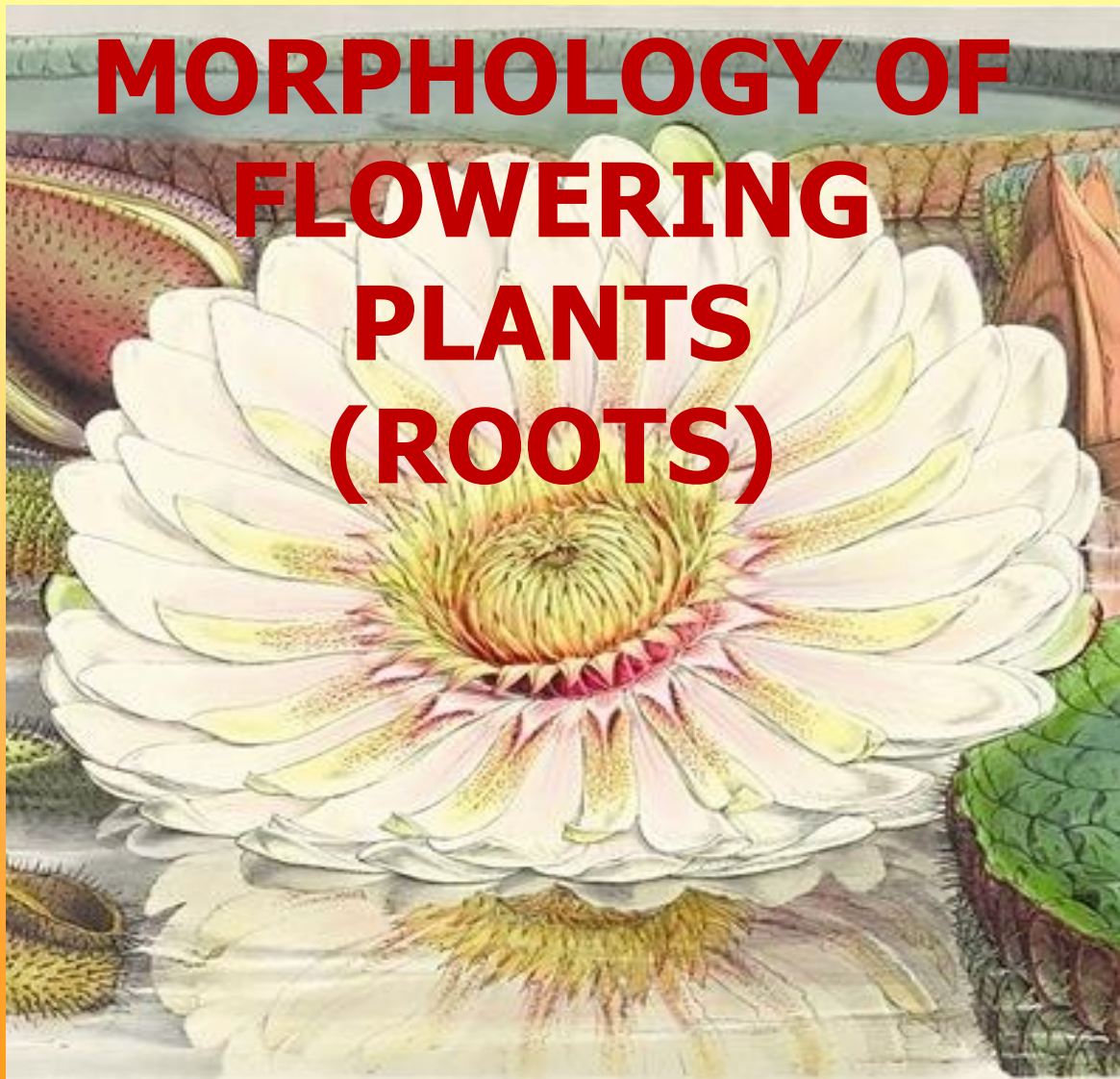


# **MORPHOLOGY OF FLOWERING PLANTS (ROOTS)**





# **MORPHOLOGY OF FLOWERING PLANT**

- **In Greek Angiosperms 'Angeion' means a case; sperma means seed are characterised by the enclosure of the ovules within an ovary or plants with encased seeds or covered seeded plants.**
- **They are the most dominant plants of the present day.**
- **There is wide range in the structure of higher plants.**
- **In Greek "Morphology" Morphos means form; logos means study deals with the study of forms and external features of plant parts.**

