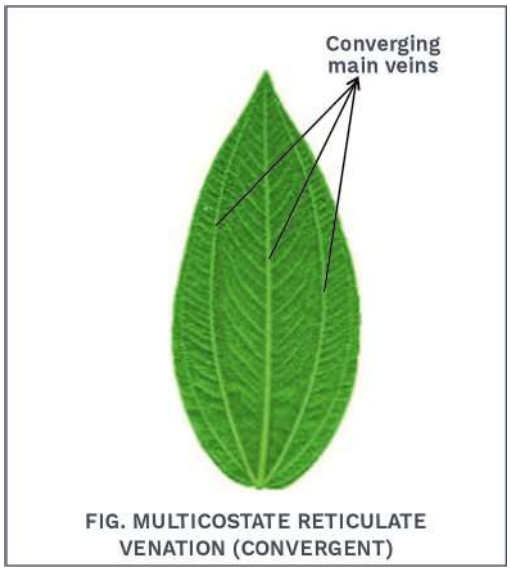


FIG. MULTICOSTATE RETICULATE VENATION (CONVERGENT)

2. Parallel Venation

- The veins arising from midrib or main veins run parallel to each other towards the margin or the apex of the lamina.
- The veinlets are inconspicuous and reticulation or network of veinlets is absent.
- Parallel venation is characteristic of the leaves of monocot plants.
- Exception: *Smilax*, *Colocasia*, *Alocasia, Dioscorea.*
- Parallel venation is of two sub-types.

(i) Pinnate or Unicostate Parallel Venation

- The lamina has a single prominent vein or midrib running from the base to the apex of the lamina.
- It gives off lateral veins that run parallel toward the margin of the lamina, e.g., *Musa paradisiaca* (banana), *Canna*, etc.

Types of Parallel Venation

A. Unicostate parallel venation of banana;
B. Multicostate convergent of bamboo;
C. Multicostate divergent venation of Fan Palm.

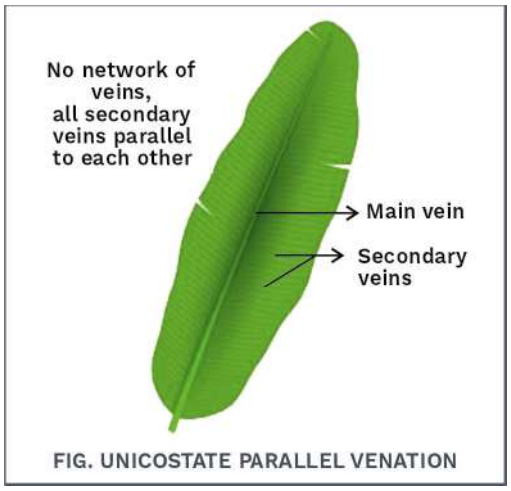


FIG. UNICOSTATE PARALLEL VENATION

(ii) Palmate or Multicostate Parallel Venation

- The lamina has several principal veins arising from the base and running towards the apex or margin of the lamina.
- The main veins do not branch further.

(a) Multicostate parallel venation has two forms

- **Convergent:** The principal veins converge towards the apex, e.g., bamboo, grass.
- **Divergent:** The principal veins diverge towards the margin *e.g.*, Fan palm.

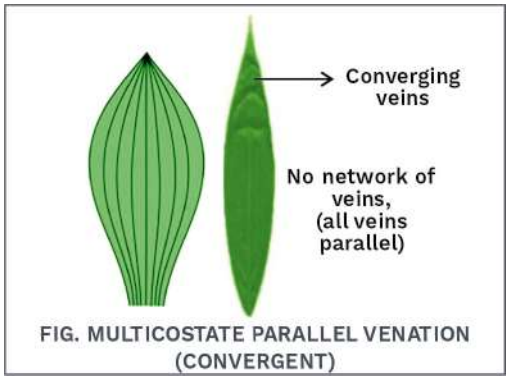


FIG. MULTICOSTATE PARALLEL VENATION (CONVERGENT)

3. Furcate Venation

- The veins give off dichotomous branching.
- The finer branches do not form reticulum.
- Furcate venation is common in ferns.
- Among higher plants, it is found in *Circaeaster.*

Rack your Brain

Why are vascular bundles arranged in linear rows in monocot leaves ?

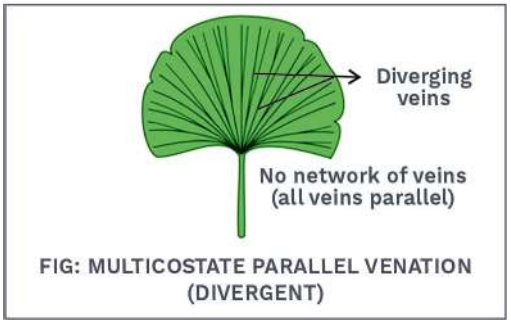


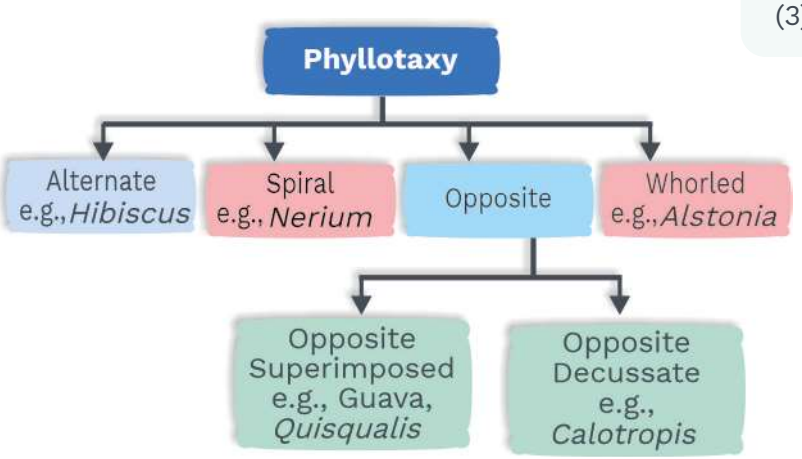
FIG: MULTICOSTATE PARALLEL VENATION (DIVERGENT)

Phyllotaxy

Phyllotaxy (Gk. *Phyllon*–leaf, *taxis*–arrangement) is the arrangement or distribution of leaves on the stem or its branches so that they may receive maximum sunlight to perform photosynthesis.

Previous Year's Question

The arrangement of leaves on a stem branch is—
(1) Venation (2) Aestivation
(3) Inflorescence (4) Phyllotaxy



Types of Phyllotaxy

1. Alternate or Spiral

- Only one leaf is borne on a node and the leaves of the adjacent nodes lie roughly towards the opposite sides, e.g., *Hibiscus rosa sinensis* (shoe flower), sunflower, mustard, etc.
- In this phyllotaxy, the leaves are arranged spirally around the stem.
- The leaves appear to form vertical rows and are termed orthostichous.
- In such cases, phyllotaxy is determined by passing a thread along with the bases of successively higher leaves till a leaf comes to lie exactly above the first one (which is counted as zero).
- This forms a spiral path on the stem. It is called **genetic spiral**.

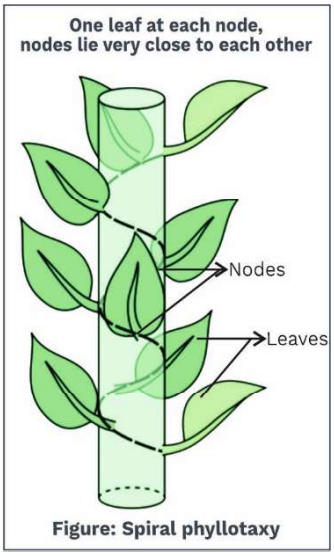


Figure: Spiral phyllotaxy

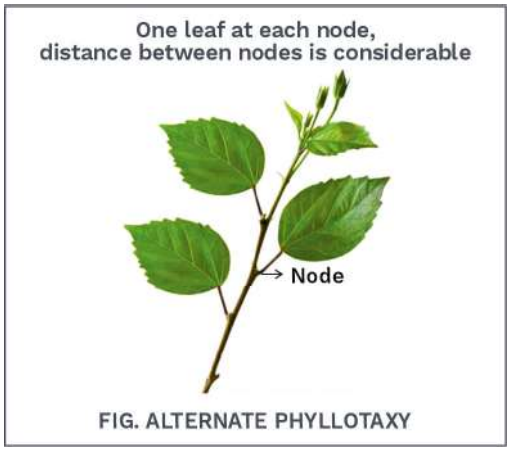


FIG. ALTERNATE PHYLLOTAXY

2. Opposite Phyllotaxy

- Two leaves are borne opposite to each other at a node.
- For example guava, *Calotropis,* etc.
- Opposite phyllotaxy is of two types.
- **Opposite superposed**
  Leaves of the successive node lie in the same plane so that only two rows are formed on the stem, e.g., *Quisqualis* (rangoon creeper), *Jamun*, etc.
- **Opposite Decussate:**
  The opposite leaves of the adjacent nodes lie at right angle so that four rows of leaves are formed on the stem. *e.g., Calotropis* (vern. Ak), *Ocimum sanctum* (vern. *Tulsi*).

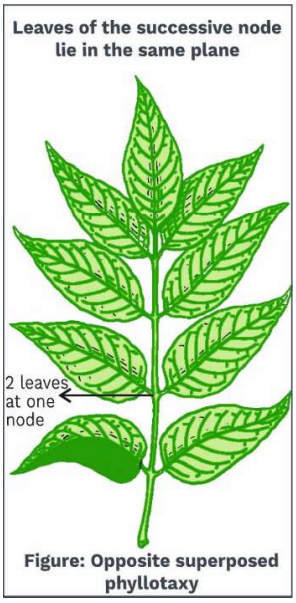


Figure: Opposite superposed phyllotaxy

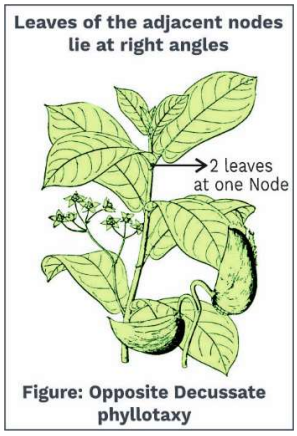


Figure: Opposite Decussate phyllotaxy

3. Whorled or Verticillate

- More than two leaves are borne on a node.
- They are arranged in a circle or a whorl.
- The leaves of one whorl generally alternate with those of the adjacent whorls to provide maximum exposure, e.g., *Nerium* (oleander), *Alstonia* (devil tree/ pencil tree).

Keywords

- Phyllotaxy
- Opposite phyllotaxy
- Alternate phyllotaxy
- Whorled phyllotaxy

Rack your Brain

How are alternate and spiral phyllotaxes different and similar?

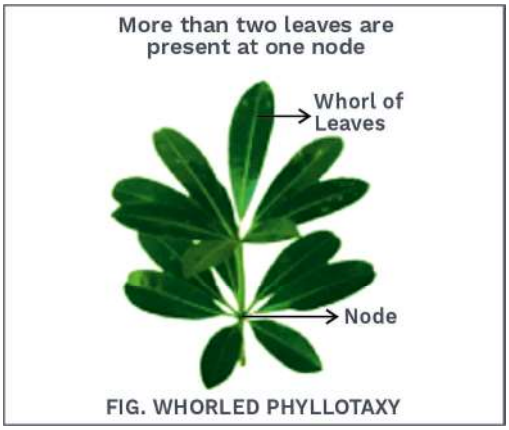
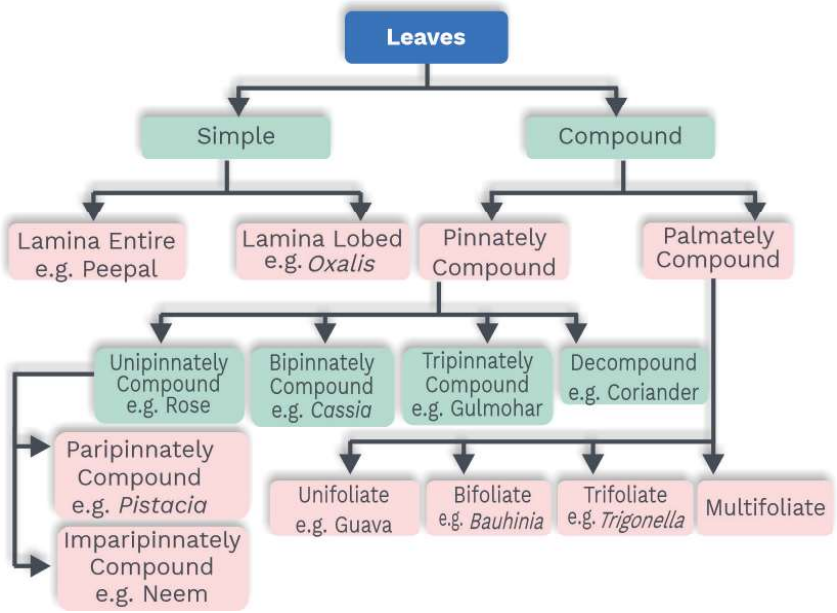


FIG. WHORLED PHYLLOTAXY

Simple and Compound leaves



Simple leaf

- The simple leaf has single or undivided lamina.
- The lamina of a simple leaf may have incisions, but the incisions do not reach the midrib and the lamina does not divide into separate lobes, e.g., Castor, *Cannabis*, *Tagetes* (marigold), etc.

Incisions of Lamina

- It is the process of dividing or partitioning the lamina. The degree of incisions varies in different plants.
- In pinnately veined leaves the incision proceeds from the margin to the midrib.
- In palmately veined (multicostate) leaves, incision proceeds from the margin to the tip of the petiole.
- The incisions may reach hardly up to half (-fid) of the leaf lamina, more than half (- partite) of the leaf lamina or near the midrib or base (-sect) of the leaf lamina.

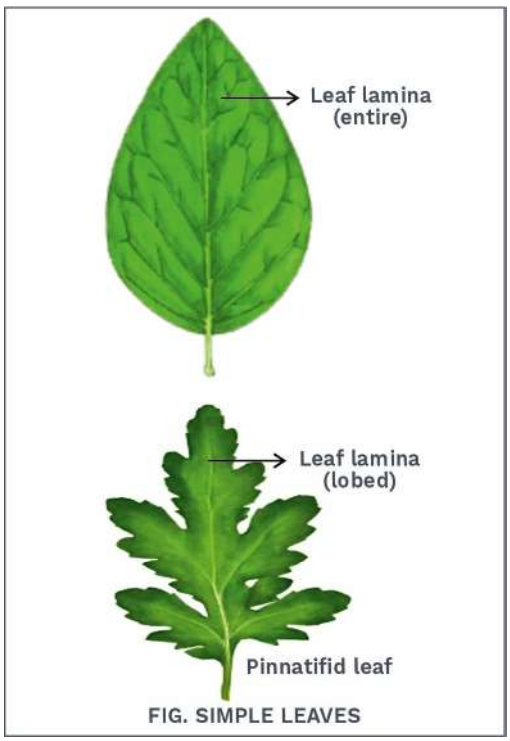


FIG. SIMPLE LEAVES

Depending upon the pinnate or palmate venation, the incision of the lamina is of the following types:

- **Pinnatifid:** The incisions are hardly halfway from the margin to the midrib, e.g., *Chrysanthemum*.
- **Pinnatipartite:** The incisions are more than halfway from the margin to the midribm, e.g., *Launea.*
- **Pinnatisect:** The incisions almost reach the midrib, e.g., *Tagetes* (marigold).
- **Palmatifid.** The incisions are hardly halfway from the margin to the tip of the petiole, e.g., *Luffa,* cotton.
- **Palmatipartite:** The incisions are more than halfway from the margin to the tip of the petiole, e.g., *Ricinus* (Castor).
- **Palmasect:** The incisions almost reach the tip of the petiole, e.g., *Cannabis, Ipomea palmata* (railway creeper).

Compound Leaf

- Compound leaf has its lamina completely divided into distinct segments called **leaflets** or **pinnae**.
- In such leaves, the leaflets are distinct, free from one another and articulated (joined) to the **rachis** (a derivative of the midrib) or the tip of the petiole.
- The leaflets or pinnae resemble leaf in having base, stalk and blade.
- Leaflets differ from the whole leaf in absence of axillary buds, basal stipules and origin in the same plane.

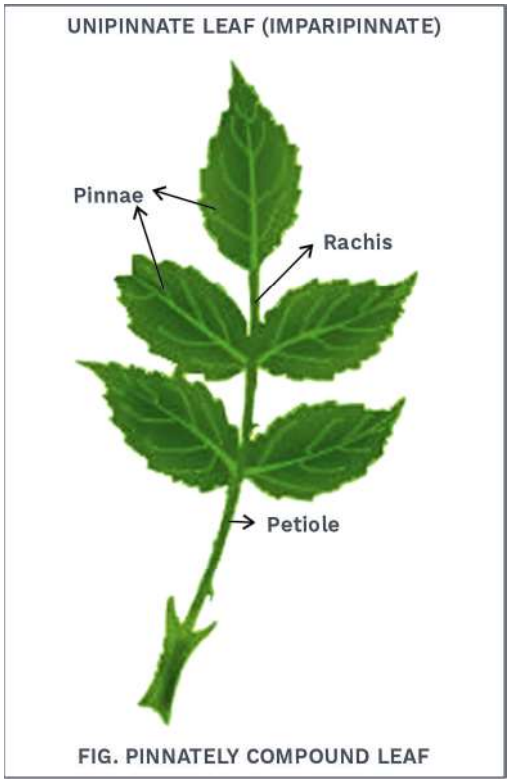


FIG. PINNATELY COMPOUND LEAF

Types of Compound Leaves— Pinnate Compound Leaf and Palmate Compound Leaf

1. Pinnate Compound Leaf

- In a pinnate compound leaf, the leaflets are borne on an unbranched or branched axis called rachis.
- The rachis represents the midrib of the lamina.
- The branches of the rachis represent the lateral veins, called **rachillae** or **rachules** and the leaflets borne on them are called **pinnules**.

