Chapter = 10

Forms and Functions in Plants

INTRODUCTION:

Living organisms required some chemical substances for their body construction and to get energy. These chemical substances are actually nutrients.

What is nutrition?

Nutrition is the processes by which organisms obtain energy from nutrients to maintain the functions of life, to construct the matters and to preserve their structures.

What is nutrient?

Nutrients are food which supplies the energy and elements to living organism's body. Main nutrients for living organisms are CO_2 and H_2O which are directly or indirectly acquire by living organisms. There are 17 essential plant nutrients which are taken in large quantity or in small quantity and known as macro nutrients and micronutrients.

Macronutrients: required in large amount includes nitrogen (N), phosphorus (P), potassium (K), sulfur (S), sodium (Na), chlorine (Cl), magnesium (Mg), and calcium (Ca). Micronutrients: required in small amount includes iron (Fe), manganese (Mn), cobalt (Co), copper (Cu), zinc (Zn), molybdenum (Mo), boron (B), fluorine (F), iodine (1).

ROLE OF SOME IMPORTANT MINERAL NUTRIENTS:

The number and amount of mineral nutrients is different in different plants. Some are discussed below;

ROLE OF MACRONUTRIENTS AND MINERAL NUTRIENTS IN PLANTS AND THEIR DEFICIENCY SYMPTOMS

Important nutrients	Major role	Deficiency symptom
Nitrogen	Essential component of protein, nucleotide and chlorophyll.	Leaves become yellow due to chlorosis but new leaves remain green. Cell division and cell enlargement inhibited and growth stunt. Rate of respiration effected.
Phosphorous	It is a part of the protein molecule Cambium activity is reduced and and necessary for transfer of energy during metabolic processes (ATP). It promotes root growth and fruit ripening and rushes maturity, improves drought and cold tolerance. It is essential for the formation of cell membrane, nucleic acid, co-enzyme (NAD, NADP) and ATP.	Cambium activity is reduced and growth stunt Necrotic patches appear on leaves, petioles and fruits. Delay in maturity lew Failure of seed to form.
Potassium	It is essential for closing and opening of stomata, activation of enzymes involved in photosynthesis and act as catalyst in carbohydrate metabolism.	Leaf color changed into dull or bluish green due to chlorosis Necrotic areas appear on tip and margins of le

		and margins become brown Growth stunt.) Internodes limitation Photosynthesis is affected.
Sulphur	Important for growth and development Component of amino acids, oils and vitamins. Activate certain enzymes.	Yellowing or pale green color Growth retarded Spindly plant Short stalk Nitrogen fixation reduced.
Zinc	Important component of various enzymes Used in protein, carbohydrate, and hlorophyll formation Convert starch to sugar Helps plant tissues to tolerate cold temperature.	Yellow leaves Yellowing between leaves Chlorosis Necrosis Stunt growth

SOME MICRONUTRIENTS AND THEIR ROLE:

Manganese (Mn):

Manganese is one of nine essential nutrients that plants require for growth and development. Many processes are dependent on this nutrient, including

- Chloroplast formation,
- Photosynthesis,
- Nitrogen metabolism,
- Synthesis of some enzymes such as phosphatase which catalyze oxidation and reduction reaction.

Iron (Fe):

Iron is micronutrient and exist in the form of Fe2+ and Fe3+, it is part of cytochrome which is electron transporter.

- Iron maintains chloroplasts.
- Iron supports photosynthesis.
- Iron supports respiration or "breathing".
- Iron is essential for enzyme functions.
- Iron aids in nitrogen-fixing.
- Iron helps move oxygen through the plant's system.

Zinc (Zn):

Zinc may be a micronutrient, but a lack of it can have a significant impact on your corn crop. Zinc contributes to a number of important plant functions such as;

- Key component of many proteins and enzymes.
- Important in anaerobic respiration.
- Growth hormone production such as auxin.
- Internode elongation.
- Plays key role in the formation of chlorophyll.
- Carbohydrate metabolism.

ESSENTIAL ELEMENTS:

Non-metallic	Metallic
Carbon	Potassium
Hydrogen	Calcium
Oxygen	Magnesium
Nitrogen	Iron
Phosphorous	
Sulphur	

CARNIVOROUS PLANTS (INSECTIVOROUS PLANTS)

Some plants use insects, so they are called carnivorous or insectivorous plants. These Plants typically live in nitrogen deficient habitat. These plants contain chlorophyll and manufacture their own food material but cannot prepare nitrogenous compounds and proteins, so to get these compounds the plants use insects.

Examples: Nepenthes (pitcher plant), Dorsera intermedia (sundew) Dionea muscipula (venus fly trap) Aldrovanda (water fly trap).

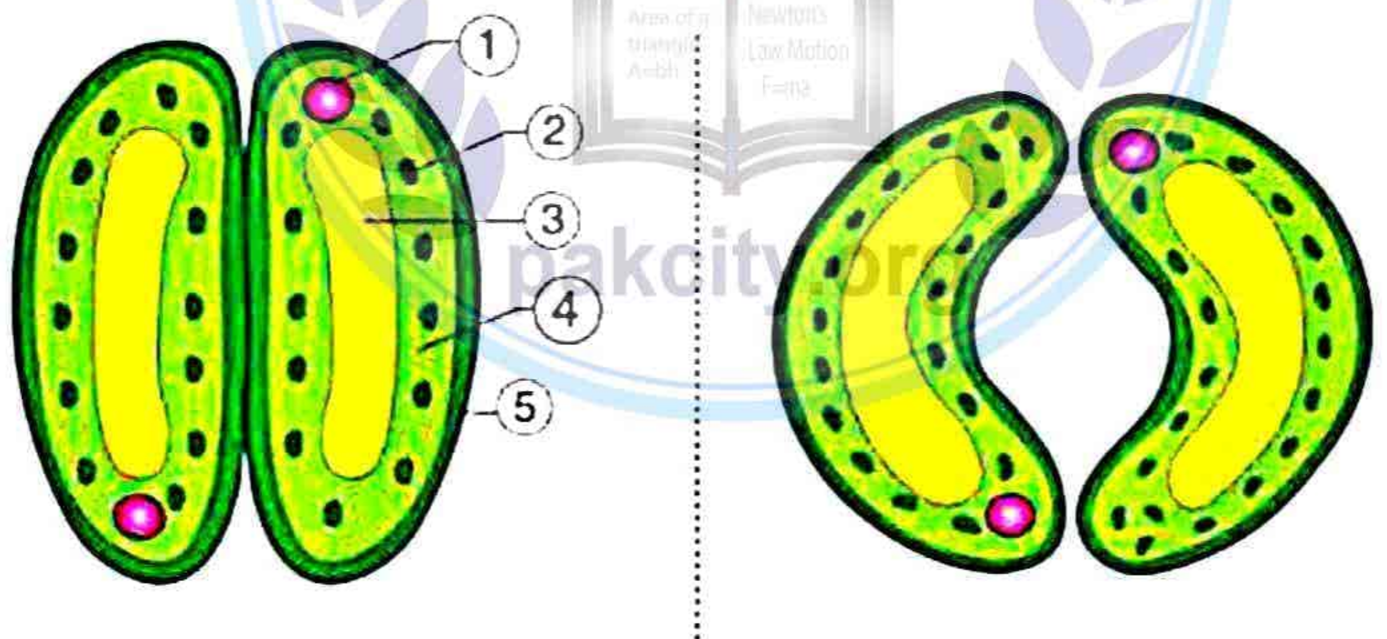
GASEOUS EXCHANGE IN PLANTS:

Gaseous exchange means exchange of O_2 and CO_2 between environment and plants. Plants need O_2 for respiration and CO_2 for photosynthesis. Respiration occurs 24 hours while photosynthesis takes place in day time only. In respiration plants intake O_2 and release CO_2 while in photosynthesis plants intake CO_2 and release O_2 through stomata and lenticels.

In lower and aquatic plants gaseous exchange occurs through moist cell membrane and bod surface while in higher plants gas exchange occurs through cell surface in leaves. I flower plants gas exchange occurs through stomata of leaves and stem.

Structure of Stomata:

Stomata are microscopic pores present in the epidermis of leaves and herbaceous stems stoma is bordered by two modified epidermal cells called guard cells. Stomata remains open during day time and close at night. Thus light is a prime which initiate the opening of stomata.