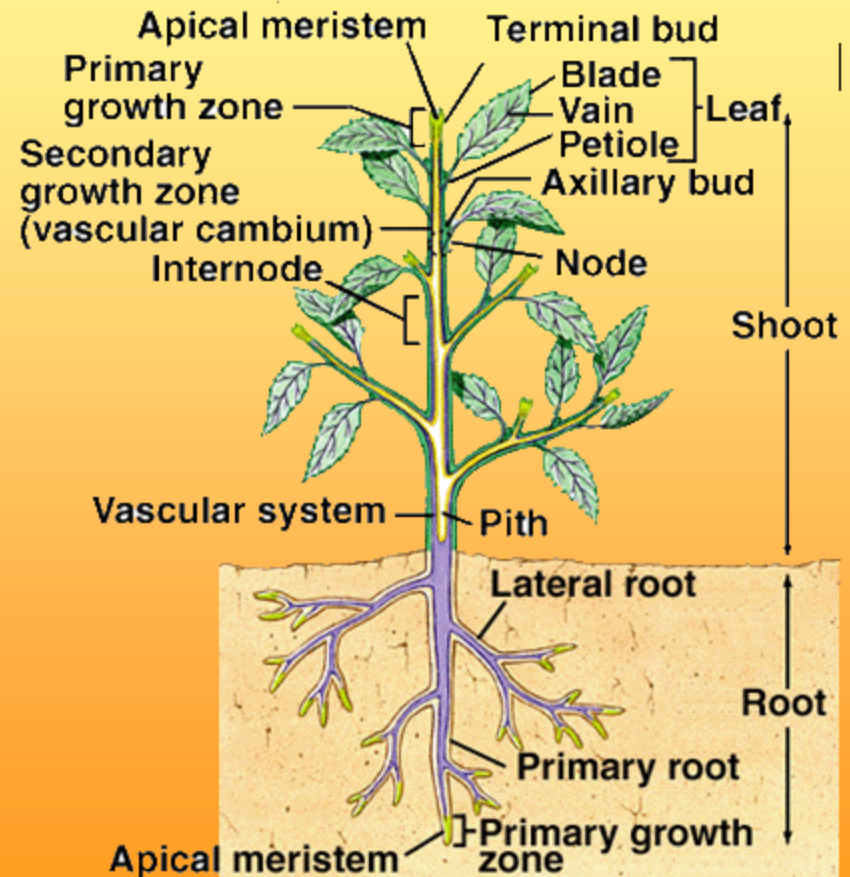
# MORPHOLOGY OF FLOWERING PLANT

- When we observe a plant then we see that every plant has roots , stem and leaves.

- Plants also have flowers and fruits.

- Root is the underground part of a plant.

- Stem is the aerial part of the plant, which bears leaves, flowers and fruits.





# **THE ROOTS**

- **Root is the underground part of the plant. It is mostly brown.**
- **Root is positively geotropic, positively hydrotropic and negatively phototropic.**
- **The branches of root arise from inner region so it is endogenous.**
- **Plants bear lateral roots of several orders that are referred to as secondary roots or tertiary roots.**
- **The primary root is the direct prolongation of the radical in nearly all dicotyledonous plants.**



## **THE ROOTS Contd....**

- **The main function of the root is to anchor the plant to the soil and absorb nourishment and water, storing reserve food material and synthesis of plant growth regulators.**
- **Root is protected at its tip by a protective structure called root cap.**
- **In aquatic plants there are root pockets for balancing.**
- **Root bears unicellular root hairs occurring in cluster for the absorption of water and minerals.**

# TYPES OF ROOTS

- There are three types of root system in plants-
- **Tap Root System**-The root which develops from radicle along with its branches is termed as tap root .Secondary roots develop from tap root.

**Example- Mustard.**

Tap Root

- **Fibrous Root System**-In Monocotyledonous plants, the primary root is short lived and is replaced by a large number of roots.

