

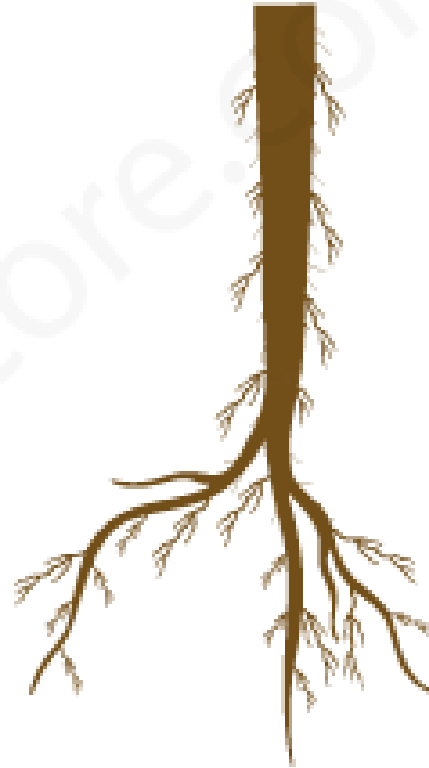
ROOT SYSTEM

In Monocots



Fibrous roots

In Dicots



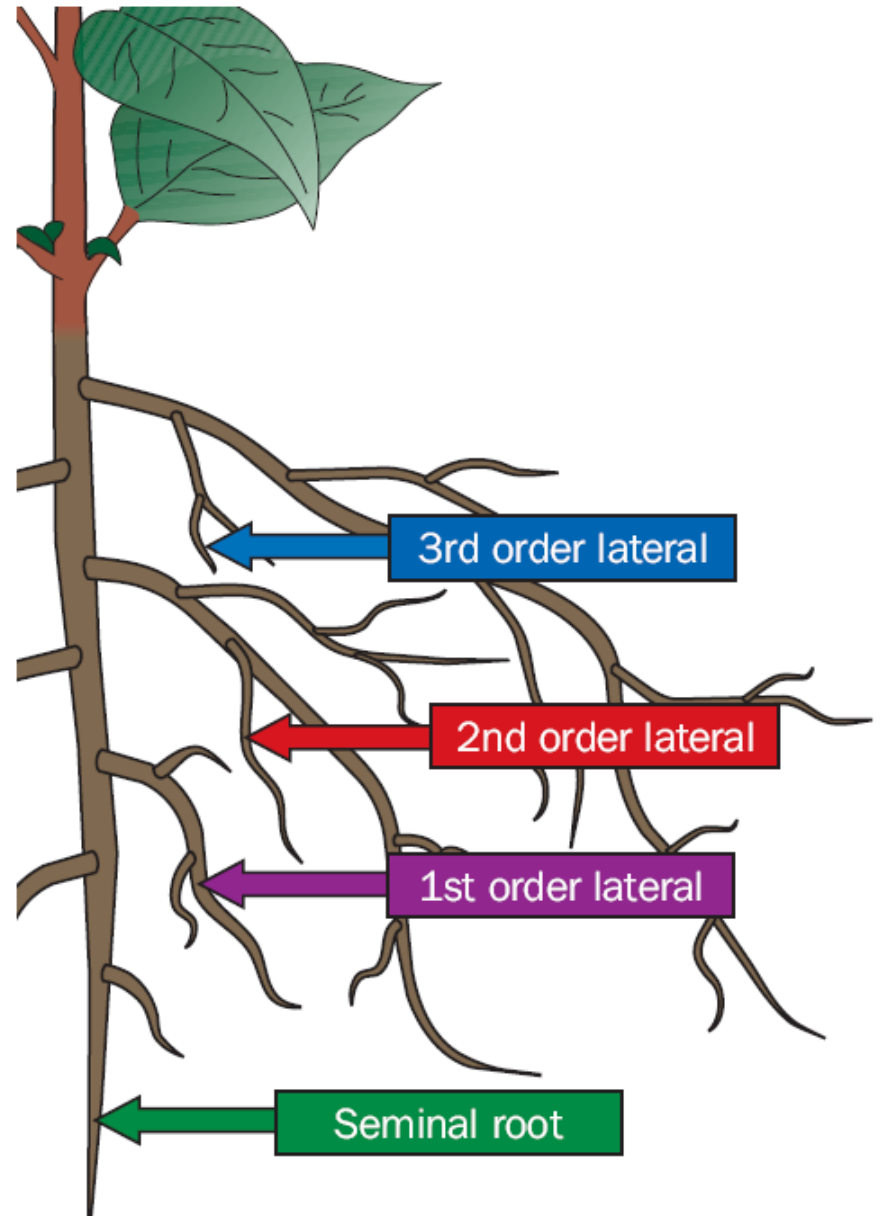
Tap roots

TYPES OF ROOTS

- The first structure to emerge from the germinating seed is a root called a ***radicle***.