Types of Pinnate Compound Leaf

(i) Unipinnate

- The lamina is divided only once in a pinnate manner.
- Rachis unbranched bears the leaflets or pinnae on other side in opposite or sub-opposite pairs.

The unipinnate leaves are of two types:

- **Paripinnate:** The leaflets are even in number, e.g., *Cassia fistula* (vern. *Amaltas*).
- **Imperipinnate:** The leaflets are odd in number with a terminal unpaired leaflet, e.g., *Rosa indica* (rose) neem, etc.

(ii) Bipinnate

- Lamina is divided twice pinnately, i.e., the leaflets of first order are again divided in a pinnate manner, forming leaflets of the second order.
- The leaflets of the second order are called **pinnules**. They are borne on the branches of rachis called **secondary axes** or **rachillae** (rachules).
- The rachillae are arranged in pinnate manner on the rachis, e.g., *Acacia nilotica* (vern. *Kikar*), *Mimosa pudica* (Touch-Me-Not).

(iii) Tripinnate

- The lamina is thrice pinnate.
- The leaflets or pinnules are borne on tertiary axes, e.g., *Moringa* (vern. *Sainjana*)

(iv) Decompound

- The lamina is more than thrice pinnate.
- The rachis is branched more than twice and the pinnules are horns on the branches of the final or ultimate order.
- In decompound leaves, the lamina is suppressed and the rachis along with the branches becomes flattened and green to perform the function of photosynthesis, e.g., *Daucus carota* (carrot), *Coriandrum* (coriander), etc.

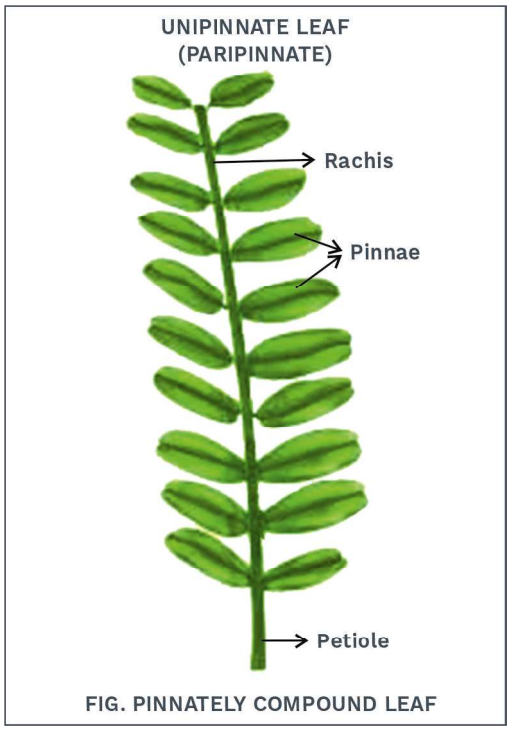


FIG. PINNATELY COMPOUND LEAF

Rack your Brain

It is which type of leaf ?

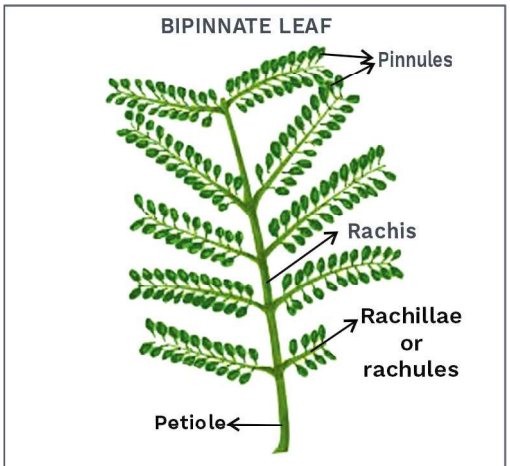


FIG. PINNATELY COMPOUND LEAF

2. Palmate Compound Leaf:

- In a palmate compound leaf, the leaflets are attached at the tip of the petiole, like the fingers of the palm.
- A joint may be present between the tips of the petiole and the leaflets, e.g., silk cotton.

Depending upon the number of the leaflets present, the palmate compound leaves are of the following types:

- **Unifoliate:** A single leaflet is joined to the tip of the petiole, e.g., *Citrus* (lemon, orange).
- **Bifoliate or Binate:** Two leaflets are attached at the tip of the petiole, e.g., *Hardwickia,* etc.
- **Trifoliate or Ternate:** Three leaflets are attached at the tip of petiole *e.g., Aegle marmelos* (Wood apple vern. *Bel*), *Butea* (vern. *Dhak*), *Medicago* (vern. *Methi*) etc.
- **Quadrifoliate or Quadrinate:** Four leaflets are attached to the tip of the petiole, e.g., *Paris quadrifolia, Marselia,* etc.
- **Multifoliate or Digitate:** More than four leaflets are present at the tip of the petiole. *e.g., Bombax* (red silk cotton, vern. *Sembal*) *Cleome,* etc.

Previous Year's Question

The leaves of lemon plant are -
(1) Compound leaves
(2) Simple leaves
(3) Unifoliate leaves
(4) Bifoliate leaves

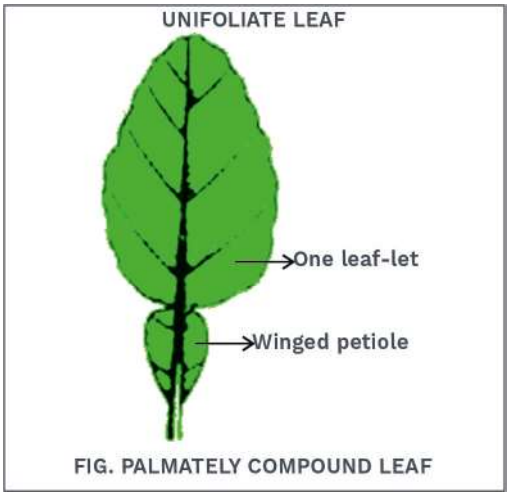


FIG. PALMATELY COMPOUND LEAF

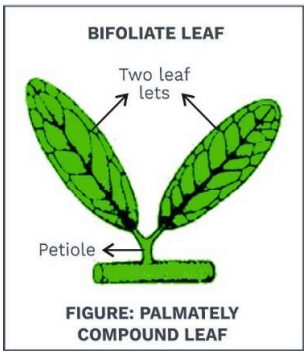


FIGURE: PALMATELY COMPOUND LEAF

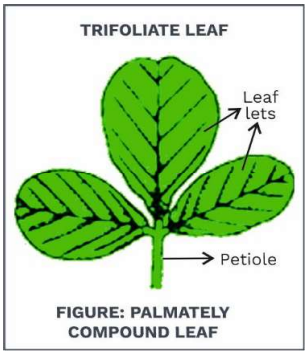


FIGURE: PALMATELY COMPOUND LEAF

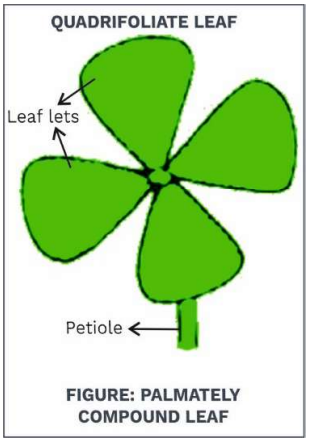


FIGURE: PALMATELY COMPOUND LEAF

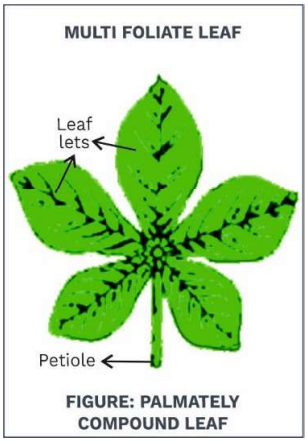


FIGURE: PALMATELY COMPOUND LEAF

MODIFICATION OF LEAVES

The modifications of leaves help to perform special functions.

1. Leaf tendrils

- In some weak stemmed plants, the leaves or their parts are modified into sensitive, spring-like slender, coiled structures called tendrils.
- Leaf tendrils help the plant to climb up a support to expose its foliage to sunlight.
- Leaf tendrils are usually unbranched and devoid of scales.

2. Leaf spines

- In some plants, leaves or their parts are modified into sharp pointed structures called spines.
- They protect the plant from grazing animals and excessive transpiration.
- In *Berberis* (Barberry), the leaves of the main stem are modified into branched 3–5 rayed spines. Dwarf branches arise in their axils.
- The spines on the areoles of *Opuntia* and cacti are modified leaves.
- The spines of *Acacia* and *Zizyphus* are modified stipules.
- Spines may also develop on the surface, margins and apex of the leaves of many plants such as, *Aloe*, *Solanum sp.*, *Argemone mexicana* (Mexican prickly poppy), etc.

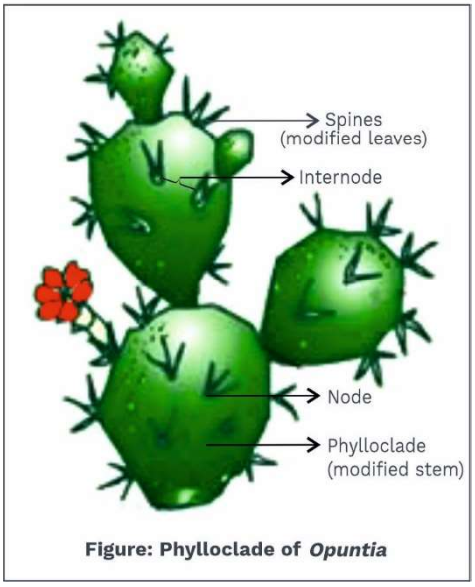


Figure: Phylloclade of *Opuntia*

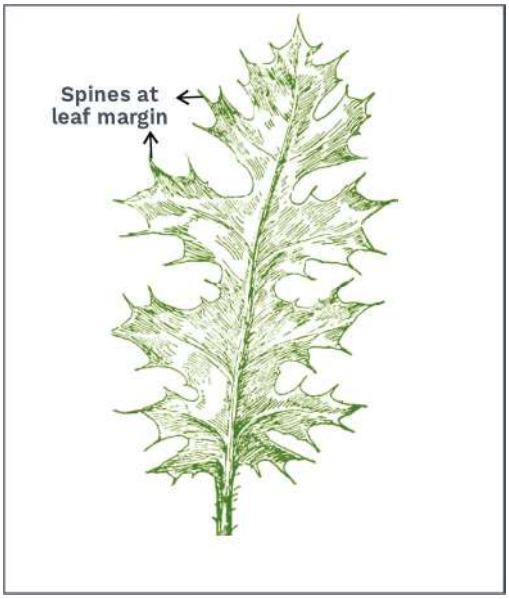
Rack your Brain

Justify why insectivorous plants are not categorized as heterotrophic plants ?

Previous Year's Question

In *Opuntia,* the spine is the modification of..... .

(1) Flower (2) Stem
(3) Leaf (4) Root



3 Phyllodes or Phyllodia

- In certain species of *Australian Acacia,* e.g., *A. longifolia*, *A. auriculiformis, A. recurva,* etc., the bipinnate lamina is absent. *Parkinsonia* is another example of phyllodes.
- The petiole of Australian Acacia and the part of rachis become flattened, taking the shape and functions of the leaf. In such plants, the normal leaves develop in seedling stage and soon fall off (leaves are ephemeral).
- The flattened petioles which carry out the functions of the lamina are called **phyllodes**.
- They also help in reducing transpiration because they are vertically placed and have fewer stomata.

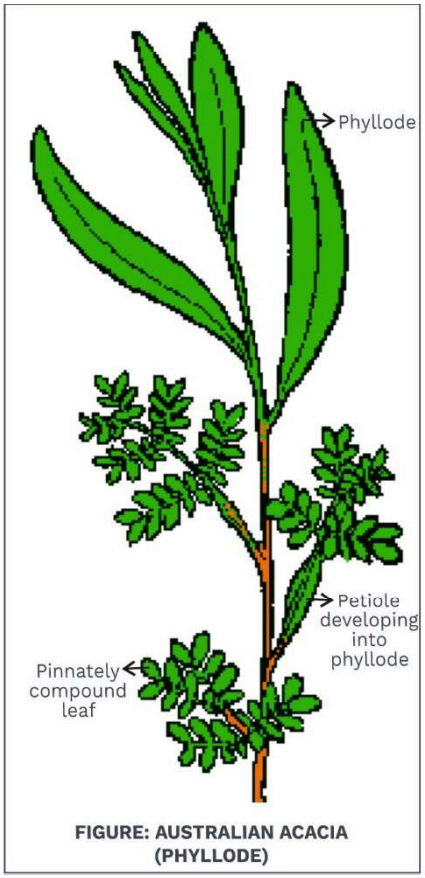


FIGURE: AUSTRALIAN ACACIA (PHYLLODE)

4 Leaf pitcher

- In some insectivorous plants, the leaf or lamina is modified into a pitcher-like structure.
- These leaf pitchers are meant for catching and digesting the insects, e.g., *Nepenthes, Sarracenia* (pitcher plants).
- In pitcher plants, the leaf apex gives rise to a coloured lid for attracting the insects.

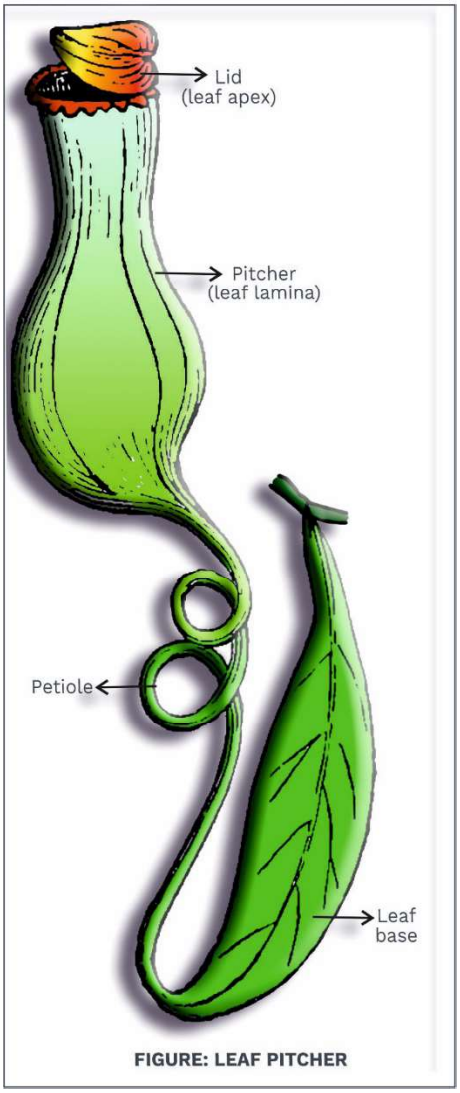


FIGURE: LEAF PITCHER

- In *Nepenthes,* the leaf base is foliaceous, while the petiole is tendrillar.
- The rim of the pitcher has nectariferous glands and its base is filled with digestive fluid.

5 **Storage or Fleshy leaves:** They are fleshy scale leaves which store water and food materials e.g., Onion, garlic etc.

FUNCTIONS OF LEAVES

Leaves perform primary and secondary functions.

A. Primary or Main Functions

- The most important function of leaves is the synthesis of organic food through photosynthesis. The leaves possess green pigment chlorophyll to capture sunlight.
- Stomata on leaves help in the exchange of **gases** that are necessary for photosynthesis and respiration.
- Leaves are the main site of loss of water called **transpiration**. Transpiration provides necessary force for the ascent of sap and keeps the temperature of plants, a bit low in summer.
- Leaves **protect** the axillary and terminal buds from mechanical injury and desiccation.

B. Secondary or Accessory Functions

- The leaves or their parts get modified into tendrils to help the weak stemmed plant climb up a support, to expose the foliage to sunlight and air.
- In *Aloe* and *Agave*, the leaves **store water** to resist drought.
- In onion, the leaf bases **store food**.
- Leaf spines of Barberry, *Argemone mexicana, Opuntia* etc. **reduce transpiration** and provide **protection** from grazing animals.
- Leaves or leaf segments of insectivorous plants (e.g., *Nepenthes, Utricularia, Dionaea* etc.) are modified into a **trap mechanism** for catching and digesting small insects.