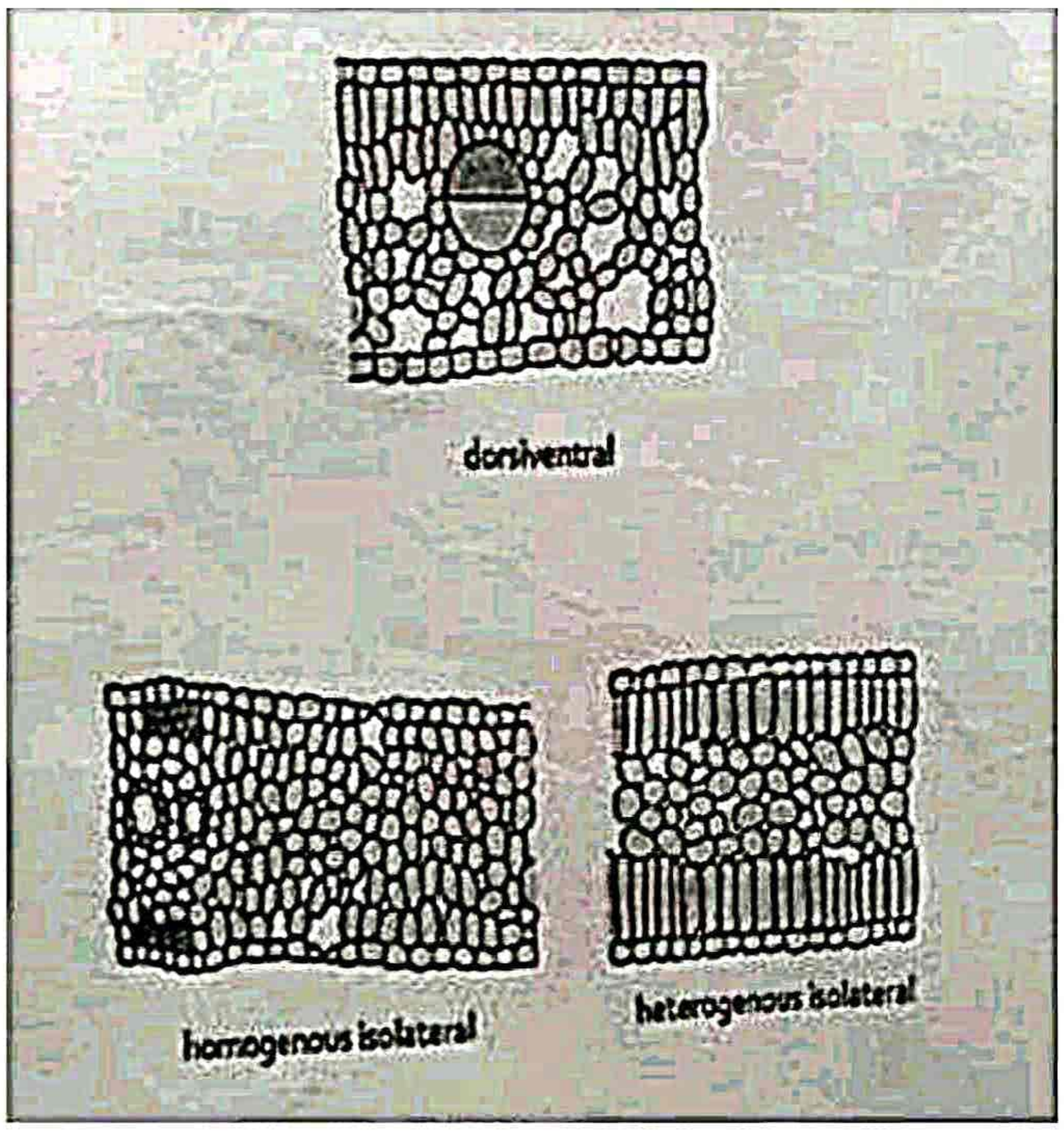


(a) Stoma Closed (b) Stoma Open

1 Nucleus 2 Chloroplasts 3 Vacuole 4 Guard Cell 5 Cell Wall

Mechanism of Opening and Closing of Stomata:

i. The opening and closing of stomata depend upon the turgidity of guard cells.
ii. Turgidity increase or decrease by the osmotic potential of guard cells.
iii. If water move in, the cells expand (become turgid).
iv. If water moves out, they go flaccid.
V. When guard cells are turgid the stomata are open.
vi. When the guard cells are flaccid, the stomata are closed.



TYPES OF LEAVES:

Leaves are of two types

i. monofacial (isolateral).

ii. bifacial (dorsiventral).

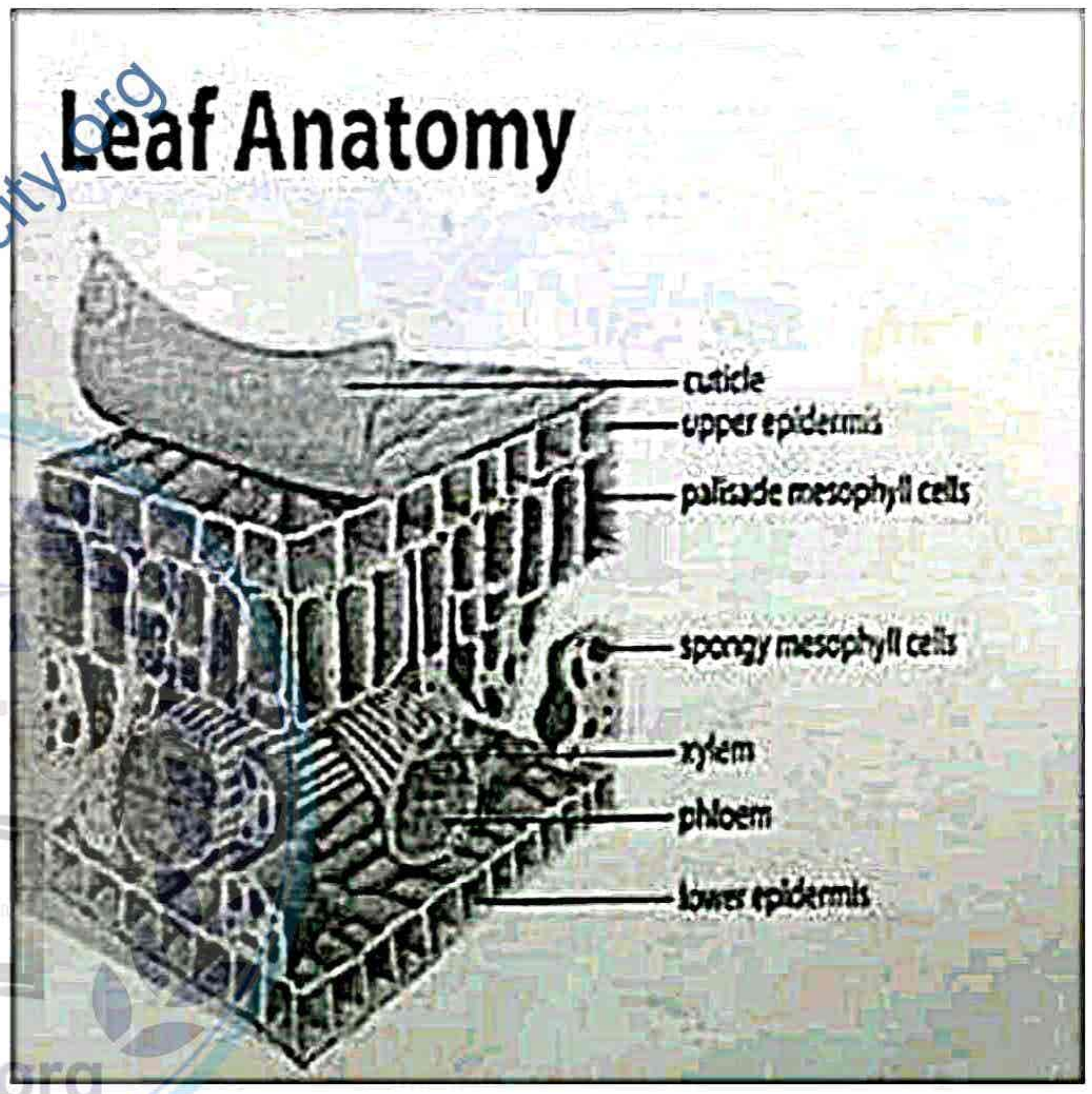
MONOFACIAL (ISOLATERAL):

Monofacial upper and lower surface cannot be distinguished, monofacial stomata are present only on lower surface.

BIFACIAL (DORSIVENTRAL):

In bifacial upper and lower surfaces can be distinguished. In bifacial stomata are present on both upper and lower surface.

In bifacial leaves upper epidermis covered with thick cuticle layer and contain less number of stomata, while lower region gives leaves contain more stomata with spongy mesophyll cells.



ROLE OF AIR SPACES IN GASEOUS EXCHANGE:

All the cells of plants continually respire and there is no special transport system for gases in plants so these air spaces facilitate the process of respiration by diffusion. Cells of leave take in O_2 from the air spaces by simple diffusion.

ROLE OF DIFFUSION IN GASEOUS EXCHANGE:

Diffusion gradient play an important role in this diffusion process. From the leave cells O_2 travels to other cells of plants by diffusion. The byproduct of respiration is CO_2 which is removed by plants cells. Removal of CO_2 use the same process of diffusion.

Photosynthesis takes place in mesophyll cells of leave, here O_2 is produced which is also eliminated by simple diffusion process. Plant can use CO_2 produce during respiration and O_2 produce during photosynthesis.

TRANSPORT IN PLANTS:

Every cell performs its metabolic activities and produces its own ATP by cellular respiration. Every cell needs some raw materials for ATP synthesis. Hence a mechanism of transport is required to transport substances for the synthesis and elimination of compounds. Plants get materials (gases, solutes and water) from atmosphere and soil through diffusion, osmosis, imbibition and active transport. These materials can be divided into gaseous (O_2, CO_2) and non-gaseous materials (amino acids, glucose, ions).

In plants transport is either short distance or long distance. Transport mechanism includes passive (diffusion and osmosis) and active processes.

PATHWAYS OF WATER MOVEMENT:

- Between solutions: in the roots and external environment.
- Between cells: either apo plastic pathway or symplastic pathway through plasmodesmata.
- Between compartments: vacuole and cytoplasm.
- Long distance: in xylem (water and solutes) and phloem (food).