- This root becomes the ***primary root***, and in most plants it is the most important root in the whole root system.

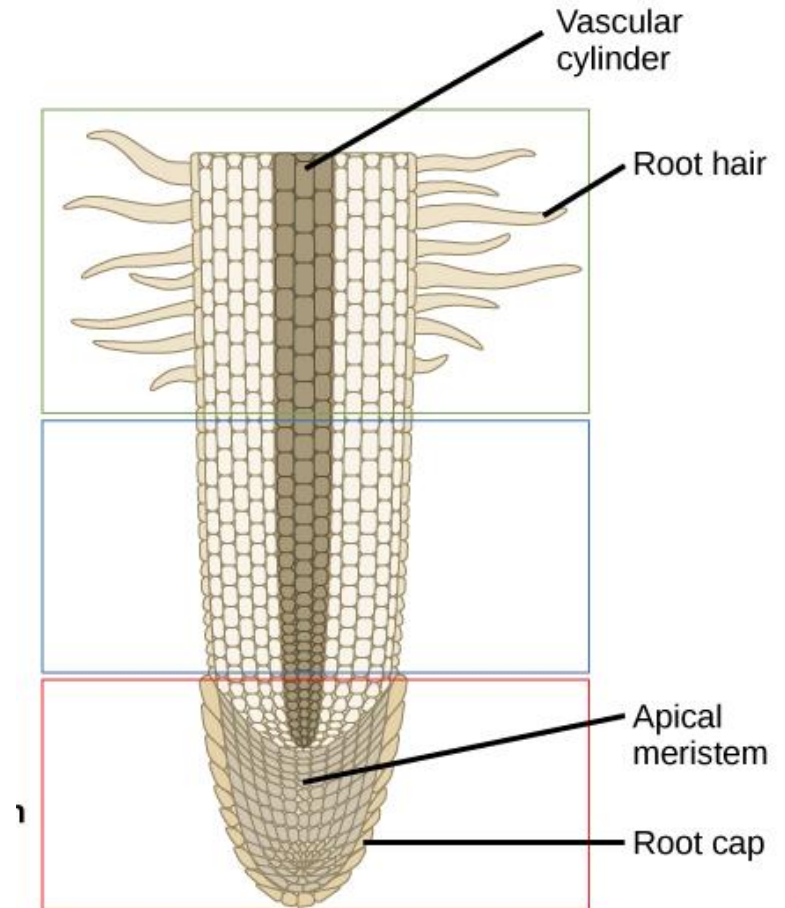


Other roots eventually branch out from the primary root. These are called secondary or *lateral roots*.