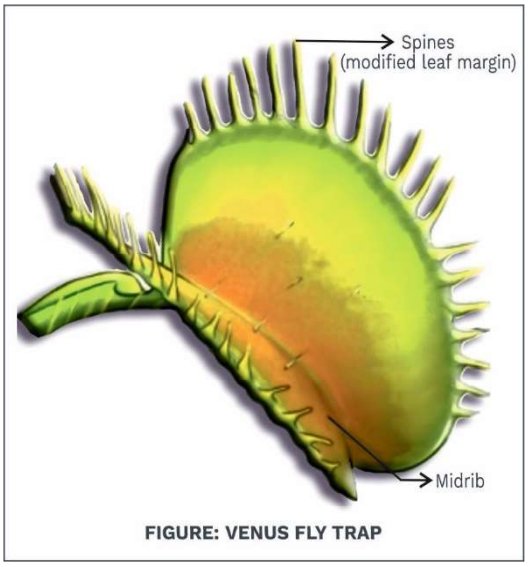


FIGURE: VENUS FLY TRAP

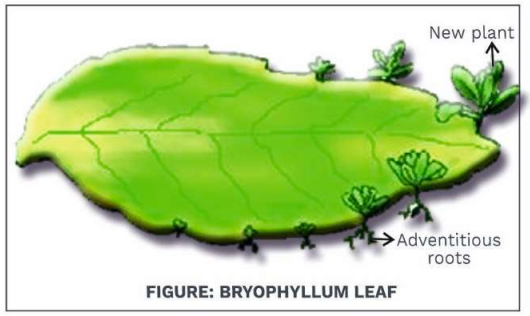


FIGURE: BRYOPHYLLUM LEAF

Rack your Brain

Lid of the pitcher in *Nepenthes* is which part of the leaf ?

- Leaves of *Bryophyllum*, *Begonia* etc. help in vegetative multiplication.

FLOWER

- A flower is a highly **modified shoot**, which performs the function of sexual reproduction. It has a highly condensed axis called **thalamus** or **torus**.
- Shoot bears flowers only when the plant has grown vegetatively.
- Flowers are either on the axils of leaves or on a special flowering branch called the **peduncle** or **floral axis**.
- It has a stalk or **pedicel**, which ends into a broad surface called **thalamus** or **torus**.
- The latter bears four distinct types of whorls of floral leaves:
  - Calyx
  - Corolla
  - Androecium
  - Gynoecium

The individual member (floral leaves) of the whorls are as known as:

- Sepals (for calyx)
- Petals (for corolla)
- Stamens (for Androecium)
- Carpels (for Gynoecium)

- **Non-Essential Floral Parts:** Sepals and Petals do not participate in Fruit and Seed formation.
- **Essential Floral Parts:** Stamens and Carpels participate in Fruit and Seed formation.

Parts of Stamen

- Broad Terminal Anther: It contains tiny structures named **pollen grains** or **microspores**.
- Filament: Stalk-like structure that holds the anthers and supplies water and nutrients to the developing microspores.

Definition

Flower: Highly modified shoot that bears floral leaves, arranged in whorls on the thalamus or torus

Rack your Brain

Which type of meristem helps in the development of floral meristem ?

Parts of a Carpel

- Receptive tip or **Stigma**
- A stalk-like **Style**
- A basal swollen part, **Ovary**
- The ovary contains one or more oval structures called **ovules**.

THE FLOWER IS A MODIFIED SHOOT

It may be confirmed from the following points:

(i) A flower arises from a bud like vegetative branch.

(ii) The thalamus of a flower represents a condensed axis in which the internode remains suppressed.

(iii) The floral leaves are borne on the thalamus on the same pattern as the leaves on the stem. They may arise in whorls or spiral fashion.

(iv) There is a striking similarity between sepals, petals and leaves relating to the structure, form and venation. The sepals are mostly green in colour and can hardly distinguished from ordinary foliage leaves.

(v) In some flowers, such as wild rose, the thalamus shows **monstrous development** *i.e.,* after bearing floral leaves, it prolongs upwards and produces a vegetative shoot or another flower.

(vi) The floral organs of *Nymphaea* (Water lily) show all stages between a sepal and petal and between petals and a stamen.

(vii) In certain primitive flowers such as *Degeneria*, stamens are expanded like the leaves.

(viii) The internal structure of the shoot and the thalamus is similar and the vascular supply to floral leaves resembles the vascular supply of leaves.

Gray Matter Alert!!!

Largest flower—*Rafflesia*
Smallest Flower—*Wolffia arrhiza*

Keywords

- Calyx
- Corolla
- Stamens
- Pistil
- Anthophore
- Androphore
- Gynandrophore
- Perianth

Parts of a Typical Flower

- The axis on which a flower is borne is called the **mother axis**.
- The flower may arise in the axil of a small leaf-like structure called **bract**.
- A typical flower has a stalk called pedicel.
- The pedicel of some flowers may bear two small green leaf like structures called **bracteoles,** e.g., *Delphinium*.

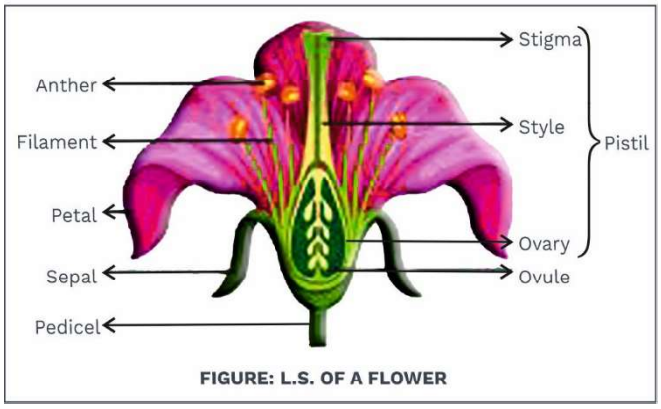


FIGURE: L.S. OF A FLOWER

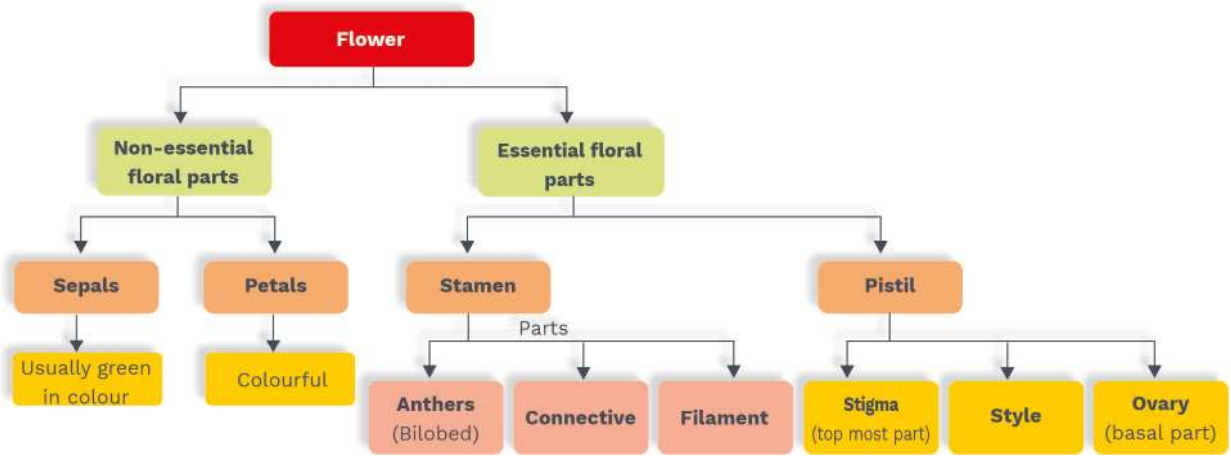
- In certain cases, a whorl of bracteoles is present on the pedicel below the calyx. It is called epicalyx or hypocalyx, e.g., *Hibiscus*.
- The tip of the pedicel forms a broad base of the flower called **receptacle** or **thalamus**.
- Flower has four kinds of floral appendages (floral leaves) borne in distinct whorls on the thalamus.
- These floral appendages in successive order are **sepals** (usually green in colour), **petals** (coloured other than green), **stamens** (Microsporophylls) and **carpels** (Megasporophylls).
- Their respective whorls are termed as **calyx, corolla, androecium,** and **gynoecium**. Sometimes, there is no distinction between calyx and corolla, and they are collectively known as **perianth.**
- The individual member of perianth is called **tepal** or **phyll.**

Rack your Brain

Why are petals and sepals termed as non-essential parts of a flower ?

Previous Year's Question

Flowers of lily possess—
(1) Calyx
(2) Corolla
(3) Perianth
(4) All the above



Note:
In some flowers, the thalamus becomes elongated showing distinct nodes and internodes. *e.g., Gynandropsis pentaphylla*.
Anthophore: The first internode between calyx and corolla.
Androphore: The second internode between corolla and androecium, also called **Gynandrophore.**
Or Gynophore: The third internode between androecium and gynoecium.

FLORAL PHYLLOTAXY

The floral organs are borne on the thalamus in three ways:

(i) Acyclic or **spiral –** borne in spirals, e.g., *Magnolia, Nymphaea*.

(ii) Cyclic – borne in whorls, e.g., *Petunia.*

(iii) Spirocyclic or **hemicyclic**- Some organs in spiral and other organs in whorls, e.g., *Ranunculus*. When the floral phyllotaxy is whorled, the number of whorls is often mentioned as **Tetracyclic** (four whorls, e.g., *Petunia*), **pentacyclic** (five whorls, e.g., *Cassia*), **hexacyclic** (six whorls, e.g., *Brassica*).

Rack your Brain

Fowers of *Cassia* are actinomorphic, zygomorphic or asymmetrical. Comment.

MEROSITY IN FLOWERS

There is some basic number of floral appendages in the floral whorls of a flower. This phenomenon is called **merosity**.

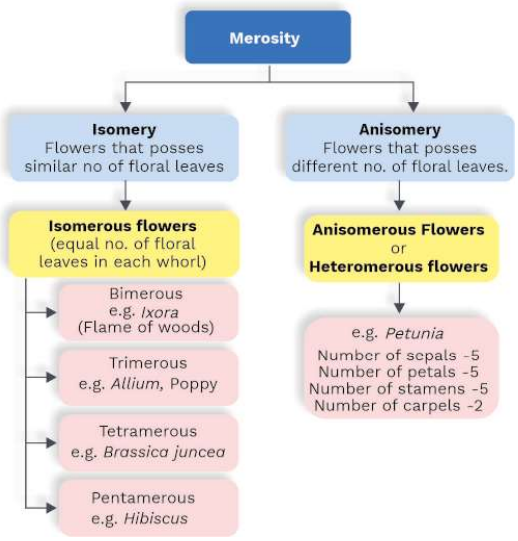
Isomery: When the number of floral leaves in each whorl is same, the phenomenon is called isomery.

Depending upon the similar basic number of floral leaves, a flower is described as:

- **Bimerous :** Floral are leaves two or in multiple of two in each whorl, e.g., *Ixora* flame of woods.
- **Trimerous :** Floral leaves are three or in multiples of three, e.g., *Trillium, Allium,* Poppy, etc.
- **Tetramerous :** Floral leaves are four or in multiple of four, e.g., *Brassica juncea*.
- **Pentamerous :** Floral leaves are five or in multiple of five, e.g., *Hibiscus*.

Heteromery: When the number of floral leaves vary in different whorls of a flower, the number of carpels may be fewer than the number of other floral leaves. This phenomenon is called heteromery.
For example, *Petunia* has 5 sepals, 5 petals, 5 stamens but two carpels, such a flower is called **heteromerous**.

Note: *Petunia* is also categorized as a pentamerous flower as floral appendages of four whorls are in multiple of five except the number of carpels.



Complete and Incomplete Flowers

- A flower having all the four types of floral organs is known as **complete.**
- The absence of any one or more of the floral organs makes the flower **incomplete.**
- The flower that contains both the essential organs, i.e., stamens and carpel is termed as **perfect, bisexual, hermaphrodite** or **intersexual.**

Rack your Brain

Some papaya plants fail to bear fruits. Give reason.

- The flower that bears only one of the two essential floral organs is described as imperfect/unisexual.
- A complete flower is necessarily perfect and an incomplete flower may be perfect or imperfect because the missing part may be the perianth or one of the essential organs.

Unisexual Flower

- A unisexual flower would be male or staminate (if only stamens are present) and female or pistillate (if only carpels are present), e.g., Papaya, *Cucurbita,* etc.

Bisexual Flower

- Flower that possesses both reproductive organs (stamens and pistil), e.g., mustard, pea,etc.

Neuter Flower

- Both the essential organs are absent in neuter flowers.

Monoecious Plants and Dioecious Plants

- **Monoecious Plants:** Both the types of unisexual flowers (Staminate and Pistillate) are present on the same plant, e.g., *Cucurbits*, castor bean, maize, etc.
- **Dioecious Plants:** When a plant bears only one type of unisexual flowers, it is termed as dioecious, e.g., date palm, mulberry, etc.
- **Polygamous Plants:** Some plants possess more than one type of flower. In mango and cashew nut plants, intersexual, staminate (male) and neuter flowers occur together. Such plants are called polygamous.

FLORAL SYMMETRY

- The arrangement of the floral organs around the thalamus of a the flower is known as floral symmetry.
- The shoot (axis) on which the flower is borne is called mother axis.

Keywords

- Staminate
- Pistillate
- Polygamous
- Monoecious
- Dioecious

Definition

Floral Symmetry: The arrangement of the floral organs around the thalamus of a flower.

- The side of flowers towards mother axis is called the posterior side and the side away from it is called anterior side.
- In terminal flowers, a distinction into anterior and posterior sides is not found.

On the basis of floral symmetry, there are following three conditions in flowers:

(i) Actinomorphic: A cyclic flower that can be divided into two equal vertical halves in any plane, the condition is that the line of division should run through the central axis of the flower, e.g., *Hibiscus, Solanum,* etc. Actinomorphic flower has radial symmetry.

(ii) Zygomorphic. A flower which can be divided into two equal vertical halves in only one plane, is termed as zygomorphic (e.g., *Fumaria*). A zygomorphic flower has bilateral symmetry.

(iii) Acyclic or Asymmetric. A flower that cannot be divided into two equal halves in any vertical plane, e.g., *Opuntia, Canna.*

Previous Year's Question

Gulmohur plant bears which type of flowers ?
(1) Asymmetric
(2) Zygomorphic
(3) Actinomorphic
(4) Does not bear flowers

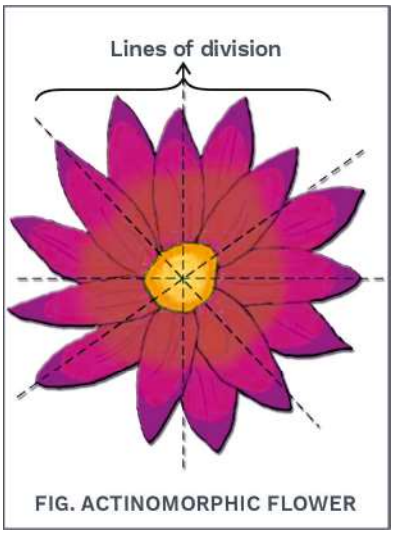


FIG. ACTINOMORPHIC FLOWER

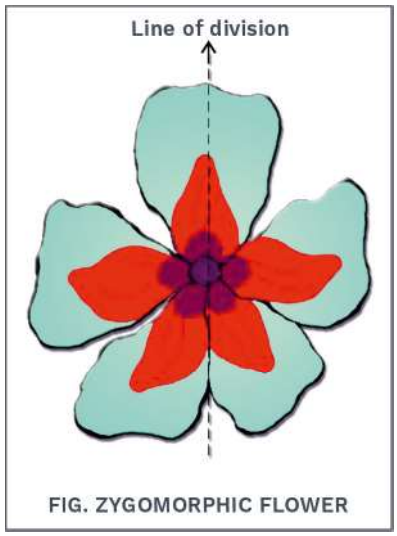


FIG. ZYGOMORPHIC FLOWER

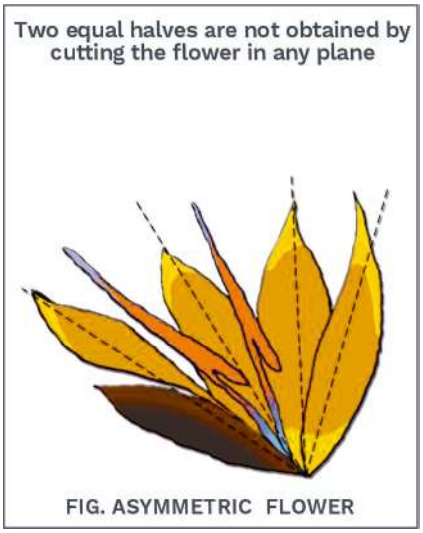


FIG. ASYMMETRIC FLOWER

Regular and Irregular Flowers:

- A flower is said to be regular when its floral parts of each series of a flower are similar in size, shape, colour and origin.
- A flower is described as irregular when it shows any irregularity in any type of its floral organs whether in shape, size, colour or origin.

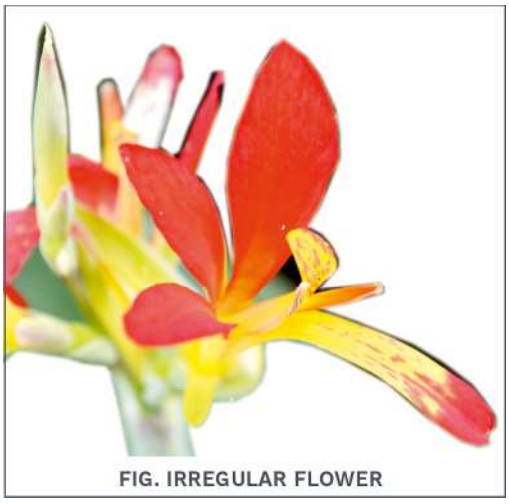


FIG. IRREGULAR FLOWER

Variations in the Forms of Floral Parts

1. **Calyx:** Outermost whorl are green leaf-like structures called sepals. Sepals are mainly meant for protecting other floral parts in the bud condition. Sepals having colour other than green are called **petaloid**.
   The sepal which lies in line with the mother axis is called odd sepal. It is posterior in most of the cases, and it is anterior, in family Leguminosae (e.g., pea, *Cassia, Acacia*) and in some other plant families.
   Polysepalous: Calyx with free sepals.
   Gamosepalous: Calyx with fused sepals.