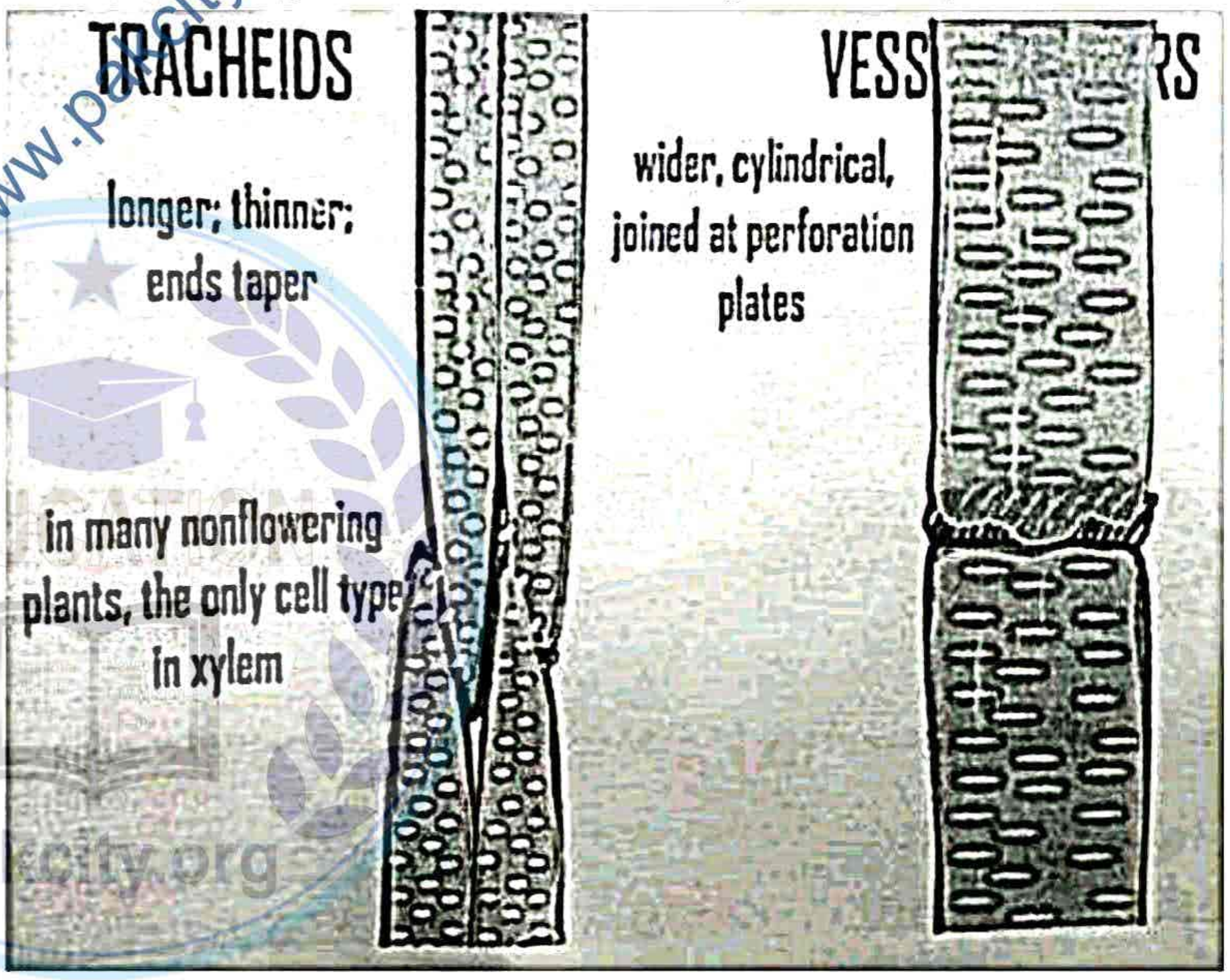
MOVEMENT OF WATER THROUGH PLANT:

XYLEM:

Xylem consists of four types of cells vessels, tracheids, parenchyma, and fibers.

VESSELS:

- They are present in angiosperms and they are dead and lack protoplasm.
- These are a long cylindrical structure having tube-like appearance, having diameter from 0.2 to 0.7 mm.
- These cells are arranged end-to-end.
- At maturity its end walls dissolved and form long straw like structures called vessels.
- This straw like structures provide better route for long distance transport from root to leaves.
- Mostly involved in the conduction of water, minerals and give mechanical strength to the plant.
- In vessels flow of water is 10 times faster than tracheids.



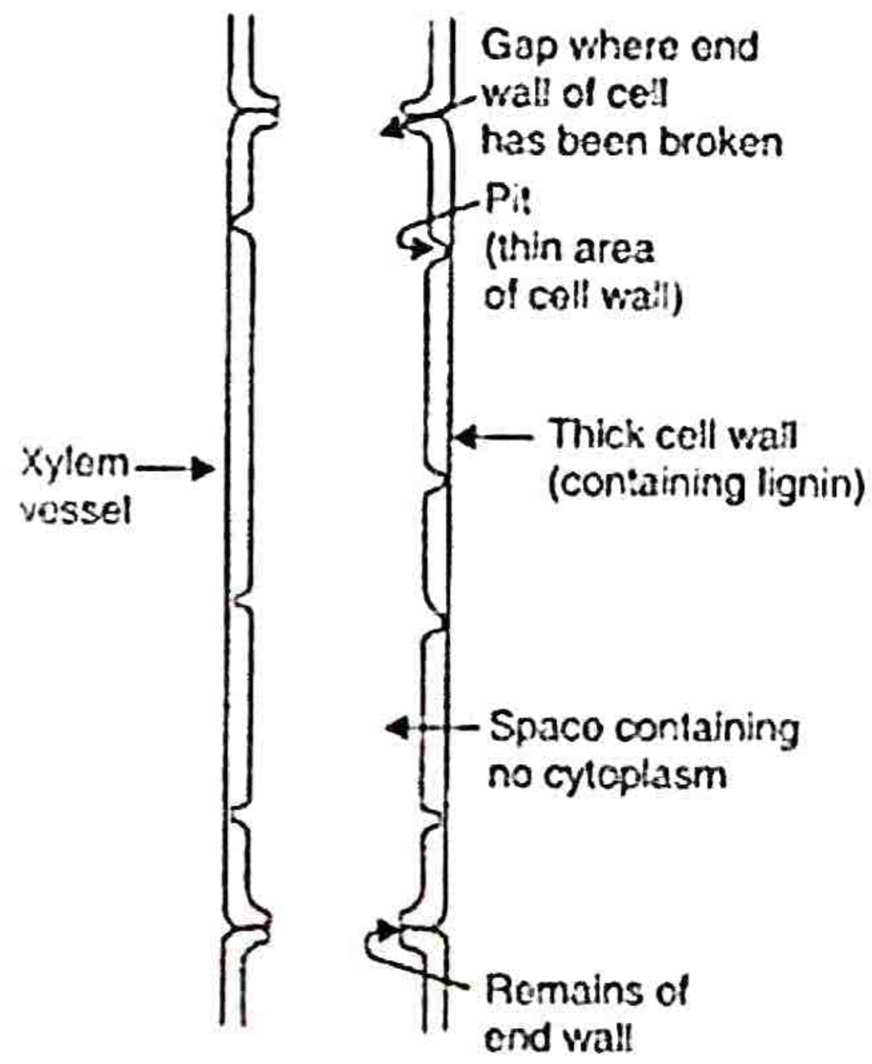
Tracheids:

- Dead, tube-like cells with a tapering end.
- They are present mostly in gymnosperm and lower angiosperm.
- They have a thick lignified wall and lack protoplasm.
- Its diameter is 0.3 mm and length is several mm.
- Its wall is perforated by pits, which are of two types simple and bordered pits.
- Their main function is water and mineral transportation.

PHLOEM:

The phloem element consists of the sieve tube, companion cells, parenchyma, and fiber.

SIEVE TUBE ELEMENTS:

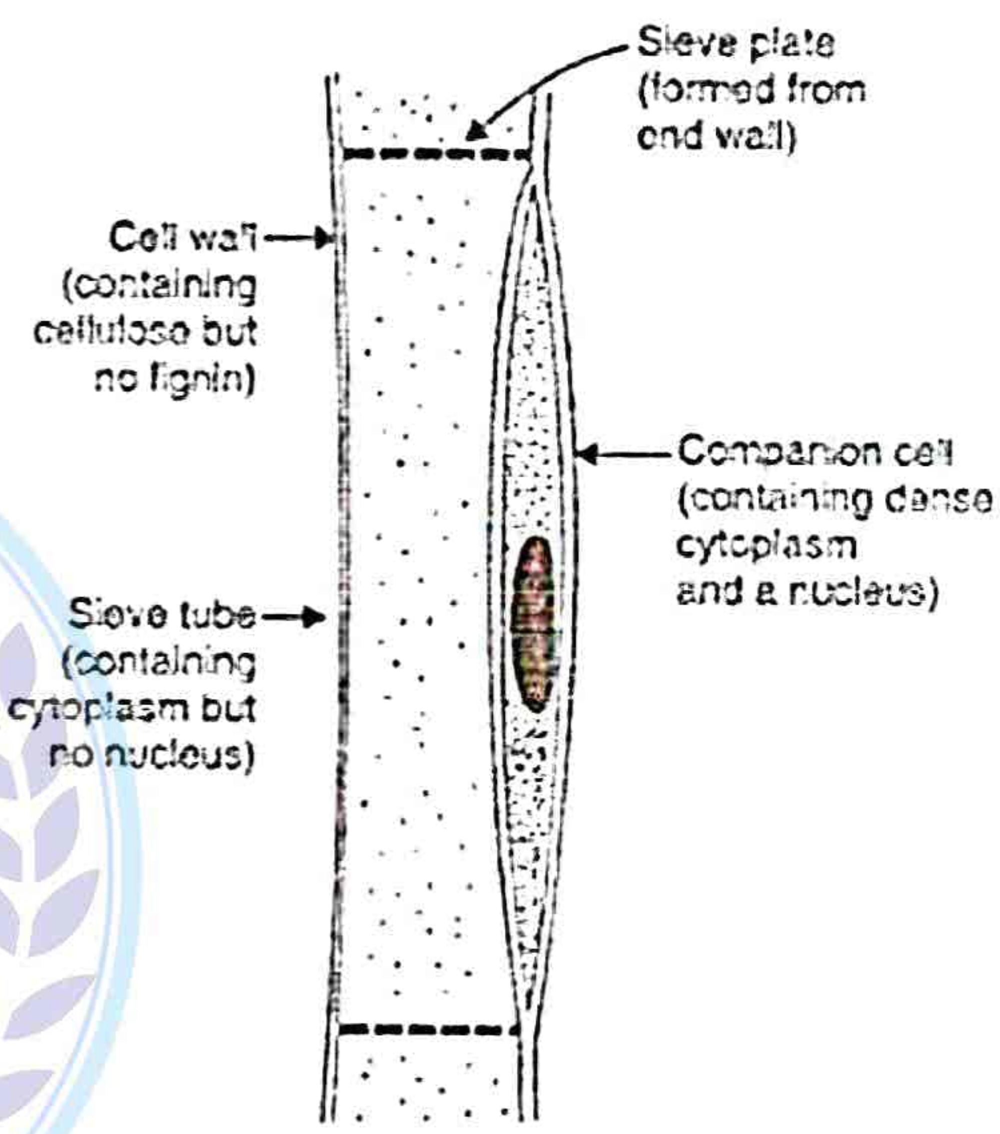


The structure of xylem vessels

- Sieve tubes are long tube like structures formed by fusion of sieve tube elements.
- Its wall is made up of cellulose and pectic substances.
- They have thin wall that connect adjacent cells.
- Its transvers wall has perforation like sieve.
- At the junction of sieve elements sieve plate is formed.
- Sieve plate is large thin section of pores that make it easier for materials to move between element cells.

Companion Cells:

- Each sieve element cell generally has a companion cell in angiosperms.
- Companion cells possess a nucleus, a thick cytoplasm, a large number of ribosomes, and a large number of mitochondria.
- Companion cells can carry out the metabolic processes and other cellular tasks.
- Thus, companion cells are responsible for supplying energy for the movement of materials throughout the plant and the sink tissues, and for the facilitation of loading sieve tubes with photosynthesis-related products and unloading at the sink tissues.



The structure of phloem (made of sieve tubes).

WATER TRANSPORT:

Water continuously moves from root to leave and from leaves to environment. Plants absorb water by diffusion, osmosis and bulk flow. Movement of water is regulated by water potential, osmotic pressure and solute potential.

Water Potential (Ψ_w):

Free energy associated with water molecule responsible for movement of water is called water potential. Free energy shows the potential for performing work. It denotes chemical potential of water. Unit of chemical potential is joule per mole but it is inconvenient for plant physiology. Hence plant physiologist recognized another term i.e. water potential for difference in energy of pure water and solution water. The unit of free energy of water will also replace by megapascal (Psi=). One megapascal is equal to 9.87 atmospheres. The water potential of pure water is 0 MP. Addition of solutes in pure water will decrease the water potential hence the value of water potential always remains less than 0 or minus.

Osmotic pressure:

The pressure exerted upon a solution to keep it with equilibrium with pure water is called osmotic pressure. Or tendency of water to move into solution by osmosis.

Osmotic potential or solute potential:

- Tendency of a solution to attract the water molecules is called osmotic potential.
- The osmotic potential of pure water is zero.
- The value of osmotic potential is always less than zero.
- Osmotic potential decreases when the osmotic pressure increases.
- Water moves from the lower osmotic potential solution to higher osmotic potential solution.
- It is represented by (Ψs).

Pressure potential (ΨP):

- Another term used for the water potential is the pressure potential.
- If a pressure greater than atmospheric is applied to pure water or a solution, its water potential increases.
- When water enters the plant cells by osmosis, pressure may be build up inside the cell making the cell turgid and increasing the water potential.
- This measure of increase in water potential of a medium due to the addition of water or due to the pressure greater than atmospheric pressure is called pressure potential.

Water relations of plant cell

- Plant cell can be divided into three regions cell wall, cytoplasm and vacuole.
- Vacuole is filled with cell sap (aqueous solution of salts, organic acids and sugar).
- Water move in and out of the vacuole depending upon the difference in water potential.
- More solute particles decrease the water potential of cell sap.

Solute potential (Ψs):

- Concentration of solute particles in a solution is known as solute potential.
- Solutes reduce the water potential by consuming some of the potential energy available in the water.
- This measure of decrease in water potential of a medium due to the addition of solutes is called solute potential.
- Solute potential is negative in plant cell and zero in distilled water.
- The amount of available potential energy is reduced when solutes are added to an aqueous system.
- Thus, solute potential decreases with the increase in solute concentration.
- The internal water potential of plant cell is more negative than pure water because of the because of the cytoplasm's high solute content.
- Because of this difference in water potential, water will move from the soil into a plants root cells by osmosis through cell membrane and tonoplast.

WATER AND MINERALS UPTAKE BY ROOT:

- Cell wall is of epidermal cells of roots is freely permeable to water and other minerals, while the cell membrane is differentially permeable.
- From root hairs water enters into epidermal cell via osmosis. Water moves along the concentration gradient.
- It passes through cortex, endodermis and pericycle and reaches the xylem vessels finally.
- There are three pathways of water to enter the xylem.

a. Apoplast pathway.
b. Symplast pathway
c. Vacuolar pathway

a. Apoplast pathway:

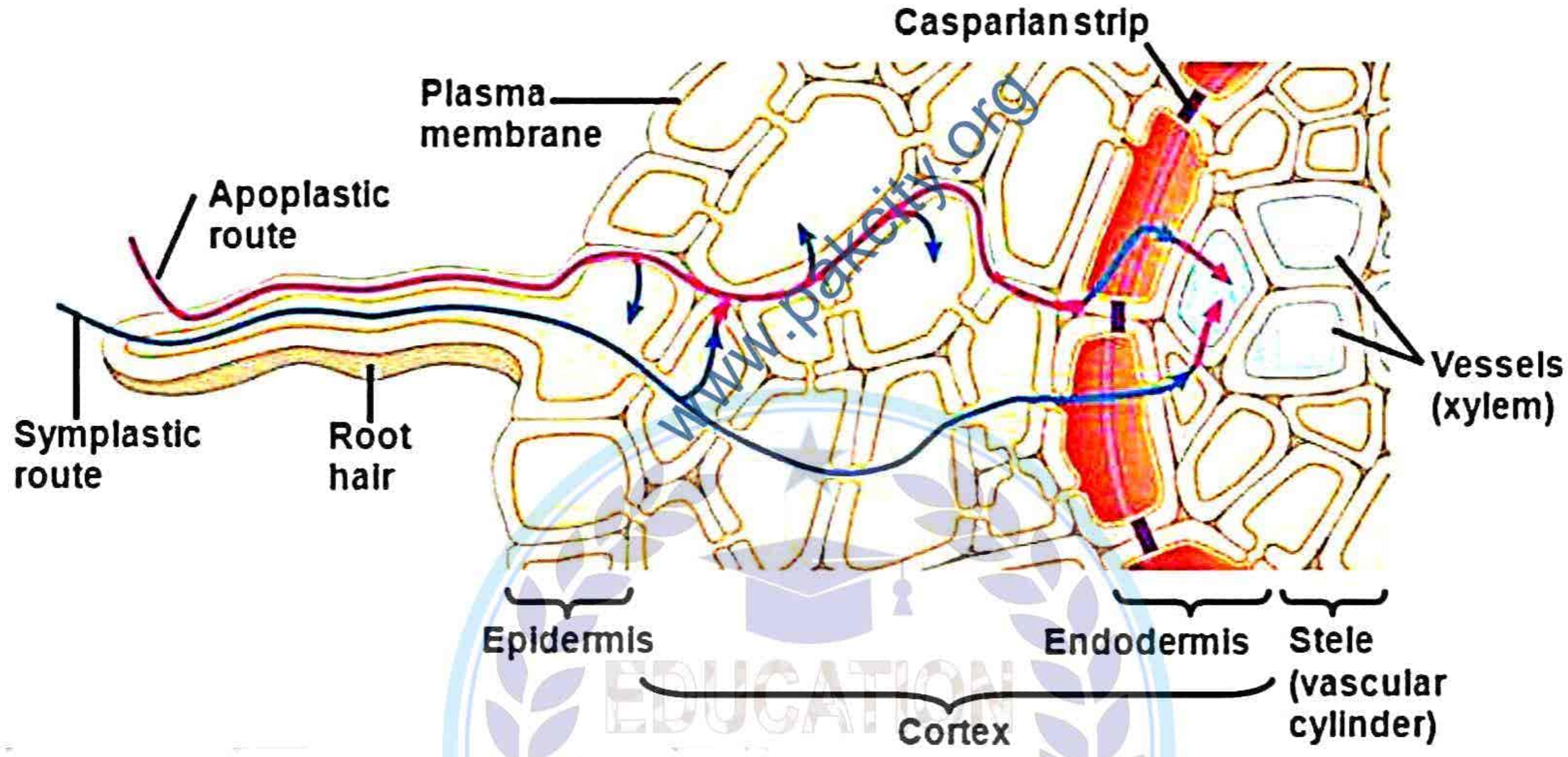
In this pathway, water moves through spaces in the cell walls of adjacent cells and reaches to the endodermis. In endodermal cells casparion strip is present which is made up of suberin and lignin. Water cannot pass this barrier.