FOUR PARTS OF ROOT

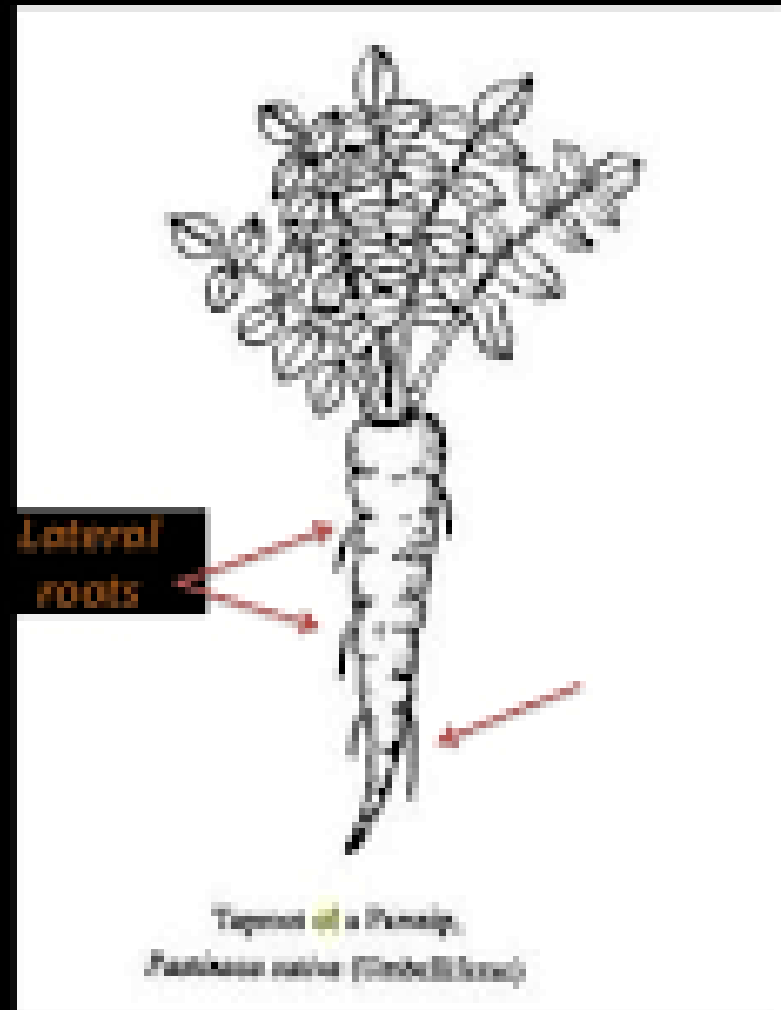
1. Root Apex – protected by calyptra.
2. Zone of elongation – mitosis, differentiation, enlargement, elongation
3. Zone of Maturation (Root hair Zone) – epidermis, cortex and vascular differentiation), root hairs develop
4. Permanent region – secondary, tertiary roots, branching roots



Types of roots

Tap root

- Generally found in dicotyledons
- Main or primary root develop from the radicle.
- Grows vertically down into the soil
- Later lateral or secondary roots grow from this at an acute angle outwards and downwards, and from these other branches may arise for absorption of water and nutrients.
- When tap root is associated with many branched roots, it forms the tap root system. e.g. *pastinaca sativa* (parsnip) and *taraxacum officinale* (Dandelion)



FIBROUS ROOTS

- Commonly found in monocots
- Growth of the radicle is usually arrested at an early stage and is replaced by numerous roots that develop from the stem.
- These adventitious roots are slender and equal in size.
- Adventitious roots associated with branched or lateral roots and form the adventitious root system.
- Also known as fibrous roots.