Few more shapes of the calyx are:

- Infundibuliform— funnel shaped, e.g. *Atropa.*
- Bilabiate— differentiated into an upper and a lower lip e.g. *Ocimum.*
- Pappus— Modified into hairy processes, e.g. *Sonchus.*
- Saccate— Pouched, e.g., *Brassica*
- Gland dotted— With oily glands, e.g. *Citrus.*

Duration of Calyx

Depending upon the life span, calyx may be of three types:

(i) **Caducous**— fall down immediately after opening of flower, e.g. Poppy.
(ii) **Deciduous**— fall down at the time of withering of flower, e.g. *Brassica.*
(iii) **Persistent**— sepals persisting in the fruit e.g., brinjal.

Rack your Brain

How do the plants protect their floral buds ?

2. Corolla:

It is the second whorl, which consists of brightly coloured floral leaves called **petals**.

- The petals may be fragrant or have nectaries at their base.
- They protect the essential organs and attract pollinating animals.
- The petals with greenish colour are called sepaloid.

Polypetalous (Choripetalous)— free petals
Gamopetalous (Sympetalous)—fused petals.

Types of Polypetalous Corolla

(i) Cruciform— With four clawed or unguiculate (with proximal narrow stalk or claw and a broad distal limb), petals arranged diagonally or like a cross, e.g., *Brassica, Raphanus* (Family— Cruciferae or Brassicaceae).

(ii) Caryophyllaceous— With five clawed or unguiculate petals with limbs horizontally bent, e.g., *Dianthus,* carnation (Family— Caryophyllaceae).

(iii) Rosaceous— With five or more sessile or shortly clawed petals, e.g., Rose (Family— Rosaceae).

(iv) Papilionaceous— Five, unequal or irregular petals are arranged like a butterfly. The posterior large bilobed petal called **standard** or **vexillum** overlaps the two smaller lateral petals named **wings** or **alae**. The latter overlap the two interior petals which are fused lightly to form a boat-shaped structure called **keel** or **carina,** e.g., Pea (Family – Papilionaceae or *Fabaceae*).

Types of Gamopetalous Corolla

(i) Infundibuliform— Funnel shaped, e.g., *Petunia*

(ii) Tubular— Tube like or cylindrical, e.g., disc florets of sunflower.

(iii) Rotate— With a flat and circular limb at right

Gray Matter Alert!!!

- Cruciform corolla is the characteristic feature of family Cruciferae.
- Papilionaceous corolla is the characteristic feature of family Fabaceae.

angles to the short tube or wheel-shaped, e.g., *Solanum nigrum*.

(iv) **Bilabiate**— Two lipped, bilabiate corolla with two lips close to one another is called **personate**, e.g., *Antirrhinum* and that with two lips wide open is called **ringent** e.g., *Salvia.*

(v) **Ligulate**— With a short narrow tube below but expanded above like a strap, e.g., ray florets of sunflower.

AESTIVATION

The arrangement of accessory floral organs (sepals or petals) in relation to one another in the floral bud is called aestivation.

Types of Aestivation.

(i) **Valvate:** The margins of the adjacent sepals or petals meet by their edges but without overlapping, e.g., *Brassica.*

(ii) **Twisted or contorted:** One margin of a petal regularly overlaps the margin of an adjacent petal; the other margin being overlapped by the margin of another adjacent petal, e.g., *Hibiscus* (china rose).

(iii) **Imbricate:** Irregular overlapping of petals by one another.

Types of imbricate aestivation

(a) **Quincuncial**— Two petals external, two internal and fifth petal with one margin external while its another margin is internal.

(b) **Ascending Imbricate**— Posterior petal is held inside by the upper margins of two laterals. They are in turn overlapped by the upper margin of two anterior-lateral petals, e.g., *Cassia* (vern. *Amaltas*).

(c) **Descending Imbricate** or **Vexillary**— The posterior petal is large and overlaps the two lateral petals, the latter overlaps the two anterior petals, e.g., pea. It is also called the papilionaceous corolla.

FIGURE: VALVATE AESTIVATION

FIGURE: TWISTED AESTIVATION

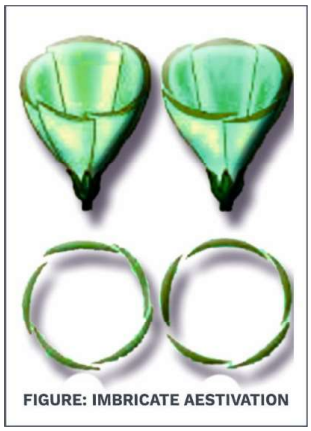


FIGURE: IMBRICATE AESTIVATION

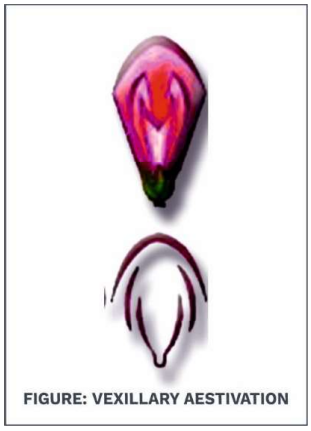


FIGURE: VEXILLARY AESTIVATION

(3) Androecium (Gk. *andros* – male):

- It constitutes the third whorl, consisting of male reproductive organ called the stamen.
- Each stamen is regarded as a highly modified leaf, termed as **microsporophyll**.
- Stamen consists of a slender stalk, called the **filament** and a knob-like structure at its tip known as **anther**.
- Each fertile anther lobe consists of two **pollen sacs** or **microsporangia**, which contain a large number of **microspores** or pollen grains (male spores).
- Each anther has two lobes which are attached at the back by a sterile tissue called **connective.**

Staminode: Sterile and undeveloped stamens are called staminodes.

Bithecous: When an anther possesses both the anther lobes, it is called bithecous.

Monothecous: When an anther consists of a single anther lobe, *e.g., Hibiscus, Althaea* (Family – Malvaceae).

Fusion of one floral part with another dissimilar floral part: It is called adhesion.

- Epipetalous: The stamens fused with petals, e.g., *Petunia, Solanum*
- Epiphyllous or Epitepalous: The stamens fused with tepals or perianth, e.g., *Asphodelus*

Types of Stamens based on length of Filaments

- **Polyandrous:** Stamens are free, may be equal or unequal in length.
- **Didynamous:** The two common types of unequal stamens, i.e., two long stamens and two short stamens, e.g., *Ocimum* (tulsi)
- **Tetradynamous:** Four long stamens and two short stamens, e.g., *Brassica* (mustard)

Definition

Androecium: It is the male reproductive part of the flower.

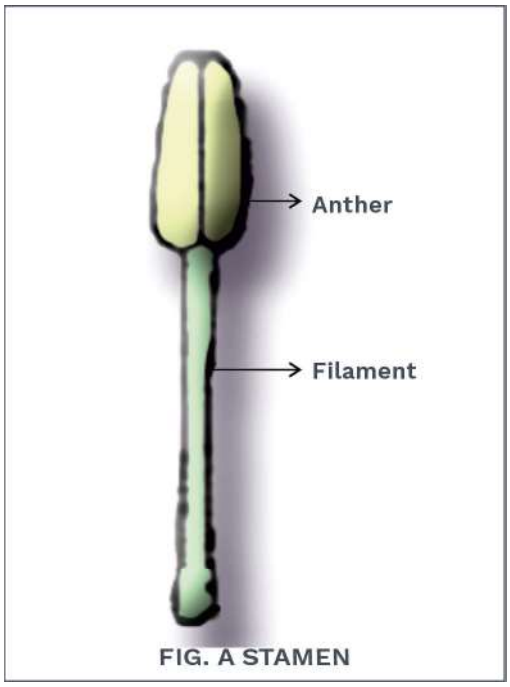


FIG. A STAMEN

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Biggest Pollen -*Mirabilis* (250 um in diameter)
Smallest pollen - Myosotis (2.5 – 3.5 um.)

Fusion of one floral part with another similar floral part: It is called cohesion.

Sometimes the stamens are united with each other and these are of three types:

(i) Adelphous: Only filaments are fused while the anthers are free only.
All stamens form a single group—**Monoadelphous,** e.g., *Hibiscus,* Hollyhock.
Stamens form two groups **Diadelphousm,** e.g., Pea
Stamens form many groups **Polyadelphous,** e.g., *Citrus*

(ii) Syngenesious or Synantherous: Stamens are fused by anthers only, filaments are free. The fused anthers form a ring around the gynoecium, e.g., sunflower.

(iii) Synandrous: Stamens are fused the entire length, both in the region of filaments and anthers, e.g., *Cucurbita*.
The stamens shorter than corolla are termed as **inserted,** while those protrude out of the corolla are called **exserted.**

Fixation of Anthers: The anthers may be attached to the filaments in the following manner:

(i) Basifixed or Innate: Filament attached to the base of the anther, *e.g., Brassica.*

(ii) Adnate: Filament runs throughout the length of the anther or becomes continuous with the connective, e.g., *Ranunculus.*

(iii) Dorsifixed Filament is attached to the dorsal (back) side of the anther, e.g., *Citrus.*

(iv) Versatile Filament is attached in the middle of the connective. In such a way that the anther can swing freely, e.g., *Grasses.*

Previous Year's Question

Tetradynamous condition occur in
(1) Cruciferae
(2) Malvaceae
(3) Solanaceae
(4) Liliaceae

Definitions

- **Adhesion of floral parts:** Fusion of one floral part with other dissimilar floral part.
- **Cohesion of floral parts:** Fusion of one floral part with other similar floral part.

4. Gynoecium (Gk. *Gyne* – female):

- It is the fourth and innermost whorl, that consists of female reproductive organs of the flower called carpels.
- Each carpel is considered to be a highly modified leaf, termed as **megasporophyll**. The carpels may be free or fused.
- A unit of gynoecium is called **pistil**.
- It is flask-shaped and consists of three distinct parts— a basal swollen **ovary**, a stalk-like **style** and a terminal receptive part called **stigma**.
- A sterile and undeveloped pistil is called pistillode.
- Ovary has one or more chambers or loculi (Singular: loculus).

Depending on the number of loci, ovary can be of the following types:

- **Unilocular:** One loculus, e.g., pea
- **Bilocular**: Two locules, e.g., *Brassica*
- **Trilocular:** Three locules, e.g., *Asparagus*
- **Tetralocular:** Four locules, e.g., *Ocimum*
- **Pentalocular:** Five locules, e.g., hibiscus
- **Multilocular:** More than five locules, e.g., lady finger

The locules of the ovary contain oval outgrowths called **ovules.**

Style: It is narrow, thin, thread-like structure for raising and holding the stigma above the level of ovary. Style maybe unbranched or branched.

Stigma: The terminal receptive part of the pistil. It may have varied shapes viz. be linear, fid, lobed, capitate, feathery, hairy or sticky.

Types of gynoecium depending on the number of carpels:

- **Monocarpellary:** Gynoecium having a single carpel.

Definition

Gynoecium: Female reproductive part of the flower

Keywords

- Pistillode
- Syncarpous
- Apocarpous
- Placentation

Gray Matter Alert!!!

Longest Style: *Zea mays* (maize)

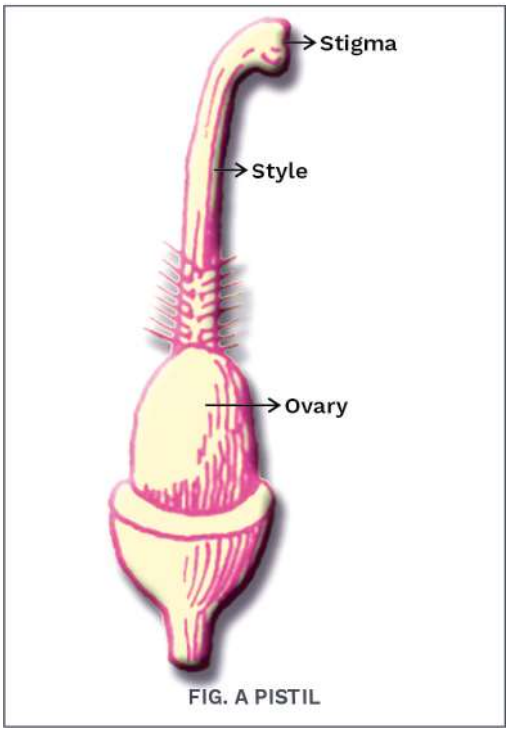


FIG. A PISTIL

- **Bicarpellary:** Gynoecium having two carpels.
- **Tricarpellary:** Gynoecium having three carpels
- **Polycarpellary:** Gynoecium having more than three carpels.

Types of gynoecium depending on the condition(fused/free) of carpels

- **Apocarpous:** When carpels are free, the gynoecium is called apocarpous (i.e., Ranunculus). Syncarpous: When carpels are fused, it is called **syncarpous,** e.g., *Hibiscus.*

PLACENTATION

The arrangement or distribution of placenta inside the ovary is called placentation.

(i) **Marginal:** Observed in monocarpellary, unilocular ovaries. A single longitudinal placenta having one or two alternate rows of ovules, occurs along the wall of the ovary called **ventral suture,** e.g., Pea, *Cassia, Acacia,* etc. (Family – Leguminosae)

(ii) **Parietal:** Observed in bicarpellary or multicarpellary, syncarpous, unilocular ovaries. Two or more longitudinal placentae develop along the wall of ovary. The number of placentae corresponds to the number of fusing carpels, e.g., *Brassica, Cucurbita,* etc.

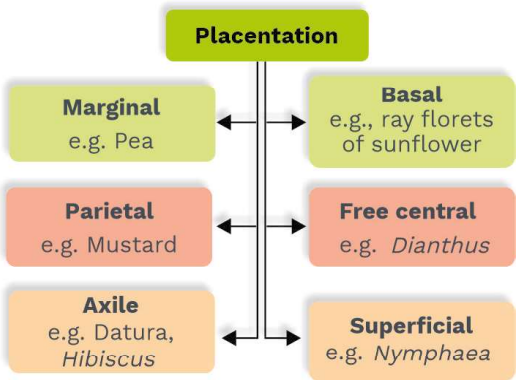
(iii) **Axile:** It is found in bicarpellary or multicarpellary, syncarpous ovaries having two or more loci. Placentae occur in the central region where the septa meet so that an axile column bearing ovules is formed, e.g., *Hibiscus* (Shoe flower), *Datura*.

(iv) **Basal:** It occurs in monocarpellary or syncarpous pistils with unilocular ovaries. It bears a single placenta at the base with generally a single ovule, e.g., *Helianthus* (Sunflower).

(v) **Free Central:** It is found in polycarpellary and syncarpous pistils with unilocular ovaries. The ovules are borne around a

Definition

Placentation: The arrangement or arrangement or distribution of ovules within the ovary.



Previous Year's Questions

An example of axile placentation is

(1) *Dianthus*
(2) Lemon
(3) Marigold
(4) *Argemone*

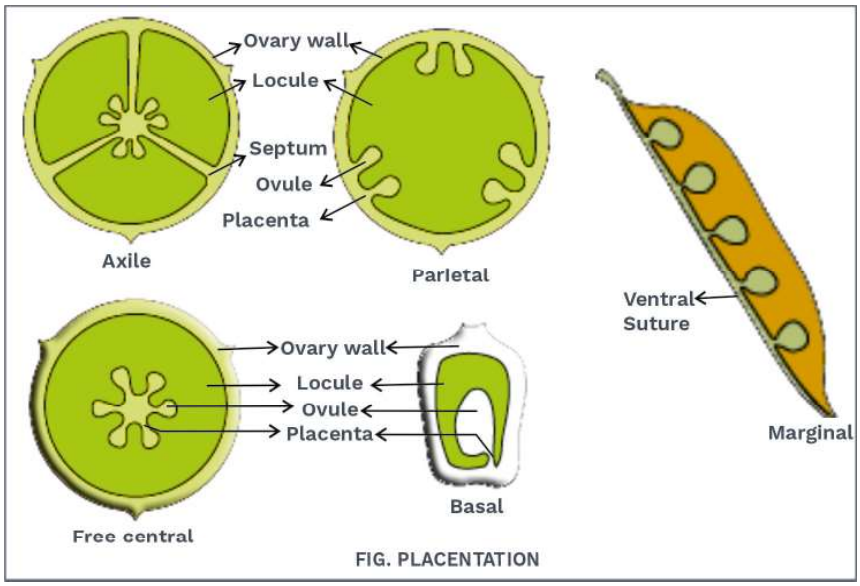


FIG. PLACENTATION

central column, which is not connected with the ovary wall by any septum, e.g., *Dianthus* (Pink), *Primula*.

(vi) Superficial: It occurs in both monocarpellary as well as syncarpous pistils. The ovules are borne on placentae which develop all around the inner surface of the ovary including the septa if present, e.g., *Nymphaea*.

Insertion of Floral Parts (Forms of Thalamus)

Arrangement of floral parts on the thalamus is called insertion.