These root which develops from base of the stem and constitute the fibrous root. **Example- Wheat.**

Fibrous Roots





## **TYPES OF ROOTS contd....**

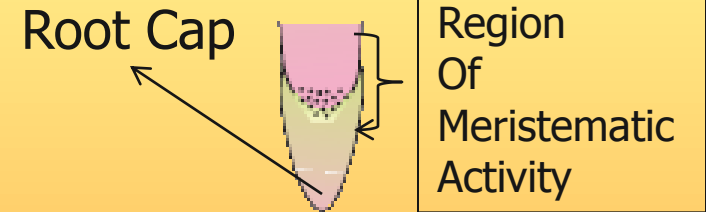
- **Adventitious Root System**-In certain plants root arises from places other than radicle, such roots are called adventitious roots. Examples - Grass , Monestra and Banyan tree.

Adventitious  
Roots



# REGIONS OF ROOT

- The Longitudinal Section of the Root Apex shows following four regions –
- **Root Cap Region-** The apical region of root is covered by a protective structure of thin walled cells known as root cap.
- The cells of root cap secrete mucilage, which lubricates the soil through which the root has to grow.
- Root cap also helps in the movement of root in the soil.
- If one root cap is slugged off another root cap is formed by Calyptra.

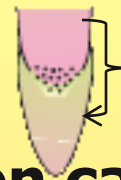




# REGIONS OF ROOT Contd....

## ▪ Region of Meristematic Cells –

- Actively dividing cells from a small region called apical meristem at the root tip.
- Quiescent Centre is located in the centre of this zone which is made of inactive cells or cells having low cellular activity.
- Apical meristem of root tip consists of three zones-
  - Dermatogen- Outermost layer of cells which make epidermis and root-cap.
  - Periblem- It lies inner to dermatogen. Its cells form cortex by division.
  - Pleurome- It is the innermost layer of cell of the apical meristem to make steel. Its cells divide to form phloem and xylem elements.

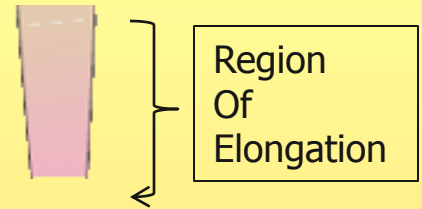


Region  
Of  
Meristematic  
Activity

# REGIONS OF ROOT Contd....

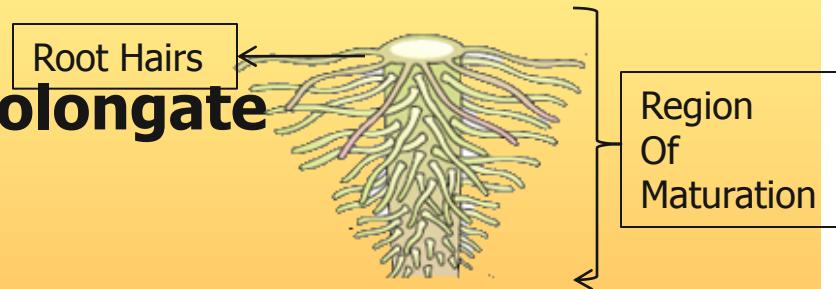
## ▪ Region of Elongation

- The cells of this region absorb water.
- The cells elongate in the region of elongation.



## ▪ Region of Root Hairs –

- The cells of the epiblema prolongate to form unicellular hairs.
- This zone takes part in the absorption of water and mineral salts.