ADVENTITIOUS ROOTS

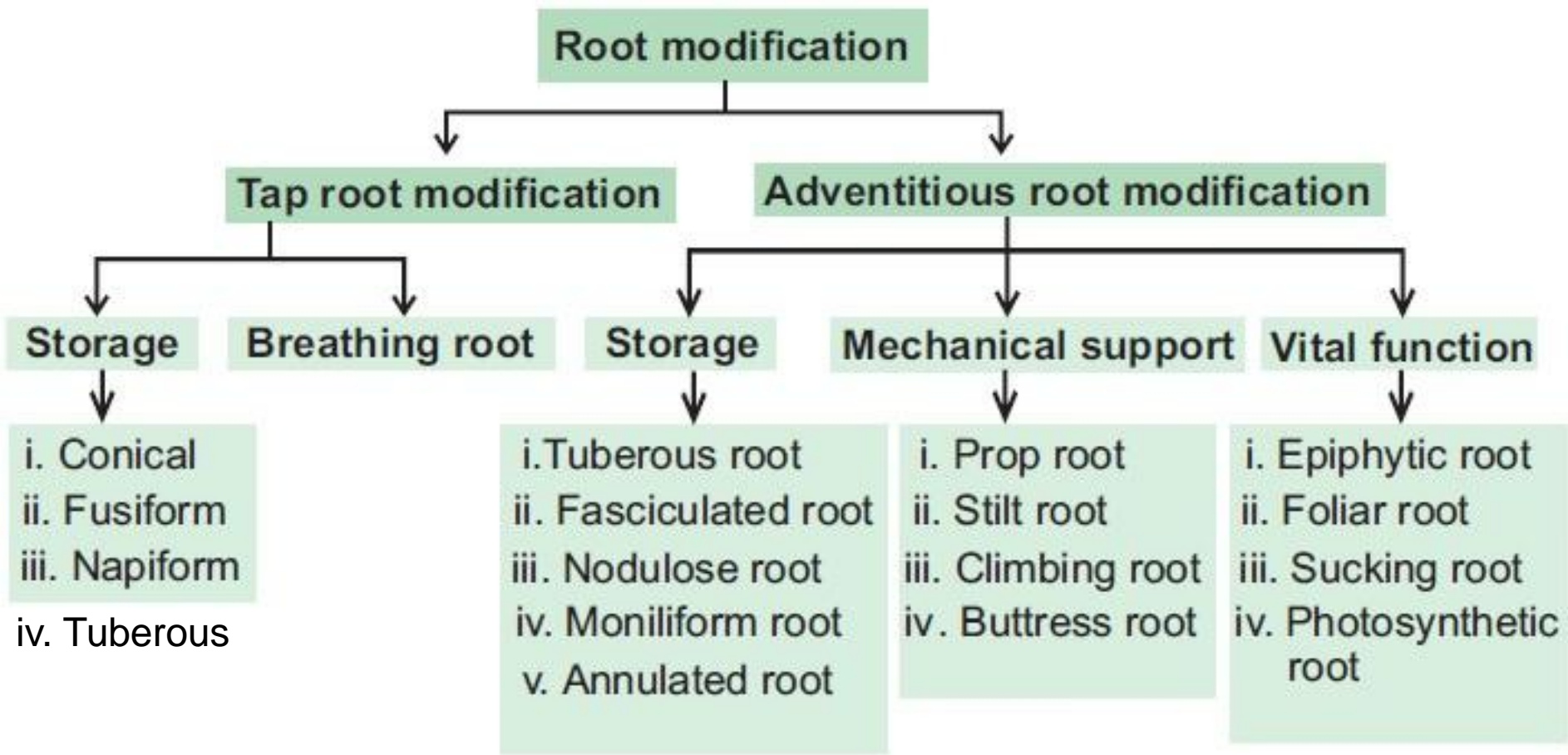
Roots from any part of plant other than radicle.

Eg. Potato, Banyan, Tapioca, Banyan, Pepper)

grow from
the [stems](#), [leaves](#), [nodes](#), [internodes](#),
etc. of the plant.

The formation of adventitious roots
increases the success rates of vegetative
propagation of certain plants.





TAP ROOT MODIFICATIONS

1. For Storage: (storage roots) - * store food prepared by the plants inside them.

*food is utilised by the plant for nutritional purpose during unfavourable environmental conditions.

*In storage roots, the cells of the primary taproot or the main root swell and start accumulating food particles. Due to the accumulation of food, such roots appear fleshy or swollen.

* the secondary or tertiary roots remain thin.

Based on the structure 4 types:

- **Conical** - primary root starts swelling from the base of the stem and gradually reduces towards the apex of the root.

One swollen end whereas the other end is tapered.

This fleshy taproot resembles the cone. Many thread-like secondary and tertiary roots arise throughout the length of the conical fleshy taproot. Eg: Carrot



- **Fusifform** - the primary root is tapered at both the ends; the ends being the base of the stem and the apex of the root. It appears like a spindle, thickest from the middle and narrow from the ends.

- tapering is present at both the ends. Eg: Radish

- Napiform** - very thick at the base of the stem and appears like a sphere.

- The swelling of the taproot occurs from the base of the stem but does not reduce gradually. The taproot tapers at the base of the root. Eg: Turnip, Beetroot



•**Tuberous Roots: -**

storage taproots which do not attain any particular shape.

A tuberous root is an enlarged fleshy root modified to store food.