Depending upon the insertion of floral leaves, the flowers are of three types:

(i) hypogynous (ii) perigynous (iii) epigynous

1. **Hypogynous:** The thalamus is convex or conical. The gynoecium or ovary develops at the top of thalamus, the rest of the floral parts are borne successively below.
   In hypogynous flowers, the ovary is described as **superior** *e.g., Petunia, Brassica* (mustard), *Hibiscus* (china rose), etc.
2. **Perigynous:** The thalamus grows upwards forming a shallow cup-shaped structure

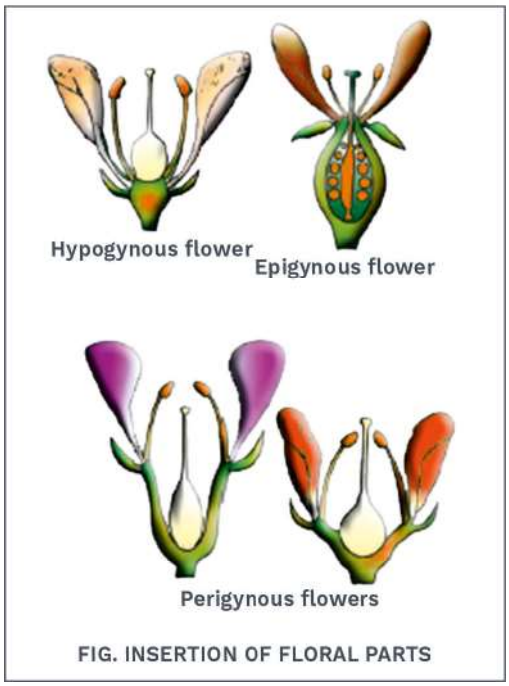


FIG. INSERTION OF FLORAL PARTS

called **hypanthium**. Ovary is in the centre of the concave thalamus. The other floral parts are inserted on the rim or margin of hypanthium. The ovary is described as **half superior,** e.g., *Pisum* (Pea), *Rosa* (Rose), *Prunus* (Peach), etc.

3. **Epigynous:** The thalamus grows upwards to completely envelop the ovary and is also fused inseparably with the ovary. The other floral parts are borne at the top of the fused thalamus and ovary. Such an ovary is described as **inferior**, e.g., *Pyrus* (apple), *Helianthus* (Sunflower), *Cucurbita* (Pumpkin) etc.

Differences between hypogynous, perigynous and epigynous flowers

Hypogynous	Perigynous	Epigynous
1. Thalamus is flat, convex or conical or dome-shaped	1. Thalamus is saucer-cup or flask-shaped.	1. Thalamus is usually deep flask-shaped.
2. Stamens, petals and sepals are inserted below the level of ovary.	2. Stamens, petals and sepals are inserted around or above the level of ovary.	2. Stamens, petals and sepals are inserted above the level of ovary.
3. Thalamus is not fused with the ovary wall.	3. Thalamus is free from the ovary wall.	3. Thalamus and ovary wall are fused.
4. No part of the thalamus is expanded.	4. The periphery of the thalamus is expanded to form the hypanthium.	4. The thalamus is hollow and contains the ovary.
5. Ovary is superior, the remaining floral parts are inferior.	5. Ovary is superior while the other floral parts are inferior.	5. Ovary is inferior, and the other floral parts are superior.
6. Whole of the pistil is visible from outside.	6. Whole pistil may or may not be visible form outside.	6. Only the style and stigmas are visible from the outside.

THE INFLORESCENCE

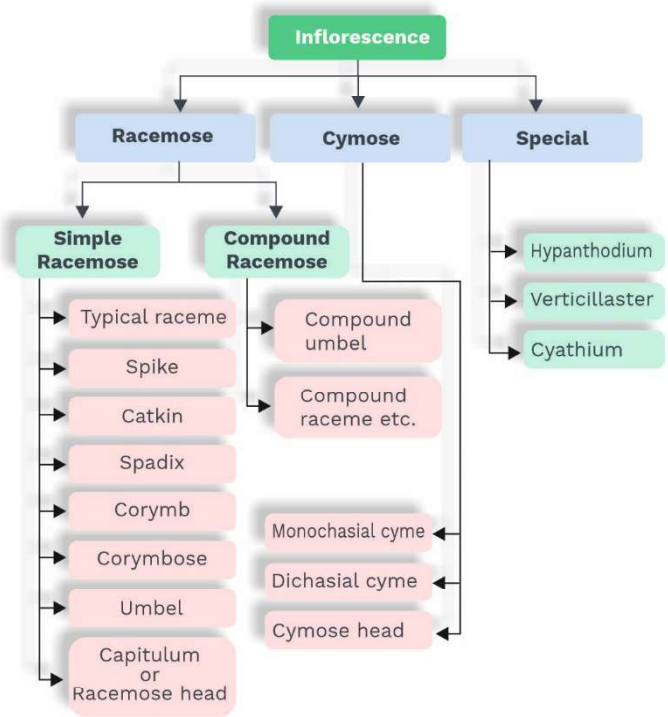
The arrangement and mode of distribution of flowers on a floral axis or peduncle is called inflorescence.

- The flowers are borne either singly or in clusters on a plant.
- Flowers that are borne singly are called **solitary.**
- A solitary flower developed at the tip of a branch or main stem is described as solitary terminal, e.g., *Papaver* (poppy), *Rosa* (rose),
- A solitary flower borne in the axil of a leaf is called solitary axillary, e.g., *Hibiscus* (shoe flower), garden nasturtium etc.

Types of Inflorescence

Depending upon the mode of branching of peduncle:

Racemose, Cymose, Mixed and Specialised inflorescences.



Gray Matter Alert!!!

Longest Inflorescence— *Agave* (12m), *Amorphophallus* (5.5m)

Definition

Inflorescence: The arrangement and mode of distribution of flowers on a floral axis or peduncle is called inflorescence.

Keywords

- Inflorescence
- Racemose
- Cymose
- Acropetal
- Centripetal

RACEMOSE INFLORESCENCE

- The peduncle is of **indefinite** growth due to the presence of an active growing point.
- Flowers in an **acropetal** order (i.e., older towards base and younger towards apex).
- If the peduncle is reduced, the flowers are borne in the **centripetal** manner (i.e., older towards the periphery and younger towards centre).
- Racemose inflorescence is of two types— simple and compound.

Definition

Racemose Inflorescence: Inflorescence with indefinite growth that bears the flowers in acropetal succession.

A. Simple Racemose Inflorescence

In this type of inflorescence, the peduncle is unbranched and flowers are borne directly on it. Few simple racemose inflorescences are as follows:

1. **Typical raceme:** An unbranched, elongated peduncle bears pedicellate (Stalked) flowers in an acropetal order, e.g., *Delphinium* (Larkspur), *Lupinus* (Lupin), *Delonix* (Gulmohar), etc.
2. **Umbel:** The peduncle is short or reduced, which bears a cluster of pedicellate flowers of equal length arising from a common point in a centripetal manner. An involucre or a whorl of bracts is often present at the base of flowers, e.g., *Centella* (Brahmi booti), *Androsace.*
3. **Capitulum or Racemose head:** The products are somewhat flattened to form a **receptacle** that bears sessile flowers called florets. The florets are arranged in centripetal manner (*i.e.,* younger towards the centre and older towards the periphery). The inflorescence is surrounded by one or more whorls of bracts called **involucre**. Capitulum inflorescence is a characteristic of the members of family Compositae. Capitulum inflorescences are of two types – **homogamous** (bearing only one type of

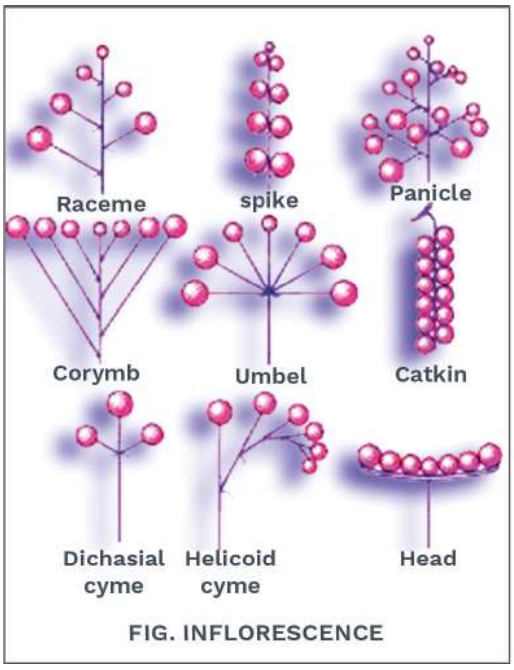


FIG. INFLORESCENCE

florets, e.g., *Sonchus, Ageratum, Tagetes, Chrysanthemum,* etc.) and **heterogamous** (bearing two types of florets i.e., ray florets in the periphery and disc florets in the centre. *e.g., Helianthus, Zinnia* etc.).

B. Compound Racemose Inflorescence

In these types of inflorescences, the peduncle is branched in racemose fashion and ultimate branches bear flowers in acropetal or centripetal manner. Following are the main types of compound racemose inflorescences:

Compound Umbel: Several small umbels are borne at a common point in an umbellate fashion. Compound umbel is characteristic of family *Umbelliferae,* e.g., *Coriandrum* (Coriander), *Foeniculum vulgare* (Fennel), *Daucus carota* (Carrot).

Rack your Brain

What is the basic difference between racemose and cymose inflorescence ?

CYMOSE INFLORESCENCE

- The growth of the peduncle is **definite**.
- The tip of the main axis terminates in a flower.
- Growth of the axis continues by the formation of one or more lateral branches, which also behave like the main axis.
- The arrangement of flowers is either **basipetal** or **centrifugal**.
- The important types of cymose inflorescence are as follows:

Definition

Cymose Inflorescence:
Inflorescence with floral axis of definite growth that bears the flowers in basipetal succession.

1. Monochasial cyme (Uniparous cyme)

- The main axis terminates in a flower.
- A single lateral branch develops from its base which also ends in a flower.
- This pattern is repeated a number of times.
- The peduncle is formed by the fusion of axillary branches and the main axis.
- It is therefore called **sympodial axis**.
- The axis normally becomes a bit straight exhibiting the flowers opposite the bracts.

Special Inflorescences

These are highly modified and densely crowded inflorescences, which need special mention. The main types of special inflorescences are as follows :

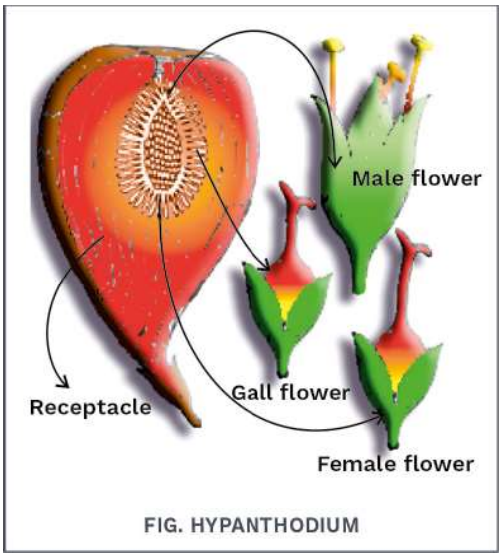


FIG. HYPANTHODIUM

1. Hypanthodium

- The main floral axis forms a cup-shaped receptacle with a small opening at the top.
- Internally the receptacle bears small sessile, unisexual flowers in cymose groups.
- The staminate flowers are borne near the opening, whereas pistillate flowers are borne towards the base.
- Sterile flowers or hair lie between the two types of flowers.
- Hypanthodium is a characteristic inflorescence of genus *Ficus* of the family Moraceae e.g., *Ficus benghalensis* (Banyan tree), *Ficus religiosa* (Peepal), *Ficus carica* (vern. *Anjeer*)

2. Verticillaster

- The peduncle bears bracts in opposite decussate manner.
- In the axil of each bract, a dichasial cyme develops that changes into a monochasium.
- The axis is greatly condensed, so the flowers appear in clusters axillary in position.
- Axillary clusters give the appearance of whorl or **verticel**.
- The verticels are arranged in acropetal manner on the main floral axis.
- A characteristic inflorescence of family Lamiaceae, e.g., *Ocimum basilicum* (Sweet basil), *Ocimum sanctum* (Sacred basil, Tulsi), *Salvia* etc.

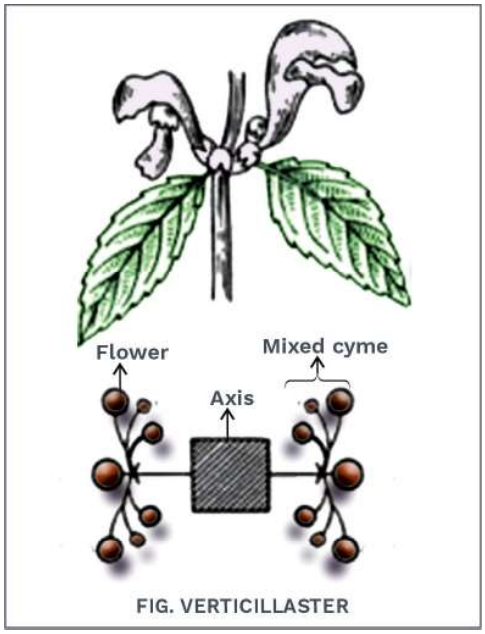


FIG. VERTICILLASTER

3. Cyathium

- In this inflorescence, the involucre forms a cup-shaped receptacle which is provided with nectar glands.
- The receptacle bears a single central pedicellate female flower which is naked (without perianth).
- A large number of pedicellate naked male flowers are arranged centrifugally around the female flowers.
- Each male flower is represented by only a single stamen.
- The inflorescence is so much compacted that it looks like a single flower.
- Cyathium is a characteristic inflorescence of genus *Euphorbia* and *Poinsettia.*

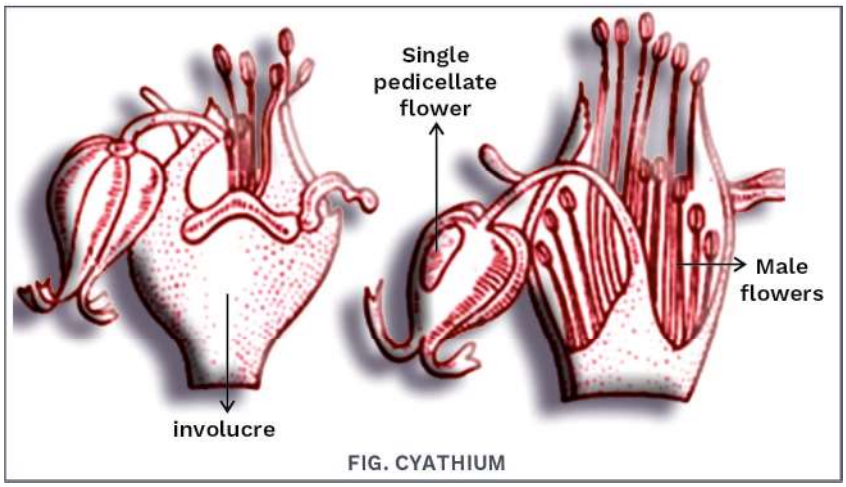


FIG. CYATHIUM

FRUIT

It is a ripened ovary.

TYPES OF FRUIT

Depending on the parts of flower that participate in fruit formation:

- True fruit
- False fruit
- Parthenocarpic fruits

1. True Fruit (Eucarp)

It develops from only the ovary part of a flower and contains one or more viable seeds, e.g., Mango, maize, brinjal etc.

2. False Fruit (Pseudocarp)

It develops from the ovary along with adjoining accessory floral parts (like sepals, petals, thalamus etc.) and contains one or more viable seeds for *e.g.,* Apple, Fig etc.

False fruits are also called spurious fruits or accessory fruits.

3. Parthenocarpic Fruit

- In some plants, fruits can be formed without fertilisation and are called parthenocarpic fruits.
- The phenomenon of formation of a parthenocarpic fruit is called as parthenocarpy.
- Parthenocarpic fruits are either seedless or contain aborted ovules or non-viable seeds. Most cultivated varieties of banana and grapes are parthenocarpic.

Depending upon the number of ovaries and the flower involved in the formation:

1. Simple Fruits

A fruit that develops from a flower having single ovary having monocarpellary or polycarpellary syncarpous pistil.

Depending upon the nature of pericarp (fruit wall), simple fruits are of two types – Dry and Succulent.

(A) Simple Dry Fruits: In these fruits, the pericarp (fruit wall) is dry, usually papery or woody and is not distinguishable into three layers. Simple dry fruits are of three kinds – **Achenial, Schizocarpic, Capsular.** For example, *Zea mays* (Maize), *Triticum* (Wheat), Water chestnut, Cashewnut. In Litchi, *Arachis* (Groundnut). *Pisum* (Pea), *Brassica* (Mustard), *Datura*, Ladyfinger.

(B) Simple Succulent Fruits

In these fruits, either only the pericarp or pericarp along with associated parts becomes fleshy.

The pericarp is distinguishable into three parts in simple succulent fruits:

- Outer Epicarp
- Middle Mesocarp
- Inner Endocarp

Definition

Pomology: The branch of horticulture that deals with the study of fruits and their cultivation.