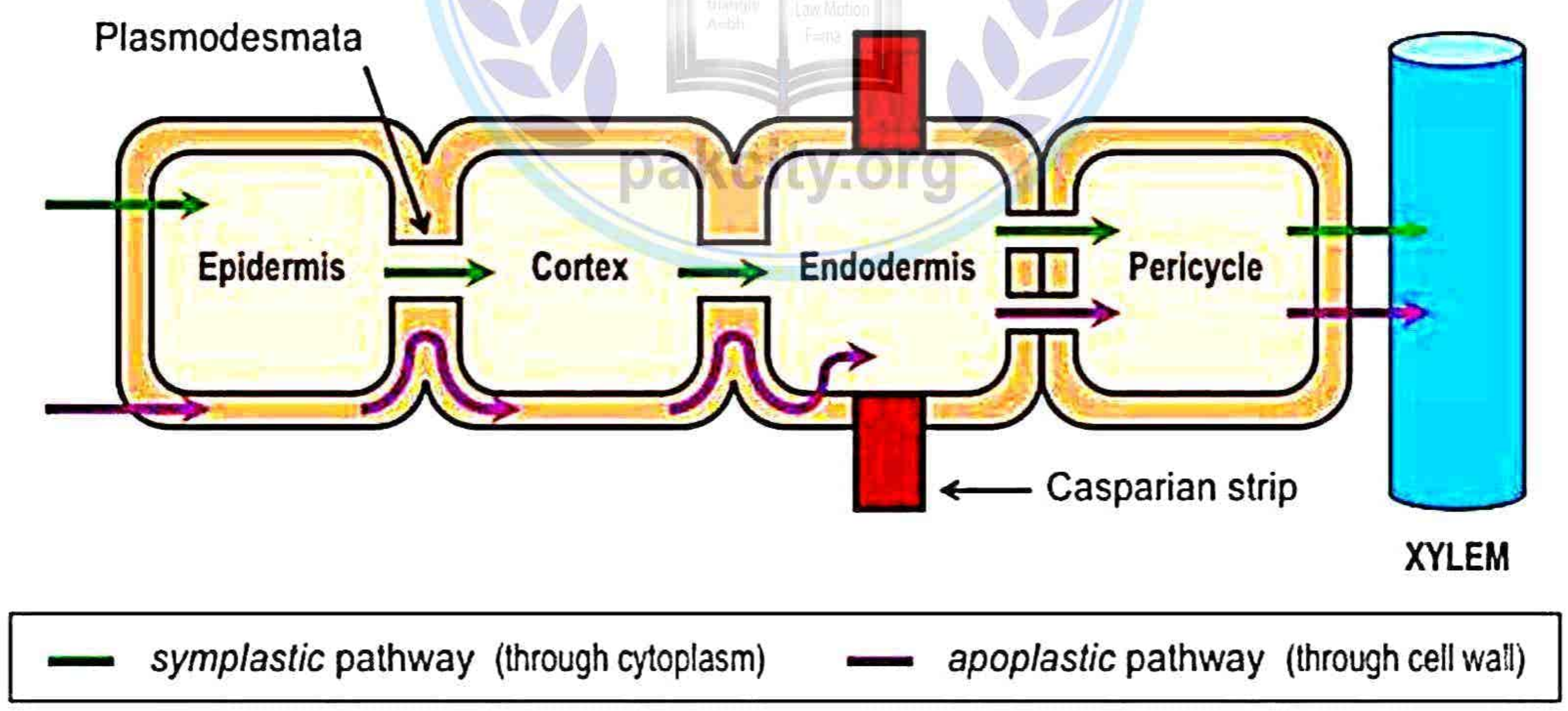
b. Symplast pathway:

Movement of cell sap that involves cytoplasmic connection of adjacent cells is termed as symplastic pathway. symplast is the system of interconnected protoplast in the plant. The cytoplasm of the adjacent cells is linked by plasmodesmata. Once water enter into the cytoplasm of one cell it can move through the symplast without having to cross further membranes. Movement can be aided by cytoplasmic streaming.

c. Vacuolar pathway:

In vacuolar pathway water moves from vacuole to vacuole through neighboring cells, crossing the symplast and apoplast in the process and moving through membranes and tonoplast by osmosis. It moves down a water potential gradient.





ASCENT OF SAP

DEFINATION:

The upward movement of water from roots to the aerial parts of plant specially up to the leaves against the force of gravity is called ascent of sap.

Path of Ascent of Sap:

In the body of plants xylem is a part which is responsible for the upward movement of water. Xylem has two main conducting cells.

i. Tracheae or vessels.

ii. Tracheids.

I. Tracheae or Vessels:

• There are elongated tube-like and dead cells. The tracheids and vessels both work together and form such system which help in the upward movement of water from root to leaves.

• The rate of flow in vessels is 10 times faster than tracheids. These are mostly found in angiosperm.

II. Tracheids:

• There are elongated tube like, dead and thick walked cells with thin ends.

• In tracheids opening (Pits) are responsible to transfer dissolved mineral from one trancheids to another easily.

• By the help of Pits the upper-tracheid is connected with lower one.

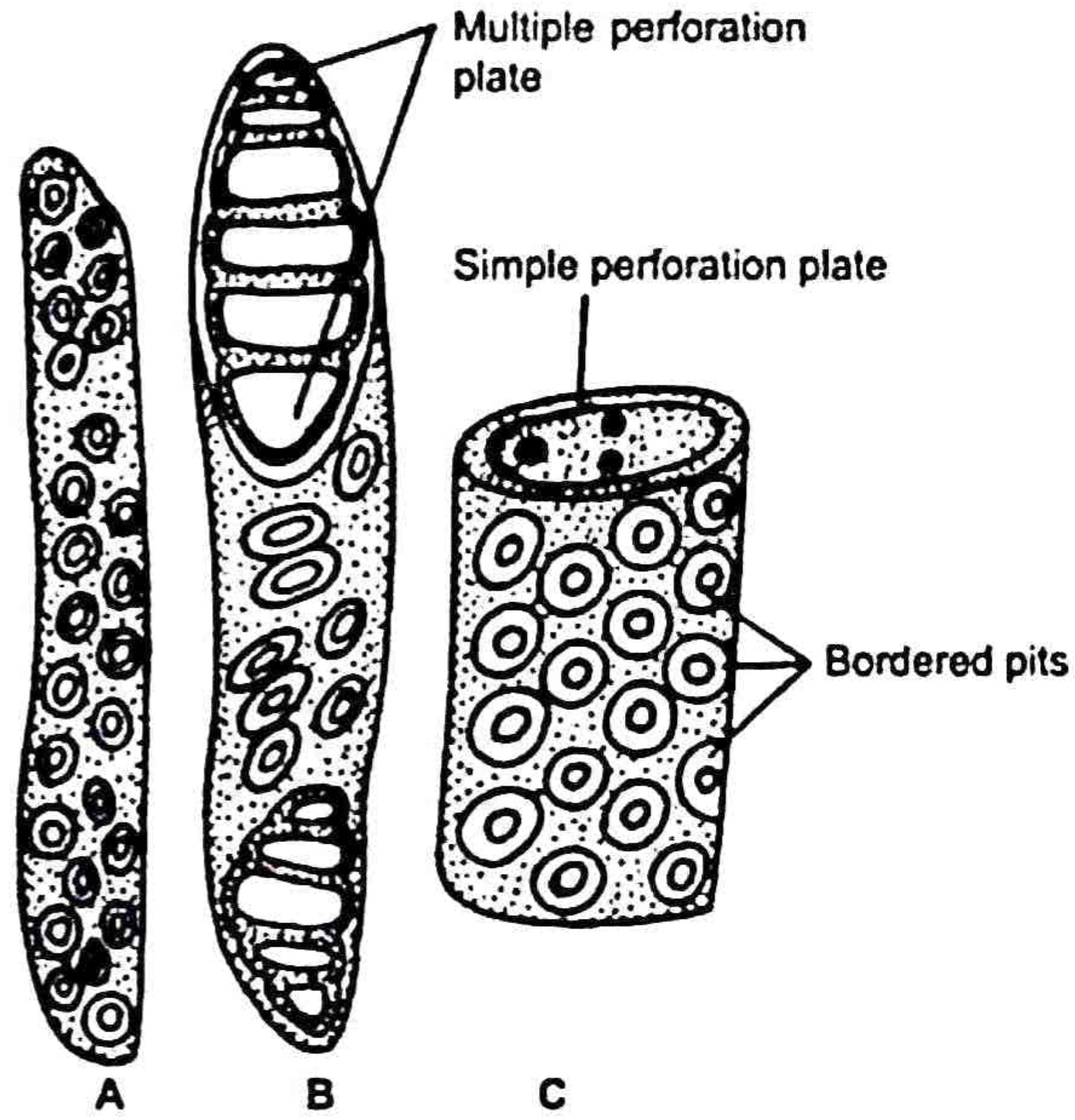


Fig. 3.3(I) Xylem (A - Tracheids & B, C - Vessels)

MECHANISM OF ASCENT OF SAP:

Several theories have been explain the mechanism of ascent of sap, among these are two theories seem to explain the mechanism of ascent of sap.

i. Root pressure theory (Push from below).

ii. Adhesion-cohesion theory.

Root Pressure Theory (Push from Below):

By the alternate expansion and contraction of cortical cells of root a pumping force is generated called root pressure theory.

Root pressure they was proposed by Hales in 1927 A/C to Hales.

"This force could take up for upward movement of water to a height of 6:4 meter, but he observed that the pressure develops at certain times of a year."

Adhesion-Cohesion Theory (Dixon Theory):

According to this theory some forces take part in ascent of Sap.

I. Transpiration pull.

ii. Adhesion force.

iii. Cohesion force.

i. Transpiration Pull:

When loss of water occurs from the surface of leaf mesophyll cells due to transpiration, the amount of water reduces in these cells. These cells get water from the neighboring cells and then from the xylem of the nearby veins.