2. For respiration:

Pneumatophores (Aerophores), Respiratory roots:-

- * aerial taproots which come out of the soil and help the plant to breathe.
 - found in mangroves or swampy areas.
 - The soil of the mangrove is clayey and sticky which does not allow the air to pass through it. Therefore, the roots of such plants come out of the soil for respiration.
 - *Pneumatophores grow vertically upwards.
show **negative geotropism**.
 - * The surface of the root contains small pore-like structures known as the l

neumathodes which help in the exchange of gases. The remaining surface of the root is covered by cork.
- Eg: Avicennia, Sonneretia



ADVENTITIOUS ROOT MODIFICATIONS

1. **For storage:** - Excess food prepared by plants stored for utilising during unfavourable conditions.

Based on the structure 4 types:

- * **Moniliform** – irregularly swollen the primary, secondary, and tertiary roots are swollen called ‘**root nodules**’ or ‘**tubercles.**’

These root nodules consist of millions of nitrogen-fixing bacteria of genus *Rhizobium*.

carries out nitrogen fixation.

exists a symbiotic relation

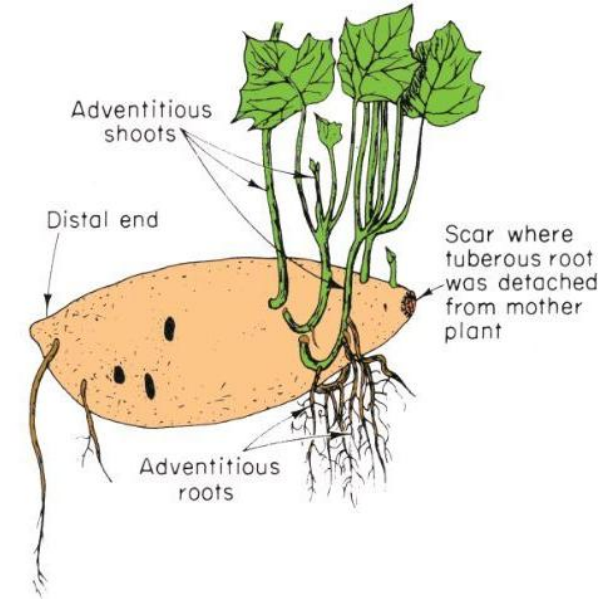
Eg: - Pea, Groundnut etc.



• **Tuberous** – fleshy, do not have any particular shape and often get swollen.

shoots sprout from one end while roots arise from the other end.

Eg; sweet Potato



• ***Fasciculated-** in the form of clusters.

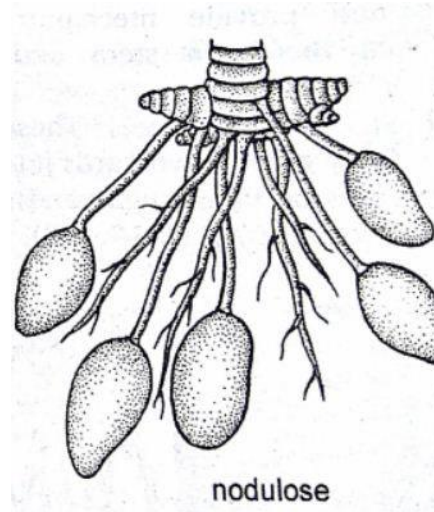
clusters arise from the base of the stem
Swollen in nature

Clustered together (Fasciculi), so the name.

Eg: Tapioca, Dahlia, Asparagus



* **Nodulose** - swollen at the apex or tips. They possess a characteristic shape.



* **Annulated-** a series of outgrowths, which resemble the shape of rings, are present on the body.

The series of these outgrowths looks like discs stacked one above the other.