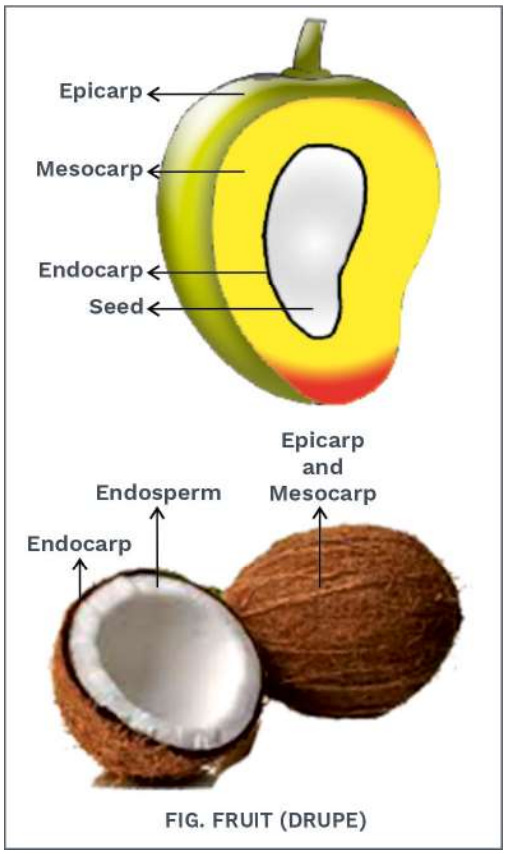
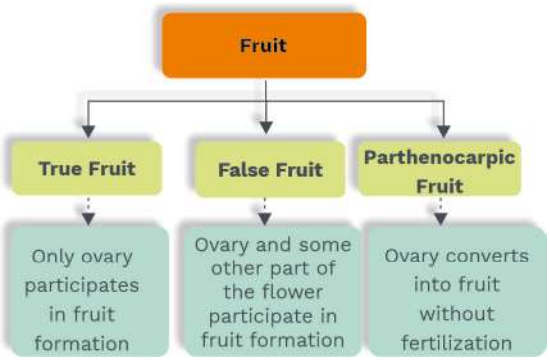


FIG. FRUIT (DRUPE)



Types of Simple Succulent Fruits

- Berries
- Drupes
- Pomes

1. (a) Berries

- Epicarp is thin or leathery.
- Mesocarp is massive and prominent.
- Endocarp is either membranous (e.g., Date, *Citrus)* or pulpy (e.g., Tomato, brinjal, grape, banana, guava).
- Seeds become free from placenta and lie freely in the pulp.

(b) Hesperidium

- Special Berry especially in citrus fruits such as lemon, orange etc.
- Epicarp and mesocarp are fused together to form a leathery skin.
- Endocarp folds inward forming distinct chambers or loculi with juicy hair.
- Seeds are within the loculi in juicy hairs.

(c) Pepo

- False berry
- Epicarp fused with thalamus.
- For example, fruits of cucurbits viz. Cucumber, Gourd, Melon etc.

2. Drupe (Stony fruits)

Pericarp differentiated into an outer peel epicarp, a middle fleshy or fibrous mesocarp and an inner hard or stony endocarp.

The endocarp usually encloses only one seed, e.g., mango, cherry, peach, plum, almond, coconut etc.

3. Pome

- It is a pseudocarp (false fruit) that develops from an inferior ovary of a compound pistil.
- The thalamus becomes fleshy and forms

Previous Year's Question

Which of the following is a true fruit?

(1) Banana (2) Fig
(3) Apple (4) Pear

Gray Matter Alert!!!

In parthenocarpic fruits, the seed factor (stimulus) for fruit growth is provided by the tissue of the ovary wall itself.

Previous Year's Questions

Edible part of mango is-

(1) Endocarp (2) Receptacle
(3) Epicarp (4) Mesocarp

Rack your Brain

What is the technical term for the milky water of coconut ?

the bulk of edible part.

- The pericarp forms a central semi-hard cartilaginous area that encloses the seeds, e.g., Apple, Pear etc.

2. Aggregate Fruit

An aggregate fruit is a group of fruitlets, which develops from a flower having monocarpellary apocarpous (free) gynoecium.

(i) Etaerio of Achenes, e.g., Strawberry, Lotus etc. In strawberry, the edible part is fleshy thalamus.

(ii) Etaerio of Berries, e.g., *Annona* (Custard apple).

(iii) Etaerio of Drupes, e.g., *Rubus* (Raspberry and Blackberry).

Gray Matter Alert!!!

Etaerio: Term used for aggregate fruit.

3. Composite or Multiple Fruits

A composite or multiple fruits develop from an entire inflorescence.

Such fruit is composed of several closely associated fruits (which may or may not be fused) along with its peduncle.

Composite fruits are thus, pseudocarps.

Such fruits are also called infructescence fruits.

Composite fruits are of two main types: Sorosis and Syconus.

(i) Sorosis: The fruit develops from a catkin or a spike e.g., Mulberry, Pineapple, Jack fruit.

(ii) Syconus: The fruit develops from hypanthodium type of inflorescence where the receptacle becomes fleshy, e.g., *Ficus carica* (Fig, vern. *Anjeer*), *Ficus religiosa* (Peepal).

Rack your Brain

Name the plant growth regulator that helps in developing seedless watermelons.

FUNCTIONS OF FRUIT

1. Fruits provide a protective cover to the developing seeds and protects the immature seeds against unfavourable climatic till maturity
2. Fruits help in dispersal of seeds that is of great biological significance.

Gray Matter Alert!!!

Artocarpus heterophyllus is a jackfruit

SEED

- A true seed is a mature ovule that contains an embryo or miniature plant, stored food material and protective coverings.
- In most of the plants, the embryo ceases to grow immediately and lies dormant for one or more seasons, within the seed. Seed dormancy in most of the plants remains till they receive adequate sunlight, temperature, water and air. This phenomenon of seed dormancy has given several advantages for survival to the seed plants.
- Thus, the seed represents a stage between the beginning and end of plant growth.

Definition

Seed: It is a ripened ovule that helps in continuity of species.

Gray Matter Alert!!!

The morphology of seeds and fruits is an important criterion for classification and phylogeny of the plants.

STRUCTURE OF SEED

Dicotyledonous seed (non-endospermic seed)

GRAM SEED

Parts of gram seed

- Seed Coat
- Cotyledons
- Embryonic axis

Seed Coat: The gram seed coat has two integuments surrounding the ovule. Seed coat is protective in nature.

Testa: It is the outer seed coat and is leathery, thick and brown in colour.

Tegmen: It is the inner coat that is thin, white, and often inseparable from the testa

Hilum: It is a scar on the seed coat through which the developing seeds are attached to the fruit.

Micropyle: It is the opening in the integuments and is visible in gram seed. Water is absorbed through the micropyle during the germination of seed.

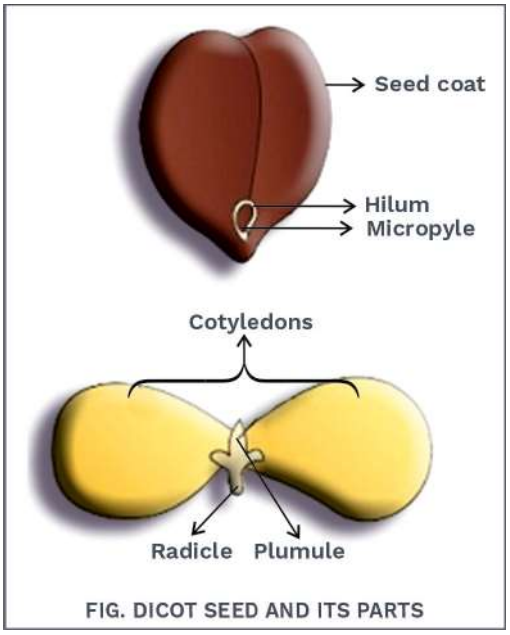


FIG. DICOT SEED AND ITS PARTS

Cotyledons

- When the seed coats are removed, the large **embryo** becomes visible. The bulk of it consists

of a pair of fleshy structures called **cotyledons** in dicot seeds.

- In gram seed, the cotyledons store food (carbohydrates and proteins) and provide nourishment to the developing embryonal axis. They lack endosperm.
- Such seeds are also found in many other plants such as groundnut, pea, mustard etc.

Embryonic axis

- The cotyledons are attached laterally to the embryonal axis.
- Embryonic axis has two parts – the **radicle** or the embryonic root and the **plumule** or the shoot tip.
- The radicle is outside the cotyledons and points towards micropyle.
- The plumule is seen only after separating the two cotyledons. The plumule or the shoot tip is enclosed within the first pair of small, folded true leaves.
- The region of the embryonal axis between the radicle and the point of attachment of the cotyledons is called **hypocotyl** (below the cotyledons), whereas the portion between the plumule and cotyledons is termed **epicotyl** (above the cotyledons).
- In the gram seed, epicotyl elongates rapidly when the seed germinates.

Monocotyledonous seed (endospermic seed or albuminous seed)

MAIZE GRAIN

A maize grain is not a seed, but a single-seeded fruit called caryopsis or grain, in which the pericarp (fruit wall) is inseparably fused with testa.

Rack your Brain

An aggregate fruit develops from which type of ovary?

Previous Year's Question

Endosperm is consumed by the developing embryo in the seed of
(1) Pea
(2) Maize
(3) Coconut
(4) Castor

Gray Matter Alert!!!

Endospermic Dicot Seeds: In many plants such as Castor bean, Rubber and Coconut, food is mostly stored in the endosperm. Such seeds are called endospermic or albuminous seeds.

The internal structure of the grain in longitudinal section shows the following parts:

- **Pericarp:** On the outer side, a single covering called pericarp and testa are found.
  Inner to pericarp, the grain is divided into two unequal portions: Endosperm and Embryo.
- Endosperm: The upper half of the grain is made up of massive **endosperm**.
  The bulk of endosperm is laden with starch, but its outer layer next to the grain coat contains abundant protein. It is called **aleurone layer**.
  Proteins present in this layer help in the synthesis of some enzymes, needed for germination of the grain.
- Embryo: The lower half of the grain is occupied by the **embryo**.
  Maize embryo has a single cotyledon attached laterally to the embryonal axis.
  This cotyledon is called **scutellum**. The scutellum has a secretory epidermis, found in close contact with the endosperm. The epithelium helps the scutellum in absorbing the food material stored in the endosperm.
- Embryonic Axis: The portion of the embryonal axis below the cotyledon is the **radicle**. It is covered by a protective sheath called **radicle sheath** or **coleorhiza**.
  The upper end of the embryonal axis is the **plumule** surrounded by a protective sheath called **plumule sheath** or **coleoptile.**

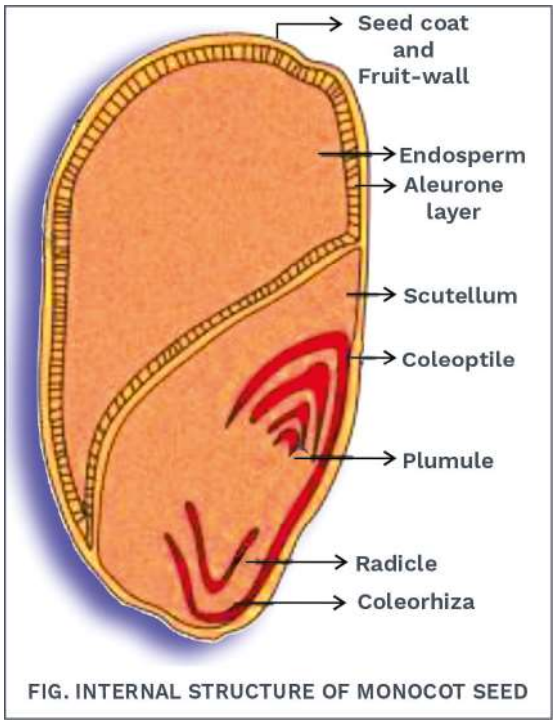


FIG. INTERNAL STRUCTURE OF MONOCOT SEED

TYPES OF SEEDS

Endospermic Seeds: Seeds that contain endosperm at maturity are called **endospermic** or **albuminous** seeds. Mostly monocot seeds are endospermic, except a few.

Non-endospermic Seeds: Seeds that do not contain endosperm at maturity are called **non-endospermic** or **ex-albuminous** seeds. Mostly dicot seeds are non-endospermic, except a few.

Keywords

- Plumule
- Radicle
- Epicotyl
- Hypocotyl
- Cotyledons

Previous Year's Question

Tegmen develops from
(1) Funiculus
(2) Chalaza
(3) Inner Integument
(4) Outer Integument

DIFFERENCES BETWEEN MONOCOTYLEDONOUS AND DICOTYLEDONOUS SEEDS

Monocotyledonous Seed	Dicotyledonous Seed
1. Pericarp and testa are fused	1. Pericarp is separate and seed coat is divided into testa and tegmen (seed integuments).
2. Single cotyledon is present in the embryo.	2. Two cotyledons are in the embryo of seed.
4. The embryo tips usually bear special sheaths i.e., coleoptile over plumule and coleorhiza over radicle.	4. Coleoptile and coleorhiza are absent.
5. Endosperm stores the food	5. The food may be stored inside the endosperm or cotyledons.

FAMILY 1. PAPILIONACEAE

Brief description

Root: Tap root, often have nitrogen-fixing bacteria forming roots nodules.

Stem: Herbaceous or woody, usually erect, sometimes climbing *(e.g., Lathyrus odoratus. L. aphaca, Pisum sativum,etc).*

Leaf: Alternate, often stipulate, stipules may become leafy pulvinate leaf base, pinnately compound or simple by suppression of leaflets.

Inflorescence: Variable, simple raceme, axillary cyme or solitary.

Flower: The flower may be sessile or pedicellate, bracteate or ebracteate complete or incomplete, unisexual or hermaphrodite, if unisexual, staminate or pistillate, zygomorphic or actinomorphic, hypogynous, perigynous

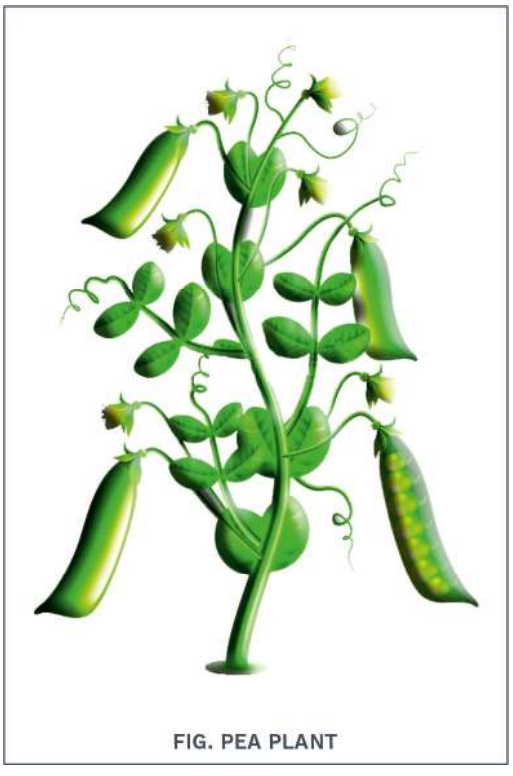
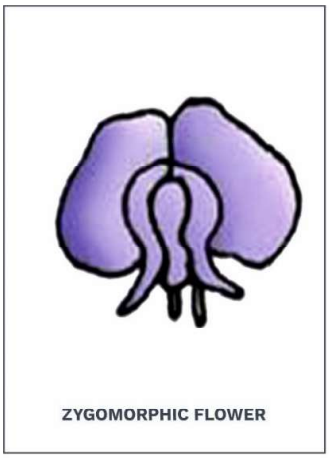
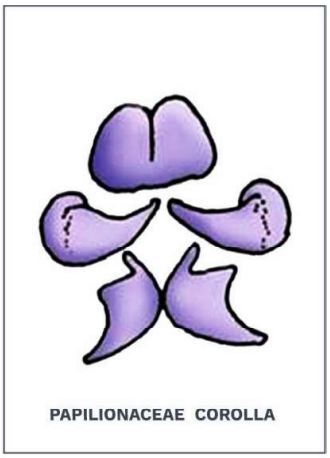


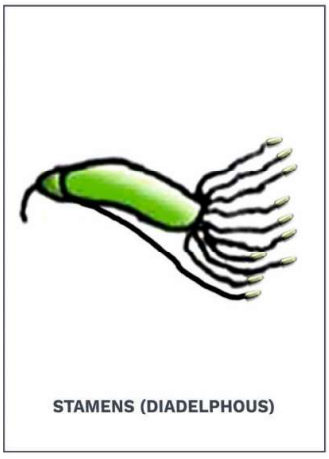
FIG. PEA PLANT



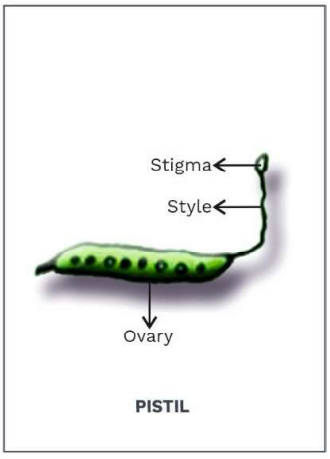
ZYGOMORPHIC FLOWER



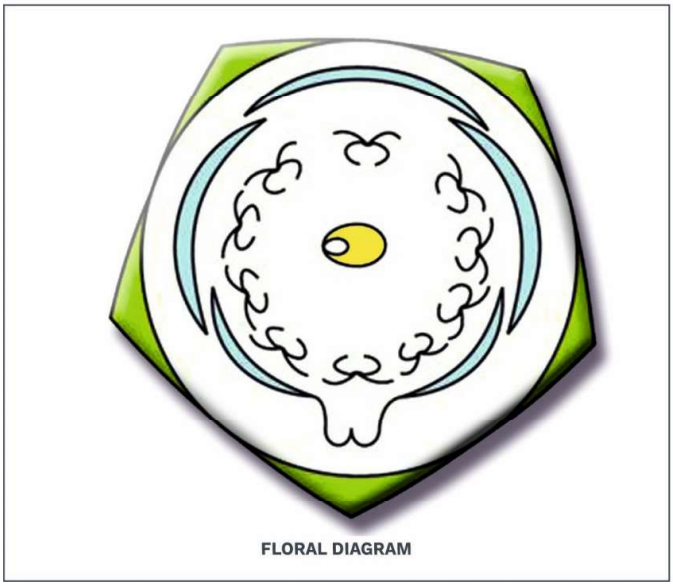
PAPILIONACEAE COROLLA



STAMENS (DIADELPHOUS)



PISTIL



FLORAL DIAGRAM

or epigynous, isomerous or heteromerous, if isomerous, tri-, tetra- or pentamerous.