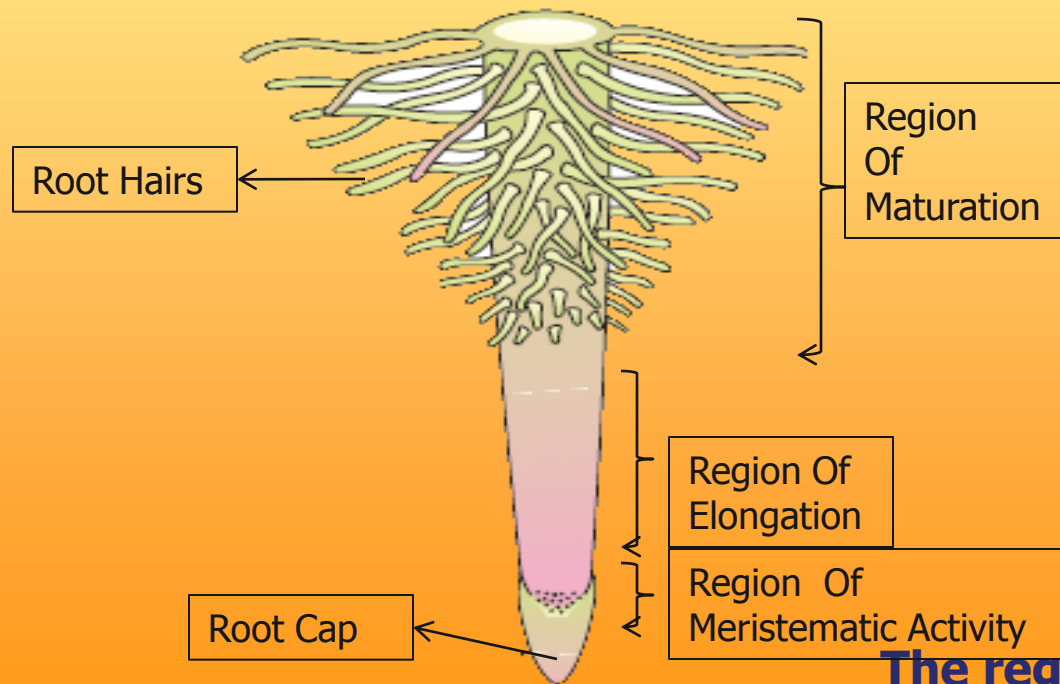


## ▪ Region of Maturation –

- Just behind the root hair zone is older part of the root. It has fully developed cells.
- There are two regions- with root hair and without root hair. Lateral root arise from this part.

# REGIONS OF ROOT Contd....

- **Region of Maturation contd...**
  - It helps in conduction of water and raw material.
  - It fixes the plant into the soil.



**The regions of the root-tip**

# MODIFICATIONS OF ROOT

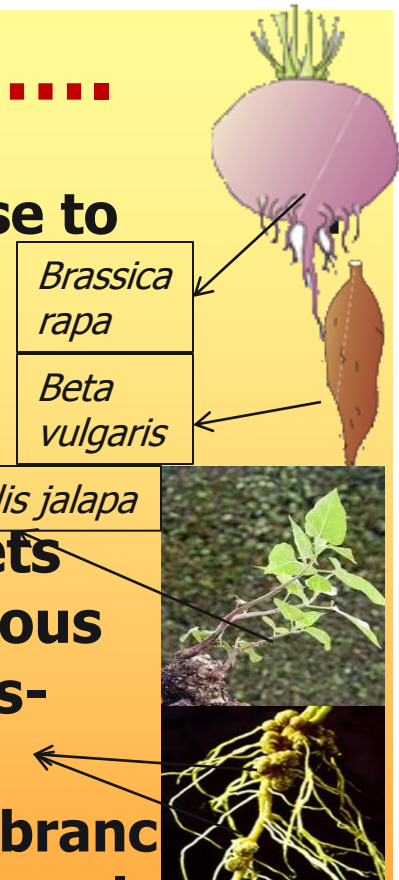
- To perform functions other than absorption and conduction of water and minerals roots in some plants change their shape and structure and become modified for support storage of food and respiration.
- Tap roots get modified into following types-
  - Fleshy Tap Root-Tap root with or without hypocotyl becomes swollen due to storage of food. Such root is of four types-
    - Fusiform Root- Such root becomes thicker in the middle and tapering on both ends. It assumes a spindle shape . Example- Radish (*Raphanus sativus*).
    - Conical Root – It is broad at the base and gradually tapers towards the apex giving it the shape of a cone. Example- Carrot (*Daucus carota*).

*Daucus carota*



# MODIFICATIONS OF ROOT Contd....

- Napiform Root- It is swollen at the base and tapering abruptly in the apical region-giving rise to top-shaped structure. Examples- Turnip (*Brassica rapa*) and Sugar beet (*Beta vulgaris*).
- Tuberous Root-It is swollen irregularly.  
Example- 4 o'clock plant (*Mirabilis jalapa*).
- Branched Tap Root-Sometimes the tap root gets branched and branches modify to perform various functions. Such roots are of the following types-  
**Nodulated.**
  - Roots -In this type, the tap root gets variously branched and at the junctions of branches many small irregular swellings called root nodules arise. They contain a large number of symbiotic  $N_2$  fixing bacteria. Such roots occurs in legumes. Example- *Rhizobium leguminosarum*.



# MODIFICATIONS OF ROOT Contd....

- **Respiratory Roots** -They are also called breathing roots .These occur in swamps or marshy places where soil becomes waterlogged and roots of plants do not get enough air for respiration. The secondary roots of these plants growing negatively geotropically into air have lenticels. They are called respiratory roots (pneumatophores). Examples- *Rhizophora* and *Sonneratia*.