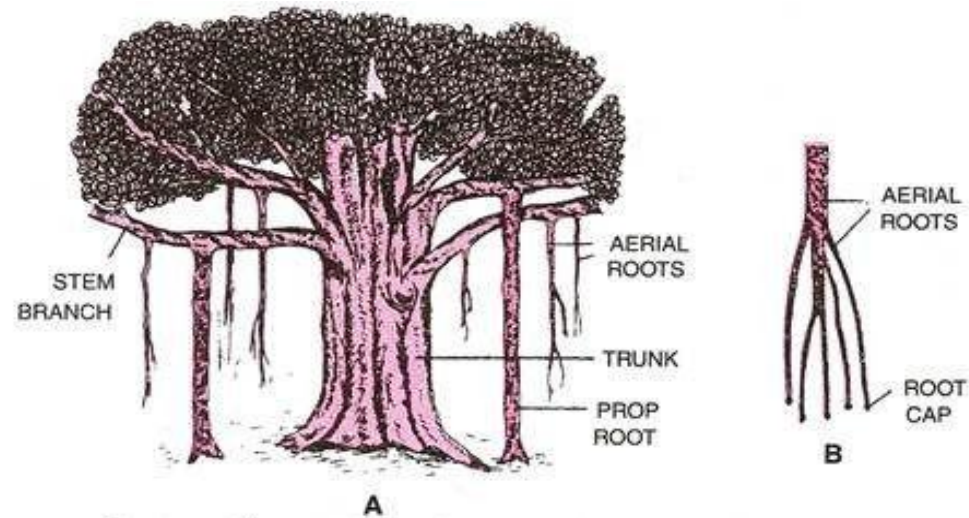
Eg: Ipecac (*Cephaelis ipecacuanha*)



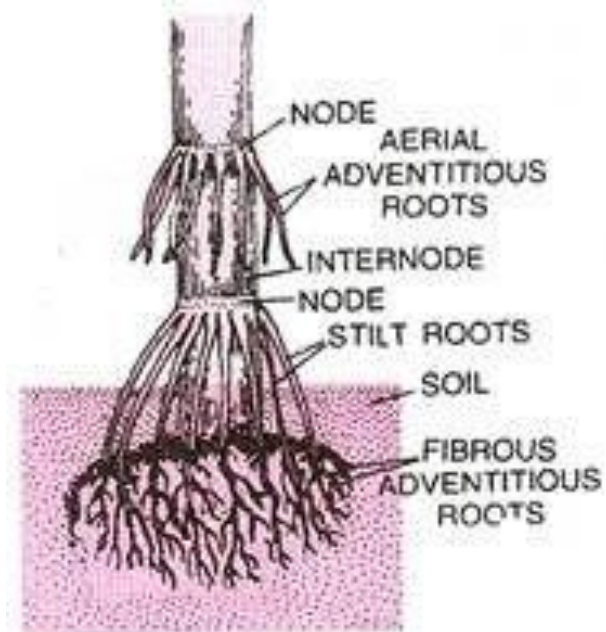
2. For mechanical support:

To give extra support for the plant
Provides better anchorage

- **Prop Roots** - grow downward from the branches of the trees.
- modified to support the thick and heavy branches.
- root caps on their tips.
- On reaching soil, become thick and pillar-like.
- even if the trunk dies, the tree as whole remains alive because the prop roots of the tree are supporting and nourishing the crown. Eg- banyan tree
- *** Stilt roots** - arise obliquely from the basal node of the stem, penetrate the soil.
- short but thick and support the plant.
- After penetrating the soil, they get modified into the fibrous roots and help in water and mineral absorption.
- Eg- Maize, sugarcane, mangroves



A, prop or pillar roots of *Ficus bengalensis* (banyan tree); B, hanging aerial roots.



Stilt roots of Maize.



Rhizophora

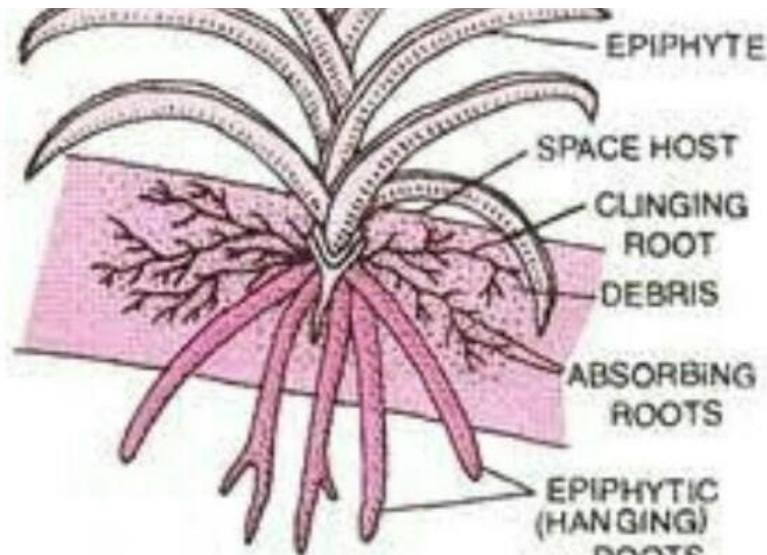
• **Climbing roots**- non-absorptive help the plant to remain adhered to the structure.

penetrate the cracks or fissures of the support and help the plant to climb.