Calyx: Sepals 5, gamosepalous, odd sepal anterior, often persistent.

Corolla: Petals 5, polypetalous, or gamopetalous, aestivation-descending or vexillary, imbricate, papilionaceous (butterfly-shaped) with five unequal petals – posterior largest petal called **standard** or **vexillum**, which overlaps two smaller lateral petals called **wings** or **alae.**
The latter overlap a boat-shaped structure called **keel** or **carina,** which is formed by two anterior petals fused slightly on the anterior side.

Androecium: Stamens 10, diadelphous 1 + (9) sometimes free, polyandrous, anther bithecous, basifixed.

Gynoecium: Monocarpellary, ovary superior, unilocular with marginal placentation, style bent, stigma simple and hairy.

Fruit: Legume (Pod).

Seed: Non-endospermic

Floral Formula:

$Br\ \%\ \male\ \female\ K_{(5)}\ C_{1+2+(2)}\ A_{(9)+1}\ \underline{G}_{1}$

Diagnostic Features

1. Presence of nodulated roots.
2. Leave alternate, stipulate, pulvinate, commonly pinnately compound.

3. Flower zygomorphic and papilionaceous.
4. Odd sepal, anterior in position.
5. Stamens 10, diadelphous or polyandrous.
6. Gynoecium monocarpellary, ovary unilocular with marginal placentation.
7. Fruit is a legume.

Economic Importance

1. **Food plants:** The most important food particles belonging to family Fabaceae are **pulses.** These pulses are rich in proteins and are an important constituent of our diet. The important pulses are *Pisum sativum* (Pea), *Cicer arientinum* (Gram), *Phaseolus mungo* (urd), *P. aureus* (Mung), P. *aconitifolius* (Moth), *Lens culinaris* (Masur), *Cajanus cajan* (Arhar), *Glycine max* (Soybean) etc. Unripe pods of *Dolichos, Lablab* (Bean), and *Cyamopsis tetragonoloba* (Guar) and young shoots of *Trigonella foenum-graecum* (Methi) and *Medicago* falcate (Kasuri methi) are used as vegetables. Seeds of *Arachis hypogaea* (Groundnut) are edible.
2. **Fodder plants:** Many plants like *Trifolium alexandrinum* (Berseem), *Medicago sativa*, *Cyamopsis tetragonoloba* etc., yield fodder for the cattle.
3. **Medicinal plants:** Roots of *Glycyrrhiza glabra* (Liquorice) are used in cough, bronchitis and urinary disorders. Flowers of *Trifolium pratense* (Red clover) are used in whooping cough. The gum of *Butea monosperma* (Dhak) and *Astragalus gummifer* is useful against dysentery and diarrhea. Flowers of *Alhagi pseudalhagi* (yavasaka) have laxative and diuretic properties. The fresh juice of *Abrus precatorius* (vern. Ratti) leaves is useful in leucoderma. The juice of *Sesbania grandiflora* (vern. *Agast*) flower is beneficial in improving eyesight.
4. **Fibre yielding plant:** *Crotalaria juncea* (Sunn hemp) yield bast fibre from the surface of stem, which is used for ropes, gunny bags etc.
5. **Timber yielding plants:** *Dalbergia sissoo* (Shisham) and *D. latifolia* (Kala shisham), provide timber for furniture, house buildings and agricultural implements.
6. **Dye yielding plants:** Formerly **Indigo** (a blue dye) was obtained from leaves of *Indigofera tinctoria, Dalbergia latifolia* (Indian rosewood) also yields a dye.
7. **Edible oil yielding plants:** Edible oils are extracted from the seeds of *Arachis hypogaea* (Groundnut) and *Glycine max* (soybean). Vegetable ghee is prepared out of the oils after hydrogenation.
8. **Ornamental plants:** *Lathyrus odoratus* (Sweet pea), *Clitoria*, *Lupinus,* etc. are common ornamental plants
9. **Some other useful plants:** Seeds of *Trigonella foenum-graecum* (Methi) are used as condiments, etc.

Previous Year's Question

Marginal placentation is found in—
(1) Pea
(2) Mustard
(3) China rose
(4) Brinjal

FAMILY 2. SOLANACEAE (potato family)

Brief description

Root: Taproot, often having N_2-fixing bacteria forming roots nodules.

Stem: Herbaceous or woody, often with bicollateral vascular bundles, hair or prickles often present, sometimes as underground tubers (e.g., *Solanum tuberosum*).

Leaf : Alternate or opposite, exstipulate, simple, rarely compound (e.g., *Solanum tuberosum, Lycopersicum esculentum*).

Inflorescence: Solitary or extra-axillary, scorpioid cyme.

Flower: Bracteate or ebracteate, pedicellate, complete, bisexual, regular, actinomorphic, hypogynous, pentamerous.

Calyx: Sepals 5, gamosepalous, campanulate, valvate or imbricate, often persistent, green,inferior.

Androecium: Stamens 5, polyandrous, epipetalous, anther bithecous, basifixed dehiscence longitudinal.

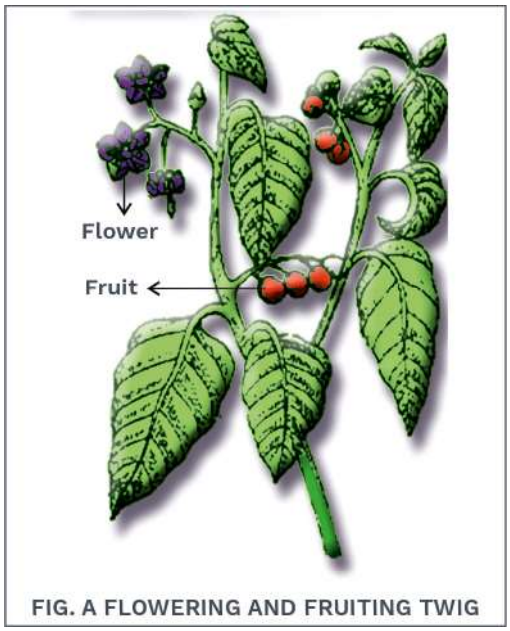


FIG. A FLOWERING AND FRUITING TWIG

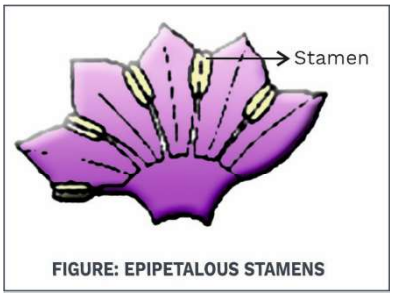


FIGURE: EPIPETALOUS STAMENS


FIG. A FLOWER

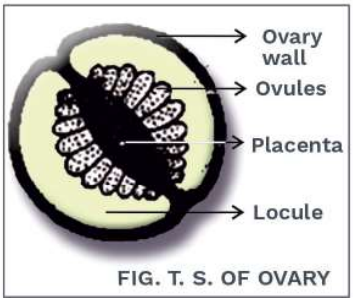


FIG. T. S. OF OVARY

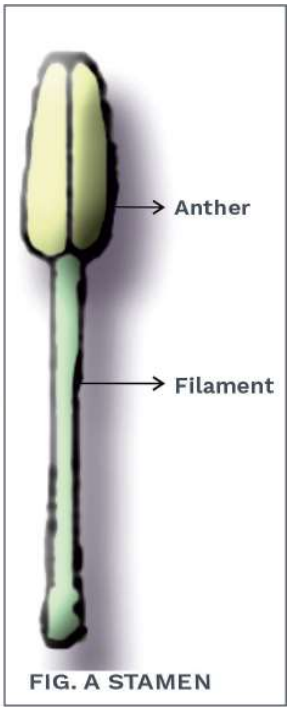


FIG. A STAMEN

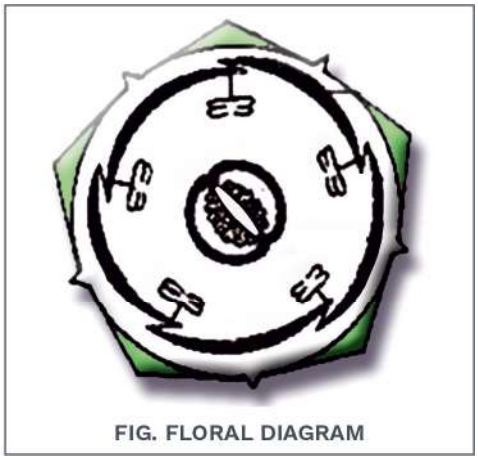


FIG. FLORAL DIAGRAM

Gynoecium: Bicarpellary, syncarpous, ovary superior, obliquely placed often with two nectaries at the base, bilocular, sometimes become tetralocular due to a false septum, placentation axile, swollen placentae, style long, stigma bifid.
Fruit: Berry or capsule.
Seed: Endospermic

Floral formula $\oplus\ \mathrm{Br}/\mathrm{Br}\ \oplus\ \varnothing\ \mathrm{K}_{(5)}\ \overset{\frown}{\mathrm{C}}_{(5)}\ \mathrm{A}_{5}\ \underline{\mathrm{G}}_{(2)}$

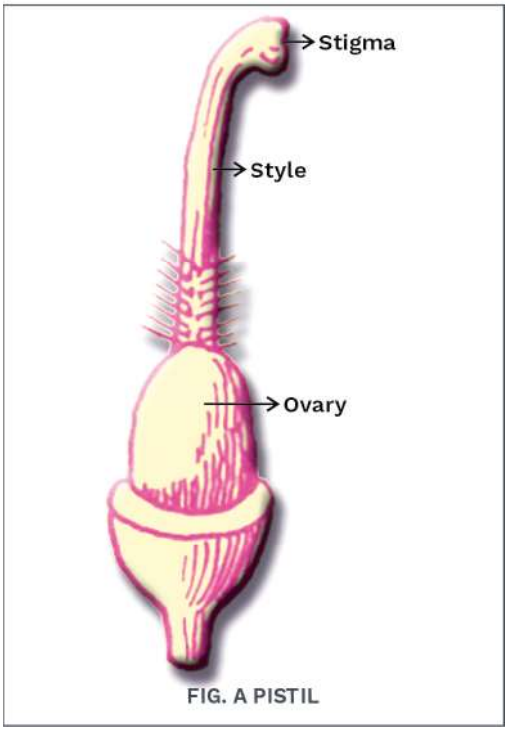


FIG. A PISTIL

Diagnostic Features

1. Aerial plant parts - hairy.
2. Leaves-alternate, opposite in floral region.
3. Calyx 5, gamosepalous, Persistent.
4. Corolla 5, gamopetalous.
5. Stamens - polyandrous and epipetalous
6. Gynoecium- bicarpellary syncarpous.
7. Ovary-superior and syncarpous
8. Placentation- axile with swollen placenta.
9. Fruit- berry or capsule

Economic Importance

1. **Food yielding plants:** *Solanum tuberosum* (Potato) is a common starch rich food source, used as vegetable. The fruits of *Solanum Melongena (Brinjal), Lycopersicum esculentum* (Tomato) and *Capsicum frutescens* (vern. Shimla Mirch) are used as vegetable. The dried fruits of *Capsicum annuum* (Chillies) are powdered and used as spice. *Physalis peruviana* (Raspberry) produces edible fruits.
2. **Medicinal plants:** A drug 'belladonna' obtained from *Atropa belladonna*, is used for relieving pain and checking cough. Another alkaloid '**Atropine'** is also obtained from the plant for dilating eye pupil. *Hyoscyamus niger* (vern. *Khursani Ajwain*) is used as sedative and hypnotic *Datura Stramonium* is used in asthma. Roots of *Withania somnifera* (vern.

Previous Year's Question

A family delimited by type of inflorescence is
(1) Fabaceae
(2) Asteraceae
(3) Solanaceae
(4) Liliaceae

Ashwagandha) and seed of *Solanum xanthocarpum* (vern. *Kateli*) are used medicinally.

3. **Ornamental plants:** *Cestrum nocturnum* (vern. Raat-ki-Rani), *Schizanthus* and *Petunia sp.* are grown as ornamental plants.
4. **Some other useful plants:** (i) Tobacco used in bodies, cigarettes and for chewing is obtained from the leaves of *Nicotiana tabacum (ii) Datura stramonium* yields a narcotic. (iii) Many plants such as *Solanum nigrum*, *S. xanthocarpum*, *Datura sp*. occur as a weed.

Family 3. Liliaceae (Lily family)

Brief description

Root: Usually adventitious, fibrous or fleshy (e.g., *Asparagus*).

Stem: Herbaceous or woody, modified into cladodes *(*e.g., *Asparagus, Ruscus)* or underground bulb, corm or rhizome. Stems of *Dracaena* and *Yucca* show anomalous secondary growth which is an exception in monocots.

Leaf: Radical or cauline, usually exstipulate or stipulate *(*stipules tendrillar *in Smilax).* Sessile with sheathing base. Leaves are cylindrical and fistular (e.g., *Asparagus, Ruscus*).

Inflorescence: Variable, compound raceme (e.g., *Asphodelus, Yucca*), Umbel (e.g., *Smilax*), Solitary terminal (e.g., *Tulip, Lilium*), Umbellate cymose head (e.g., *Allium*).

Flower: Bracteate, pedicellate, incomplete, bisexual, rarely unisexual *(*e.g., *smilax),* regular, actinomorphic, hypogynous and trimerous.

Perianth: Tepals 6 in two whorls of 3 each, gamo or polyphyllous, sepaloid, inferior.

Previous Year's Question

Pulses are obtained from—
(1) Fabaceae
(2) Asteraceae
(3) Poaceae
(4) Solanaceae

FIGURE: ONION PLANT

Androecium: Stamens 6 in two whorls of 3 each, sometimes only 3 *(*e.g., *Ruscus),* epiphyllous and antiphyllous, another dorsifixed or versatile, dehiscence longitudinal, inferior.

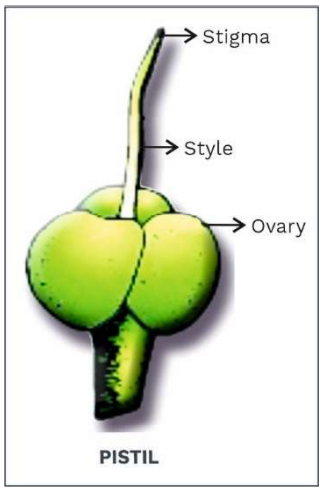
Gynoecium: Tricarpellary, syncarpous, ovary superior, trilocular, placentation axile, style simple, stigma trifid.

Fruit. Capsule or berry.

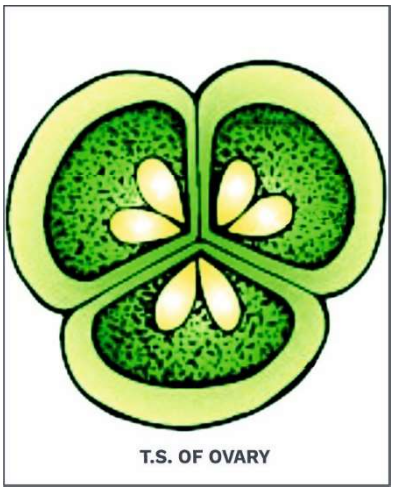
Seed. Monocotyledonous, endospermic.