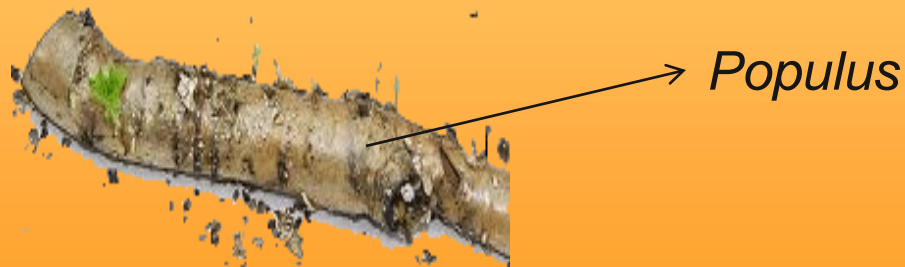


→ pneumatophores ←



# MODIFICATIONS OF ROOT Contd....

- **Reproductive Roots** -In some plants tap roots or their branches develop adventitious buds for formation of new plants.
- **Examples** - *Dalbergia sissoo*, *Populus*, etc.
- Turnips and adventitious roots of Sweet potato, get swollen and store food.
- These are called prop roots.





## MODIFICATIONS OF ROOT Contd....

- To perform functions like storage of food, mechanical support and some special or vital functions adventitious roots get modified into following types-
- Modifications of Adventitious roots for storage of food-
  - Tuberous Roots- A single indefinite shaped root arising from nodes of weak stem. Example - Sweet Potato (*Ipomoea batatas*).
  - Fasciculated Roots – A cluster of tuberous root. Examples – *Dahlia*, *Ruellia*, *Asparagus* etc.



*Dahlia*



*Asparagus*



*Ipomoea batatas*

# MODIFICATIONS OF ROOT Contd....

- **Beaded or Moniliform Roots** – Root swollen at regular intervals like beads of a necklace. Examples - *Portulaca*. Indian Spinach, Bitter gourd.
- **Nodulated Roots**-Roots swells at their tips. Example - Mangoginger (*Curcuma amada*).
- **Annulated Roots**—A series of ring like swellings. Example - Ipecac (*Cephaelis ipecacuanha*).



→ *Curcuma amada*

*Cephaelis ipecacuanha*



# MODIFICATIONS OF ROOT Contd....

- Modifications of Adventitious roots for mechanical support –

- Prop Roots- Pillar like root arising singly from one point of horizontally growing branches and growing vertically downward. Example - Banayan (*Ficus benghalensis*).

*Ficus benghalensis*



- Stilt Roots- Thin, thread like small roots growing obliquely from the basal nodes of the main stem. Examples - Maize (*Zea mays*), sugarcane (*Saccharum officinarum*), Screw pine (*Pandanus racemosus*).

*Pandanus racemosus*



# MODIFICATIONS OF ROOT Contd....

- Climbing Roots - Thread like roots arising from nodes and internodes and surrounding the support. Examples - Betel (*Piper betle*), black pepper (*P.nigrum*), money plant (*Pothos aureus*), poisonous ivy (*Hedera helix*).

*Hedera helix*



- Buttress - Thick roots that flare out from the base of large canopy trees, often found on rainforest trees, that provide support as well as additional nutrients. Examples - *Salmelia* (*Bombax cieba*), old banyan tree, etc.

*Bombax cieba*



# MODIFICATIONS OF ROOT Contd....

- **Contractile Roots** –Roots having wrinkles and can shrink. Examples - Saffron (*Crocus*) Zimikand (*Amorphophallus sativus*) etc.

*Amorphophallus* ←



- **Floating Roots**- Thick spongy, fleshy roots with air filled air chambers arising from the nodes of stem. Example - *Jussiaea repens*.

*Jussiaea repens* ←



- **Leaf Roots** – Root produced on the injured margin of leaves. Examples - *Bryophyllum*, *Kalanchoe*, *Bignonia*, etc.

*Bryophyllum* ←



# MODIFICATIONS OF ROOT Contd....

- **Modifications for vital functions –**
  - **Epiphytic or Hygroscopic Roots –** A special kind of aerial root hanging freely in the air and possessing a covering of dead spongy tissue known as Velamen to absorb moisture, having no root cap and root hair.  
Example - *Vanda roxburghii*, etc.
  - **Assimilatory or Photosynthetic Roots -** Green roots capable of photosynthesis. Examples - Water Chestnut (*Trapa bispinosa*), Gurcha (*Tinospora sp.*) etc.