Eg- Pepper

Clinging roots - climbing adventitious roots may also sprout from each node and get branched. Such types of climbing adventitious roots are known as clinging roots.

form claw, swell, or secrete sticky juice from their tips to hold the support firmly.



- **Buttress roots** - develop at the base of the stem and help in maintaining the structural integrity of the plant.

- basal part of the stem, which is vertically elongated, spreads in different directions in the soil.



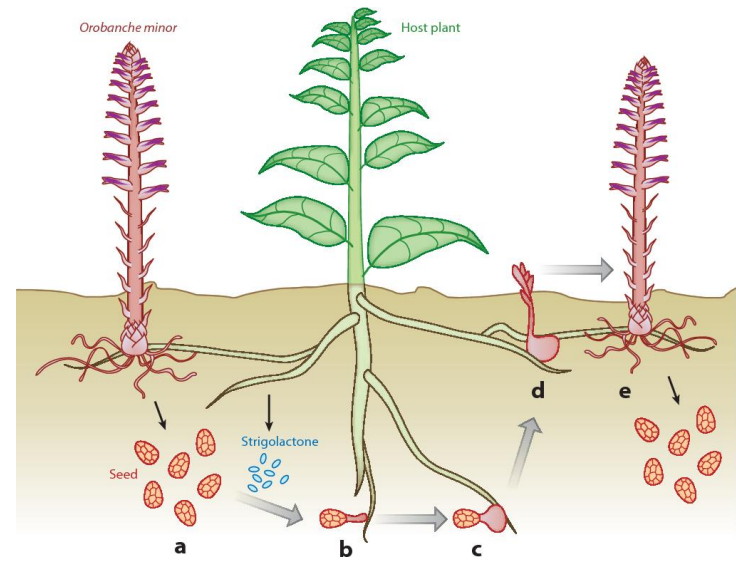
3. For nutritional purpose:

- **Haustoria** - absorb nutrients from the host, parasites develop microscopic roots which are known as sucking roots.

- found in non-green parasitic plants
- * sprout from the nodes and penetrate deep into the conducting tissue of the host to obtain nutrients.

- Eg- Cuscuta, Loranthus, Viscum, Striga etc.





- Velamen roots – (Epiphytic roots), Hygroscopic roots-**

- develop in some orchids which grow as epiphytes upon the trunks or branches of trees.

- They hang freely in the air and absorb moisture with the help of special sponge like tissue called velamen.

- Velamen is modification of epidermis. e.g., *Vanda*, *Dendrobium* etc.



- **Photosynthetic or Assimilatory roots** -

green, aerial, adventitious roots which prepare food materials by photosynthesis e.g., Taeniophyllum, Trapa and Tinospora

- In some epiphytes like *Taeniophyllum*, the stem and leaves are absent.

- The entire plant is represented by thin green, ribbon like roots which contain velamen. These roots absorb moisture from the atmosphere and manufacture food materials by photosynthesis.

- Since the roots are green and perform photosynthetic activity, these roots are called photosynthetic roots or assimilatory roots.





• **Floating Roots –**

- Jussiaea- spongy roots give buoyancy and help plant to float on the water surface.



Jussiaea repens

ROOT – FUNCTIONS & COMPARISON

Primary Functions:

- anchorage of the plant
- , absorption of water and dissolved minerals
- conduction of these to the stem
- and storage of reserve foods.

Secondary/ Accessory functions:

- * Gas exchange – Pneumatophores
- Climbing & clinging
- Moisture absorption by velamen
- Nutrients absorption – haustoria
- Photosynthesis – Assimilatory roots
- Mechanical support prop, stilt, buttress
- Hydrophytes – floatation

Comparison with stem:

- lacking leaf scars and buds
- having a root cap,
- having branches that originate from internal tissue rather than from buds.
(endogenous origin from pericycle)