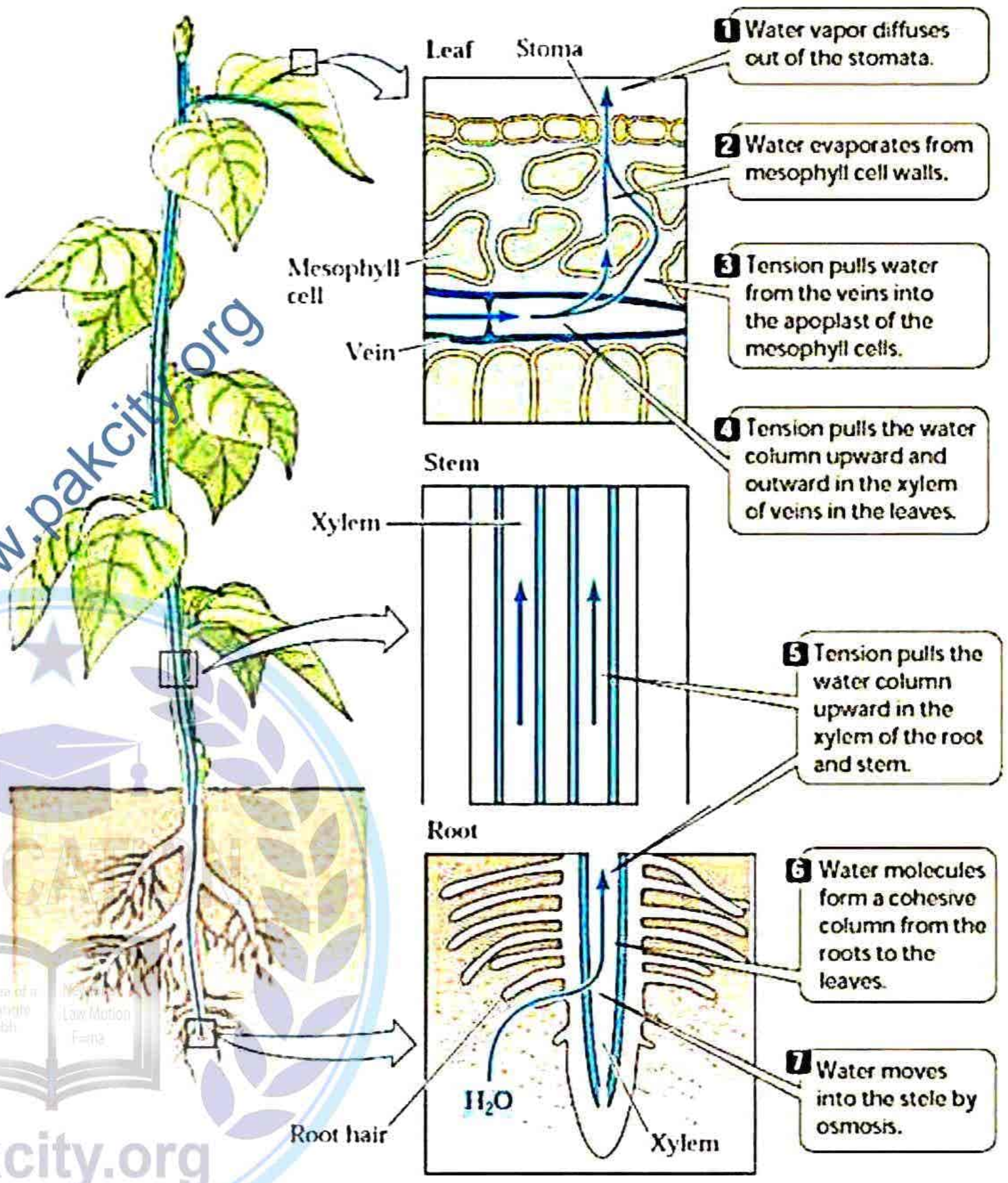
These veins take water from the midrib of the leaf. Now water present in the xylem pull water from stem. This tension transmitted down words and the water through the stem is taken up from the roots. This tension developed due to transpiration is called transpiration pull.

ii. Adhesion Forces:

There are two physical properties of water, adhesion and cohesion. Adhesion is the attraction of water molecules of the wall of xylem vessels.

iii. Cohesion Forces:
Cohesion is the force of attraction among water molecules due to water they are firmly attached with each other so water forms a continuous column extending from root through shoot into leaves. i.e from base of the plant to its top.
Due to cohesive forces between water molecules. The continuous column is not broken and water rises up.

Working:
Ascent of sap is consider as the solar powered process, because plants do not use their metabolic energy. Transpiration pull and adhesion-cohesion forces work together, they become so powerful that water rises in the body of plant up to the top of plant within no time.



Translocation:
The movement of organic and inorganic materials from one region to another in the body of plant is known as translocation.

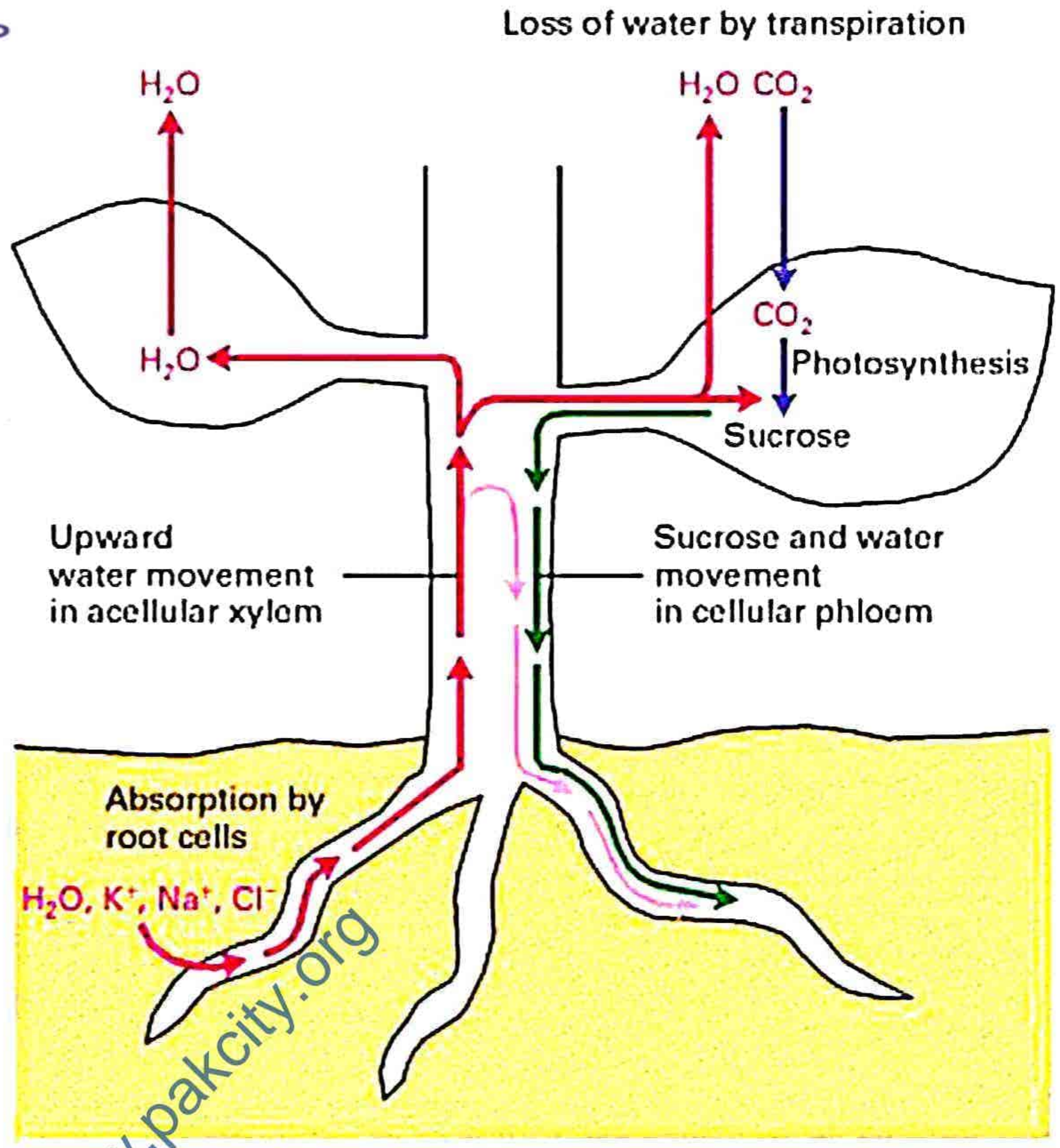
Path of Translocation:
Source Sink Movement:
The transport of food substance take place from the region (source) to the region of metabolism or storage (sink), therefore the phloem transport is also called source-to-sink movement.

MECHANISM OF TRANSLOCATION (MUNCH HYPOTHESIS):
PRESSURE FLOW OR MASS FLOW HYPOTHESIS:
To describe the mechanism of translocation many theories have been put forward but important is this theory known as Munch Theory.
A/c to this theory the food migrates from leaves to the roots and other storing parts in a flow, called mass flow.
This flow of solution is the sieve tubes is due to the osmotic pressure gradient b/w source (leaves) and sink (storage region) parts.

i. When leaves manufacture food material by photosynthesis, their osmotic pressure increase, so these mesophyll cell of leaves get water from neighboring cells, as a result of this process a high turgor pressure is developed in mesophyll cells.
ii. The mesophyll cells are connected with each other through small pores called plasmodesmata. These connections are reached up to the sieve tubes of Phloem.
iii. The food substances are diffused through plasmodesmata to the sieve tubes due turgor pressure.
iv. The movement is from a region of higher turgor pressure (source, leaf cells) to the region of lower turgor pressure sink tissues (storage tissues).