*Vanda roxburghii* ←



*Trapa bispinosa* ←





# MODIFICATIONS OF ROOT Contd....

- Modifications for vital functions – *Cuscuta reflexa*
  - Parasitic Roots or Haustorial Roots or Suctorial Roots— roots penetrating the host with the help of haustoria. Example – Dodder (*Cuscuta reflexa*).
  - Mycorrhizal Roots – Roots associated with fungi. Examples - Chir (*Pinus*), birch (*Betula*) etc.
  - Root thorns – Roots modified into hard pointed structures. Examples – *Acanthorrhiza*, *Pothos* etc.
  - Reproductive Roots- Roots bearing vegetative buds. Examples - *Trichosanthes*, *Ipoemea*, etc.







# **FUNCTIONS OF ROOT**

- **Roots have following types of functions –**
  - **Anchorage-** Roots fix the plant in the soil. They also provide mechanical support to the aerial parts against gravity and wind.
  - **Absorption of Water & Minerals -** Root hair zone of the root is specialized to absorb water because the thin walled tubular root hairs are able to pass into fine interspace of the soil. Minerals occur in very dilute concentration in soil water. Roots are specialized to absorb the same partly in the root hair zone and partly in the elongation zone.
  - **Conduction of Organic Nutrients-** Organic nutrients synthesized by the leaves are passed down to the roots for translocation to every part.



## **FUNCTIONS OF ROOT Contd....**

- **Conduction of Water & Minerals-** Water and minerals absorbed by the rootlets are conducted by the various parts of the root system to the shoot system.
- **Holding Soil Particles-** By their branches and mucilaginous secretions, the roots bind the soil particles against forces of erosion.
- **Hygroscopic roots –** Young prop roots of Banyan and epiphytic roots are specialized to absorb water from damp air.
- **Nitrogen Fixation-** Nodulated roots of pulses and other legumes contain nitrogen fixing symbiotic bacteria of *Rhizobium* species. They increase the protein content of the crop plants.



## **FUNCTIONS OF ROOT Contd....**

- **Aeration-Pneumatophores** take part in exchange of gasses in many mangrove plants. Knee roots and Prop roots of these mangrove plants also help in aeration.
- **Clinging-** A number of climbers possess one or more adventitious roots for clinging to the support. Examples - *Betel, Tecoma, Ivy*.
- **Mechanical Support-** Extra mechanical support is provided by specialised roots like buttress roots - Almond, prop roots- Banyan, Stilt Roots - *Sorghum , Saccharum*.
- **Balancing-** Floating plants possess one or more adventitious roots passing downwardly in water for balancing. Examples- *Lemna, Pistia, Eichhornia*.



## **FUNCTIONS OF ROOT Contd....**

- **Storage-** Normal roots store small quantity of nutrients. Certain roots are specialised to retain a large quantity of nutrients because of which they swell up. Examples –
  - **Fusiform-** Radish,
  - **Conical Roots-** Carrot,
  - **Napiform Roots –** Turnip and beet,
  - **Tuberous Roots –** Sweet Potato,
  - **Fasciculated Roots-** *Asparagus* and *Dahlia*,
  - **Palmate Roots-** *Orchis*,
  - **Nodulose Roots-** Mango Ginger,
  - **Moniliform Roots-** *Momordica*,
  - **Annulated Roots-** *Ipecac*.



## **FUNCTIONS OF ROOT Contd....**

- **Root Floats-** In *Jussiaea*, some of the roots store air, get inflated and help the plant in floating on the surface of water.
- **Haustorial Roots** – They occur in parasitic plants. The roots penetrates the host and withdraw nourishment , water, or both. Examples - *Cuscuta*, *Viscum*.
- **Release of Oxygen** – Roots of rice and some other amphibious plants release oxygen that overcomes the reducing environment for functioning of various microorganisms and availability of minerals.
- **Photosynthesis-** Roots of *Trapa*, *Taeniophyllum* , *Tinospora*, and *Podostemum* are photosynthetic and green . They synthetase organic nutrients for the whole plants.