Floral Formula $Br \oplus \, ♂ \, ♀ \, P_{(3+3)} A_{3+3} \underline{G}_{(3)}$

INFLORESCENCE

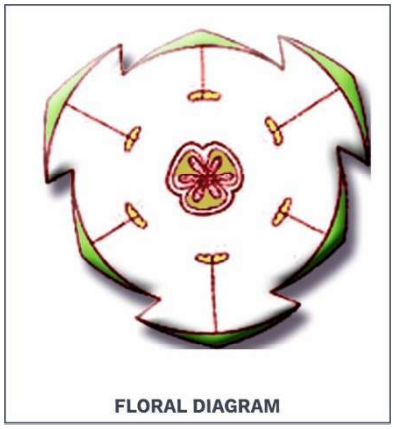


PISTIL

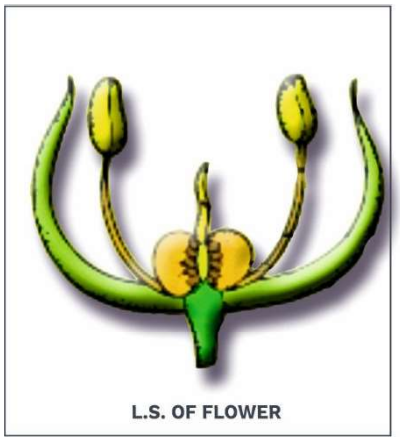


T.S. OF OVARY

FLOWER OF ONION



FLORAL DIAGRAM



L.S. OF FLOWER

Diagnostic Features

1. Plants are mostly perennial herbs.
2. Flower actinomorphic, hypogynous, trimerous.
3. Perianth six in two whorls.
4. Stamens six in two whorls, polyandrous, epiphyllous and antiphyllous.
5. Gynoecium tricarpellary syncarpous, ovary trilocular with axile placentation.
6. Fruit-generally a capsule

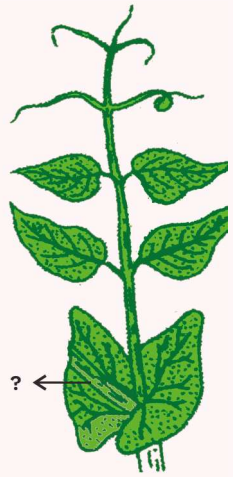
Economic Importance

1. **Food yielding plants:** The bulbs of *Allium cepa* (onion) and *A. sativus* (Garlic) are used as food and for flavouring the vegetables. Young shoots and fleshy roots of *Asparagus* (vern. *Shatavari*) are cooked as vegetable.
2. **Medicinal Plants:** The leaves of *Aloe barbadensis* are used to cure piles, liver troubles and boils. **Aloin**, a purgative is obtained from *Aloe vera*. A drug **'sarsaparilla'** obtained from the roots of *Smilax*, is used as blood purifier. Raw onion is useful in constipation, diarhoea and cholera. Dried corms of *Colchicum autumnale* (Meadow saffron) are used against rheumatism and gout. The bulbs of *Urginea maritima* are cardiac stimulant and diuretic.
3. **Ornamental Plants:** *Asparagus, Ruscus, Dracaena, Yucca, Aloe, Tulips, Gloriosa, Lilies, Smilax* etc. are grown in the gardens as ornamental plants.
4. **Some other useful plants:** *(i)Agave (Sisal), Yucca gloriosa and Phormium tenax* are fibre yielding plants. *(ii)* Rat poison is prepared from the bulbs of *Urginea maritima* (Red Squill) and *Scilla*. *(iii) Colchicum autumnale* yields a drug 'Colchicine' which is used to induce polyploids.

Gray Matter Alert!!!

Anthology: Branch of Biology that deals with the study of flowers.

Rack your Brain

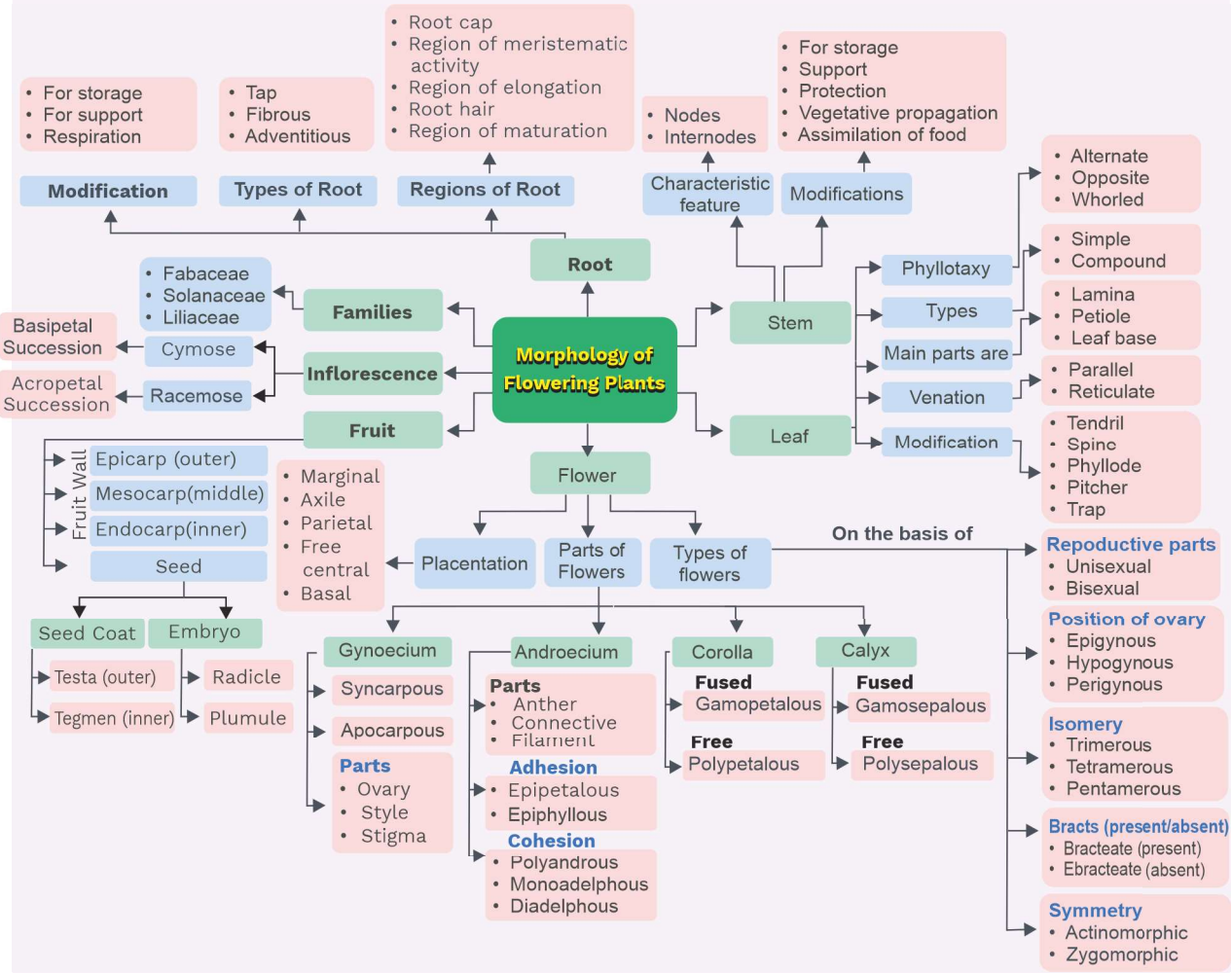


Identify the marked part of the given plant.

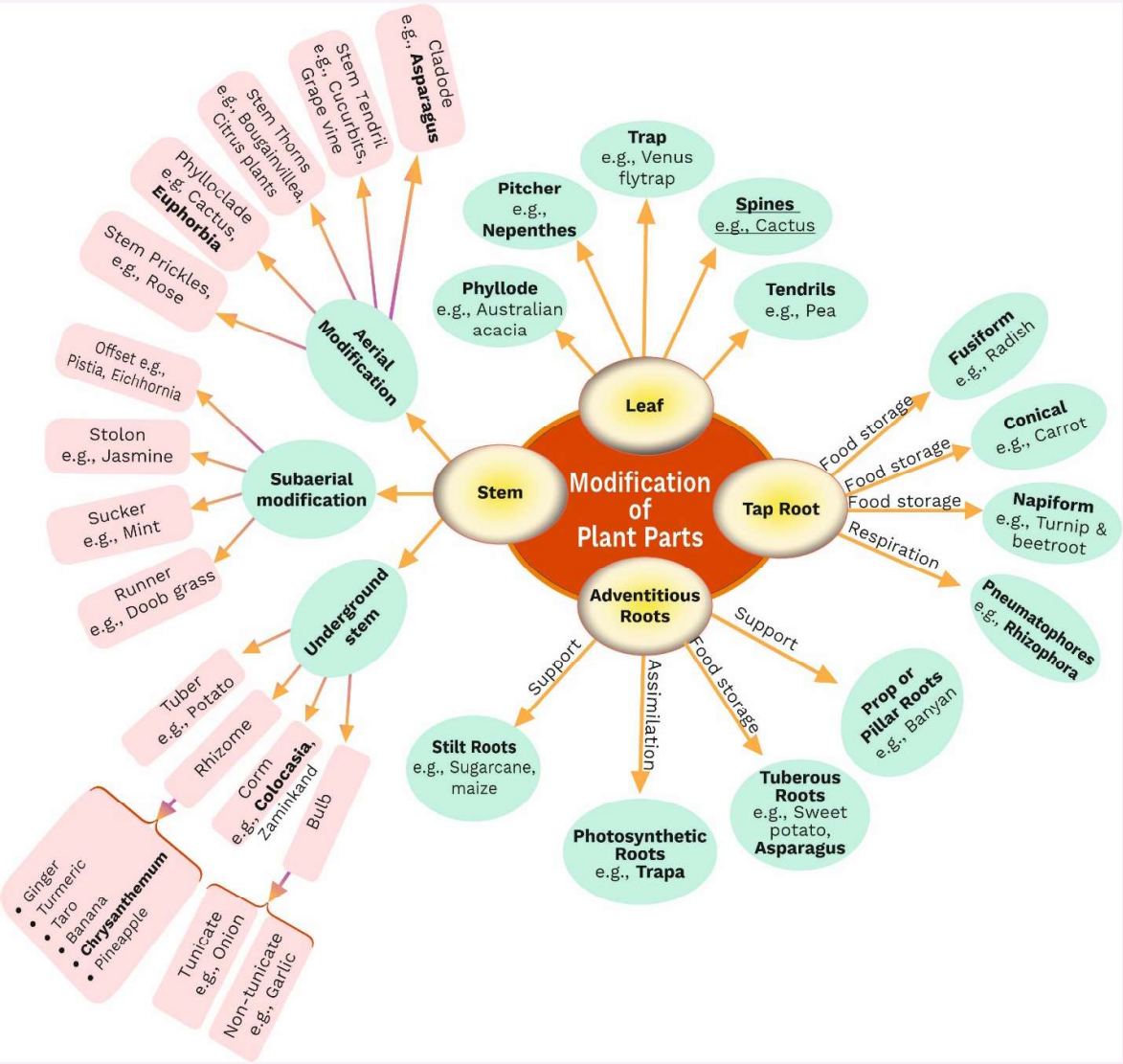
Gray Matter Alert!!!

Largest Seed
Lodoicea maldivica (Double coconut) the fresh weight of seed is about 6 kg.
Smallest Seed- *Orchid*

Summary


Morphology of Flowering Plants
Root
Modification
For storage
For support
Respiration
Types of Root
Tap
Fibrous
Adventitious
Regions of Root
Root cap
Region of meristematic activity
Region of elongation
Root hair
Region of maturation
Stem
Characteristic feature
Nodes
Internodes
Modifications
For storage
Support
Protection
Vegetative propagation
Assimilation of food
Phyllotaxy
Types
Main parts are
Venation
Modification
Alternate
Opposite
Whorled
Simple
Compound
Lamina
Petiole
Leaf base
Parallel
Reticulate
Tendril
Spine
Phyllode
Pitcher
Trap
Leaf
Families
Fabaceae
Solanaceae
Liliaceae
Inflorescence
Cymose
Basipetal Succession
Racemose
Acropetal Succession
Fruit
Fruit Wall
Epicarp (outer)
Mesocarp(middle)
Endocarp(inner)
Seed
Seed Coat
Testa (outer)
Tegmen (inner)
Embryo
Radicle
Plumule
Flower
Placentation
Marginal
Axile
Parietal
Free central
Basal
Parts of Flowers
Types of flowers
On the basis of
Gynoecium
Syncarpous
Apocarpous
Parts
Ovary
Style
Stigma
Androecium
Parts
Anther
Connective
Filament
Adhesion
Epipetalous
Epiphyllous
Cohesion
Polyandrous
Monoadelphous
Diadelphous
Corolla
Fused
Gamopetalous
Free
Polypetalous
Calyx
Fused
Gamosepalous
Free
Polysepalous
Repoductive parts
Unisexual
Bisexual
Position of ovary
Epigynous
Hypogynous
Perigynous
Isomery
Trimerous
Tetramerous
Pentamerous
Bracts (present/absent)
Bracteate (present)
Ebracteate (absent)
Symmetry
Actinomorphic
Zygomorphic

Summary


Modification of Plant Parts
Stem
Leaf
Tap Root
Adventitious Roots
Aerial Modification
Subaerial modification
Underground stem
Cladode e.g., Asparagus
Stem Tendril e.g., Cucurbits, Grape vine
Stem Thorns e.g., Bougainvillea, Citrus plants
Phylloclade e.g., Cactus, Euphorbia
Stem Prickles, e.g., Rose
Offset e.g., Pistia, Eichhornia
Stolon e.g., Jasmine
Sucker e.g., Mint
Runner e.g., Doob grass
Tuber e.g., Potato
Rhizome
Corm e.g., Colocasia, Zaminkand
Bulb
Ginger
Turmeric
Taro
Banana
Chrysanthemum
Pineapple
Tunicate e.g., Onion
Non-tunicate e.g., Garlic
Trap e.g., Venus flytrap
Pitcher e.g., Nepenthes
Spines e.g., Cactus
Phyllode e.g., Australian acacia
Tendrils e.g., Pea
Fusiform e.g., Radish
Conical e.g., Carrot
Napiform e.g., Turnip & beetroot
Pneumatophores e.g., Rhizophora
Prop or Pillar Roots e.g., Banyan
Tuberous Roots e.g., Sweet potato, Asparagus
Photosynthetic Roots e.g., Trapa
Stilt Roots e.g., Sugarcane, maize
Food storage
Food storage
Food storage
Respiration
Support
Food storage
Assimilation
Support

SOLVED EXAMPLES

Q1 **A root can be differentiated from a stem because of the absence of**
(a) Green colour (b) Nodes and internodes (c) Hair (d) Branches

A1 **(b)**
Roots do not bear nodes and internodes as this is a feature of stem.

Q2 **Which one of the following is not a characteristic of root?**
(a) Presence of root tip (b) Presence of unicellular hair
(c) Presence of chlorophyll (d) Absence of bud.

A2 **(c)**
Roots are underneath the soil, where no sunlight is found, thus chlorophyll is not found in roots.

Q3 **Which of the following underground fleshy structure is a stem?**
(a) Potato (b) Sweet potato (c) Turnip (d) Carrot.

A3 **(a)**
Potato is a modification of stem that stores food. Sweet potato, Turnip and carrot are modified roots.

Q4 **Phyllode is a modification of**
(a) Petiole (b) Bud (c) Flower (d) Root

A4 **(a)**
Phyllode is a xerophytic adaptation in which petiole/leaf is modified in order to reduce transpiration through leaves.

Q5 **Potato tubers are formed at the tips of**
(a) Lateral roots (b) Adventitious roots (c) Stolon (d) Primary roots

A5 **(c)**
Potato tubers are originated from stolon swelling.

Q6 **A stem modified into leafy structure is known as**
(a) Phyllode (b) Phylloclade (c) Tendril (d) Bulb

A6 **(b)**
Phylloclade is a modified stem that aids photosynthesis.

Q7 **Pitcher of *Nepenthes* is formed from-**
(a) Leaf base (b) Petiole (c) Lamina (d) Apex

A7 **(c)**
Pitcher of *Nepenthes* is a modified lamina.

Q8 **Cladode is**
(a) One internode, long phyllode (b) One internode, long phylloclade
(c) One internode, long thorn (d) One internode, long sucker

A8 **(b)**
Cladode is a long phylloclade with a single internode.

Q9 **Haustoria or sucking roots are found in**
(a) *Cuscuta* (b) Betel (c) *Orchid* (d) *Tinospora*.

A9 **(a)**
Cuscuta (Dodder plant) is a parasitic vine that invades the plant with sucking roots called as Haustoria.

Q10 **What do you eat in pea?**
(a) Fruit (b) Cotyledon (c) Entire seed (d) Fruit wall.

A10 **(c)**
Entire seed is edible in pea.

Q11 **Pineapple is an example of**
(a) An etaerio of berries **(b) An etaerio of drupes**
(c) A simple fleshy fruit **(d) A sorosis**

A11 **(d)**
Greek '*soros*'- means a heap, i.e., sorosis is a fleshy, multiple fruit, formed from flowers that are crowded together on a fleshy stem.

Q12 **A pome fruit is said to be false because**
(a) Its pericarp is inconspicuous **(b) Its endocarp is cartilaginous**
(c) Its actual fruit is located within an edible fleshy thalamus
(d) It develops from an inferior ovary.

A12 **(c)**
The Pome is developed from a ripened thalamus and hence is called as false fruits.

Q13 **Scutellum is a**
(a) Endosperm of gymnosperm **(b) Shield shaped cotyledon of monocot**
(c) Protective covering of radicle **(d) Protective covering of plumule**

A13 **(b)**
Scutellum is derived from Latin 'Scutella' meaning a small shield. It is an equivalent cotyledon of monocots.

Q14 **Epipetalous is a condition of**
(a) Placentation **(b) Stamen** **(c) Position of ovary**
(d) Aestivation of petal (CPMT 1991)

A14 **(b)**
Epipetalous is a condition in which the flower has androecium attached with the petals.

Q15 **The aleurone layer in maize grain is specially rich in**
(a) Auxin **(b) Proteins** **(c) Starch** **(d) Lipids**

A15 **(b)**
Aleurone layer in maize grain is specially, rich in protein.