V. In this way a mass flow of water and dissolved organic solutes occurs in phloem from upper region to lower region, so it is called mass flow or bulk flow.

Phloem Loading:
The actively transportation of sucrose (prepared food) into the sieve element in a step ommonly called phloem loading.
i. The pathway of phloem loading may be either symplastic or aplastic depending upon species.
ii. It is due to short distance transport of leaf.



Phloem Unloading:
The photoassimilate or sucrose is unloaded at the sink in process called phloem unloading.
i. The pathway of phloem unloading is same as loading but in opposite direction.
It is due to long distance transport of sieve tubes.

HOMEOSTASIS IN PLANTS
Osmotic adjustment or osmoregulation:

- Plants have adaptations and adjustments for survival in stressful conditions of environment.
- Such as water stress, salinity, and drought stress.
- Plants have homeostatic mechanisms that help in the maintenance of internal environment.
- Such as osmoregulation, help in water salt maintenance.
- If a plant cell is placed in the hypotonic solution then water moves inside the cell than in the vacuole as a result cell become turgid.
- If a plant cell is placed in the hypertonic solution then water moves out cell as a result cell become flaccid.
- It is known as plasmolysis.

1-HYDROPHYTES:
They mostly live in water and therefore face no shortage of water. They have various adaptations to avoid the flooding of cells in fresh water.
i. The surface area of leaves in hydrophytes is very large.
ii. Hydrophytes have many stomata.
iii. In hydrophytes stomata present on upper surface of the leaves facing the atmosphere to promote the loss of water.
iv. Stem and leaves of hydrophytes lack cuticle.
V. Stem is cylindrical and sponge.
Examples: Water Lilly, Hydrilla, Elodea, Lotus.

2-HALOPHYTES:

The plants growing in salt marshes are halophytes. They have to absorb water from a soil which is higher in salt concentration and having lower water potential. So, halophytes have following adaptations.

i. They start accumulation of higher amount of salts into their roots that causes lower water potential inside their roots than surrounding soil.

ii. So, water moves from outside to inside by endosmosis.

iii. The excess salt is stored or excreted out from the salt glands present in the leaves. The excreted salt on leaf's surface traps water vapors from air (obtaining additional water).

Examples: Glasswort, Cord grass etc.

3-MESOPHYTES:

i. Mesophytes grow in well-watered soil.

ii. They have moderate water availability i.e. enough, not more means adequate.

iii. They usually have broad, flat and green leaves.

iv. They have stomata on the underside of the leaves.

V. They overcome water loss through transpiration by absorbing water from soil.

Vi. Mesophytes have cuticle on leaves surface that prevent excessive transpiration.

Example: Brasica, Rose, Mango etc.

4-XEROPHYTES:

Xerophytes grow where there is severe depleted availability of water (dry places) and water potential of soil and air is very low. They have various adaptations to reduce the rate of transpiration.

A) Seed or spore adaptations during drought condition.

Seeds or spores of land plants protected externally by hard coats and thus remain viable for the considerable period of time.

B) Adaptations for balance between transpiration and water uptake.

i. They have small and thick leaves, reduce surface area of leaves by reducing size of lamina (expanded area of leave) due to which water loss reduce through transpiration.

ii. They have thick, waxy and leathery cuticle on leaves.

iii Stomata are reduced in number and on lower surface of the leaves and located in sunken pits (sunken stomata).

iv. They have hairy epidermis.

v. Some plants such as cacti completely shed their leaves during the dry season to restrict the transpiration.

vi. In rainy season stem store water for use in dry condition such plants are known as succulent (juicy plants with fleshy water storing parts) such as cactus and euphorbia etc.

vii. Development of very deep vertical roots as seen in Acacia and banyan etc.

vii. Some plants such as cacti have superficial horizontal roots which can absorb water before it evaporates.

ADAPTATIONS TO LOW AND HIGH TEMPERATURE:

EFFECT OF LOW TEMPERATURE:

In the low temperature, the fluidity of the cell membrane is altered because lipids of the membrane become locked into crystalline structure which affects the transport of solutes. Freezin temperature causes ice crystal formation within the cytoplasm that interferes with the metabolic activities of the cell.

ADAPTATIONS TO LOW TEMPERATURE:

Plants increase unsaturated fatty acid (which have low freezing point) in cell membrane, which helps cell membrane to maintain structure at low temperature by preventing lipids crystal formation.
In order to prevent ice crystal formation within cytoplasm plants accumulating a range of solutes including carbohydrates (sucrose) and amino acids such as glutamic acid. These solutes molecules cause cytosol to super cool without ice crystal. Due to such alteration of solute, the ice crystals are formed in the cell wall.

EFFECT OF HIGH TEMEPERATURE:

High temperature causes excessive evaporation of water that may lead to dehydration and wilting. It also causes denaturation of enzymes and damages the metabolism therefore harms or kills the plants.

ADAPTATIONS TO HIGH TEMERATURE:

In hot areas, the Aplants develop a shiny cuticle, which reflects much of the incident light. Thus preventing the heat absorption and overheating by the plant.
At temperature above 40 C plants synthesize the heat shock protein that prevents enzyme denaturation.

Growth and Development in Plants:

Development:

The progressive change in zygote in order to become a multicellular adult is called development.

Growth:

The process in which permanent increase excess in the body of plant in respect to its size, form, weight and volume is called Growth.

Growth Points:

In higher plants the growth occur only in certain regions called growth points.
In these regions cells divide rapidly. These cells are called meristems.

Types of Meristems Tissues:

There are three types of meristems tissues:
i. Apical Meristems.
ii. Intercalary Meristems.
iii. Lateral Meristems.

Apical Meristems:

These cells are present at the apices of stem or roots. They increase the length of plant at both of the stem and root sides. They take part in the formation of branches, leaves, flowers and root hair.

Intercalary Meristems:

These meristems are considered as the portions of apical meristems but separated by permanent tissues and temporary regions of growth. In grasses, they are found at the base of internodes.

Lateral Meristems:

These meristems are found in gymnosperm and dicot plants. They are composed of cambium and phellogen tissues. They bring about secondary growth and increase the thickness of plants.

TURGOR PRESSURE:

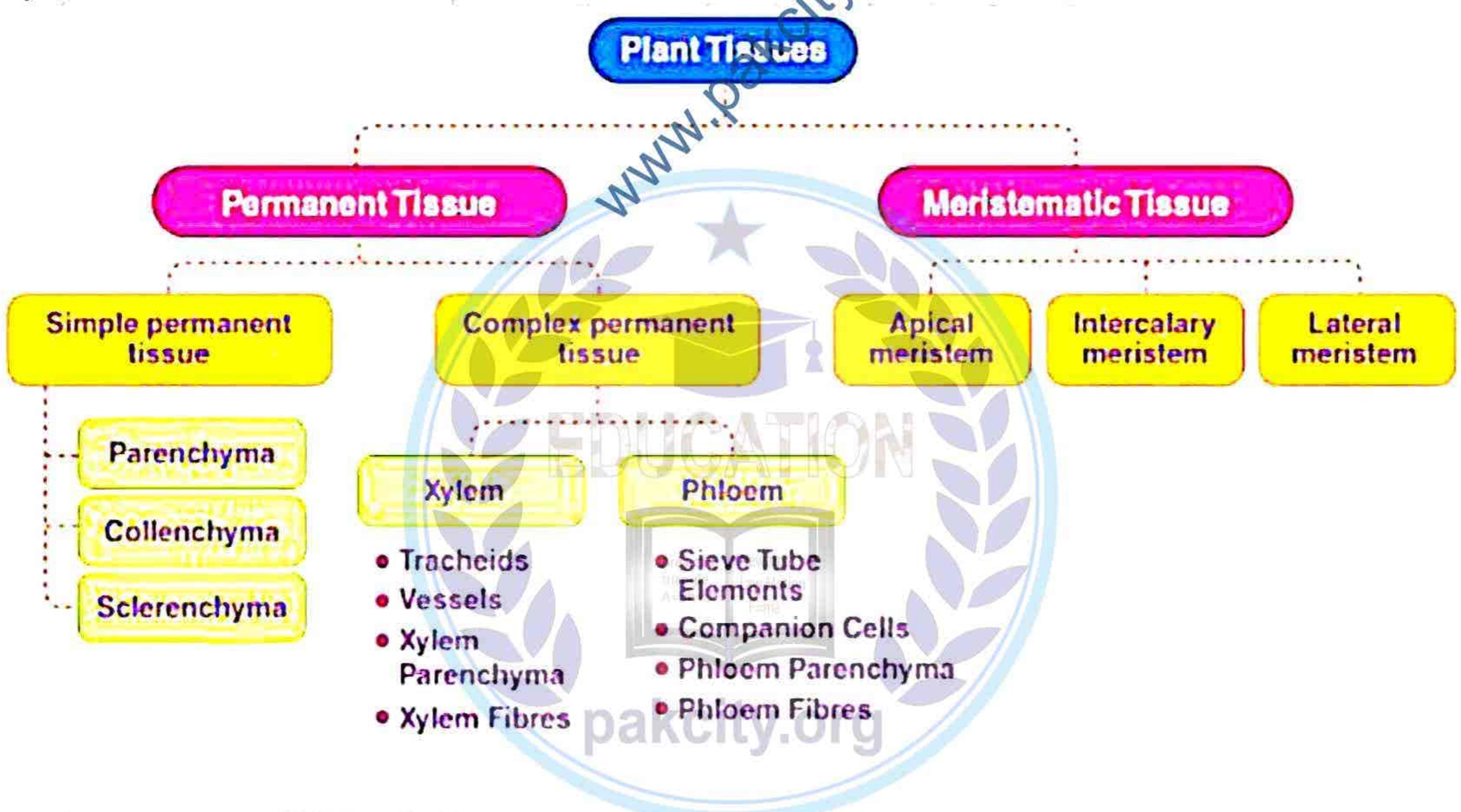
- Pressure built inside the cell due to entry of water by endosmosis is called turgor pressure.
- Turgor pressure specially built in parenchyma cells of lower plants plays an important role in support of plant.
- Parenchyma cells have thin primary cell wall and chloroplast hence, water move inside the parenchyma cells and extended.
- Due to turgor pressure plants cells remain firm and rigid.
- If plant cells loose water than also loose turgor pressure and resulted in the wilting of leaves and stem.