# **FUNCTIONS OF ROOT Contd....**

- **Levelling-** The contractile roots attached to corns and rhizomes maintain their specific depth in the soil. Examples - *Crocus, Canna*.
- **Perenation-** Storage roots of some plants help in perenation or passage through depth in the soil. Examples - *Trichosanthes*.
- **Reproductive Roots** – Many roots can develop adventitious buds and take part in vegetative propagation. Examples - Poplar, *Dalbergia*, Dahlia, Sweet Potato.
- **Protection** – Root thorns and root spines present in certain plants are protective devices against animals and excessive loss of water.
- **Mycorrhiza-** They are roots having symbiotic association with fungi. The fungi help the roots in obtaining water and minerals.



# **DIFFERENCES BETWEEN ROOT & STEM**

<b>ROOT</b>	<b>STEM</b>
-------------	-------------

- |   |   |
|---|---|
| <ul style="list-style-type: none"><li>• The main root develops from radicle of the embryo.</li><li>• Root forms the descending axis.</li><li>• Root is generally underground.</li><li>• Root is usually nongreen and nonphotosynthetic.</li><li>• Root branches are endogenous in origin.</li><li>• Root apex is subterminal.</li></ul> | <ul style="list-style-type: none"><li>• The main stem develops from plumule of the embryo.</li><li>• Stem forms the ascending axis.</li><li>• Stem is generally above the ground.</li><li>• Young Stem is green and photosynthetic.</li><li>• Stem branches are exogenous in origin.</li><li>• Stem apex is terminal.</li></ul> |
|---|---|





## **DIFFERENCES BETWEEN ROOT & STEM CONTD..**

### **ROOT**

- Root has a cap called Root cap.
- Root does not have differentiation of nodes and internodes.
- Leaves are absent. It does not bear buds.
- Root hairs are restricted to the subterminal region of the rootlets.

### **STEM**

- Stem do not have cap.
- Stem possess nodes and internodes.
- Leaves are present. It bears buds. Buds may be terminal or lateral. Terminal bud is essential for growth.
- Stem hairs if present cover the whole surface of the stem.



## **DIFFERENCES BETWEEN ROOT & STEM CONTD..**

<b>ROOT</b>	<b>STEM</b>
-------------	-------------

- |   |  |
|---|--|
| <ul style="list-style-type: none"><li>• <b>Root hairs are unicellular outgrowths and take part in absorption of water and mineral salts.</b></li><li>• <b>Root branches develop away from the root apex.</b></li><li>• <b>Roots are positively geotropic and hydrotropic.</b></li><li>• <b>Roots are neutral or negatively phototropic.</b></li></ul> | <ul style="list-style-type: none"><li>• <b>Stem hairs are multicellular outgrowths. Stem hairs take part in protection.</b></li><li>• <b>Stem branches develop from near the apex.</b></li><li>• <b>Stem is negatively geotropic and hydrotropic.</b></li><li>• <b>Stem is generally positively phototropic.</b></li></ul> |
|---|--|



## **DIFFERENCES BETWEEN MONOCOT ROOT & DICOT ROOT**

### **MONOCOT ROOT**

- **Monocots usually have fibrous root system.**
- **Monocots have a circle of xylem with the pith in the middle of the root.**

### **DICOT ROOT**

- **Dicots have a taproot system.**
- **Dicots have a star shaped grouping of xylem in the centre of the root.**



## **Points to Remember**

- Flowering plants vary in habit, habitat, shape, size, structure, mode of nutrition and life span.
- The plant body is mainly divided into root stem and leaves.
- The root system is of two types- Tap root or Fibrous root.
- Tap root is found in dicotyledonous and Fibrous root in monocotyledonous plants .
- In some plants root is modified for storage of food, mechanical support and respiration.
- Podostemum is a plant which is represented by only root. It means root performs the function of assimilation and reproduction.



## Points to Remember

- ***Casuarina equisetifolia*** is a flowering plant with nodules containing filamentous nitrogen-fixing microorganism.
- Root pockets are present in **Eichhornia, Pistia** and **Lemna**.
- In maize root arises from the base of stem.
- In ***Bryophyllum*** roots arise from leaf.
- Mangrooves have respiratory roots.
- Parasitic roots are found in ***Cuscuta***.
- Geocarpic fruits are produced by groundnut.
- Presence of epiphytic roots is the characteristic feature of Orchids in which Velamen tissue is present.
- ***Canna, Zingiber*** and ***Curcuma*** is a group of rhizome.



**Thanks...**