SUPPORT OF PLANT:

Plants require some supporting tissues and materials in order to keep the body in erect form These tissues are present in all parts of the plant body such as root, stem and leaves.

Support through the supporting tissues:

- **Parenchyma:** thin walled living tissues having turgidity.
- **Collenchyma:** thick walled living tissue.
- **Sclerenchyma:** thick walled dead tissues.
- **Stele:** cylindrical core of vascular bundles.



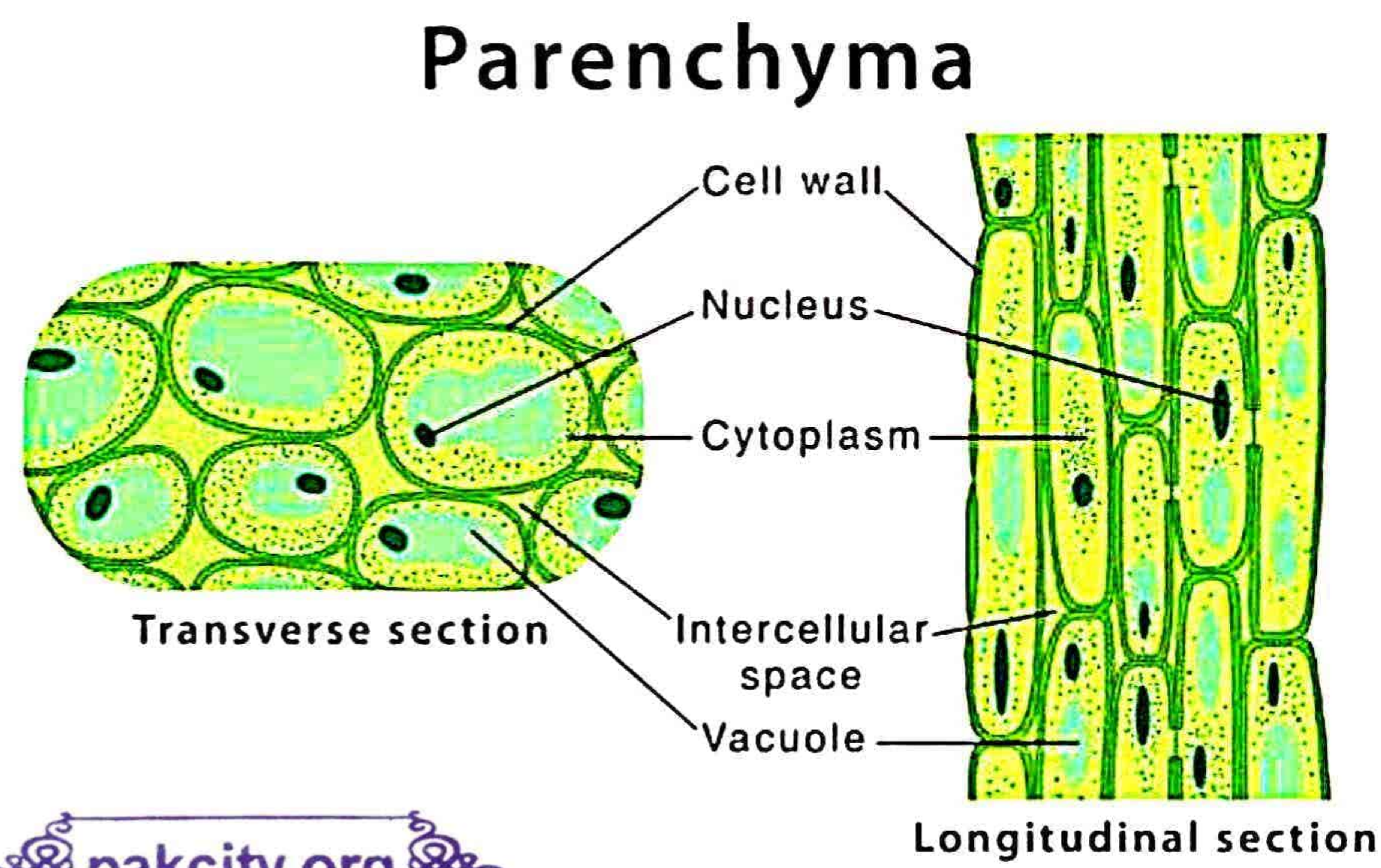
A-SIMPLE TISSUES:

i. Parenchyma:

It is composed of thin walled spherical, oval or elongated cells but have no secondary walls. They are loosely packed with Intercellular spaces. They are living cell and contain chloroplast known as chlorenchyma. Parenchyma gain water by endosmosis and become turgid and exerts internal pressure called turgor pressure. This turgor pressure provides rigidity and firmness.

Location; - They are found in epidermis, cortex and pith of stem.

Functions; - Their function is synthesis of food and storage of food. They may serve as a supporting tissue in soft plant due to internal turgor pressure.

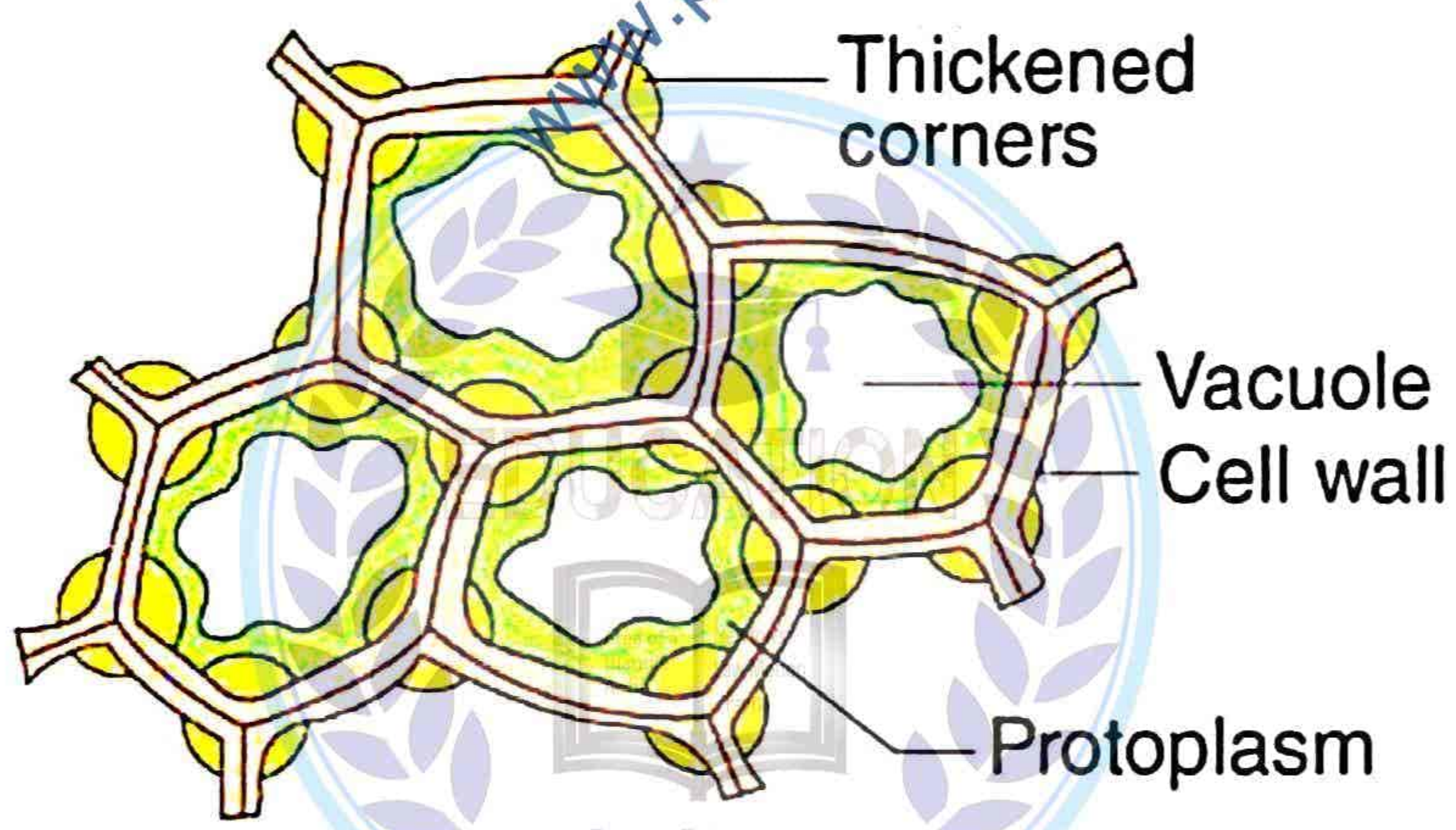


ii. Collenchyma:

Collenchyma is a simple permanent tissue. It is composed of thick walled spherical, oval or polygonal cells. They are living cells with protoplasm. Intra cellular spaces are absent and these cells thickened at the corners due to deposition of cellulose and protopectin.

Location: These tissues are found in the Dicot stem below the epidermis.

Functions: Collenchyma cell provide support to young herbaceous part of the plant. It elongate with the growing stem and leaves.

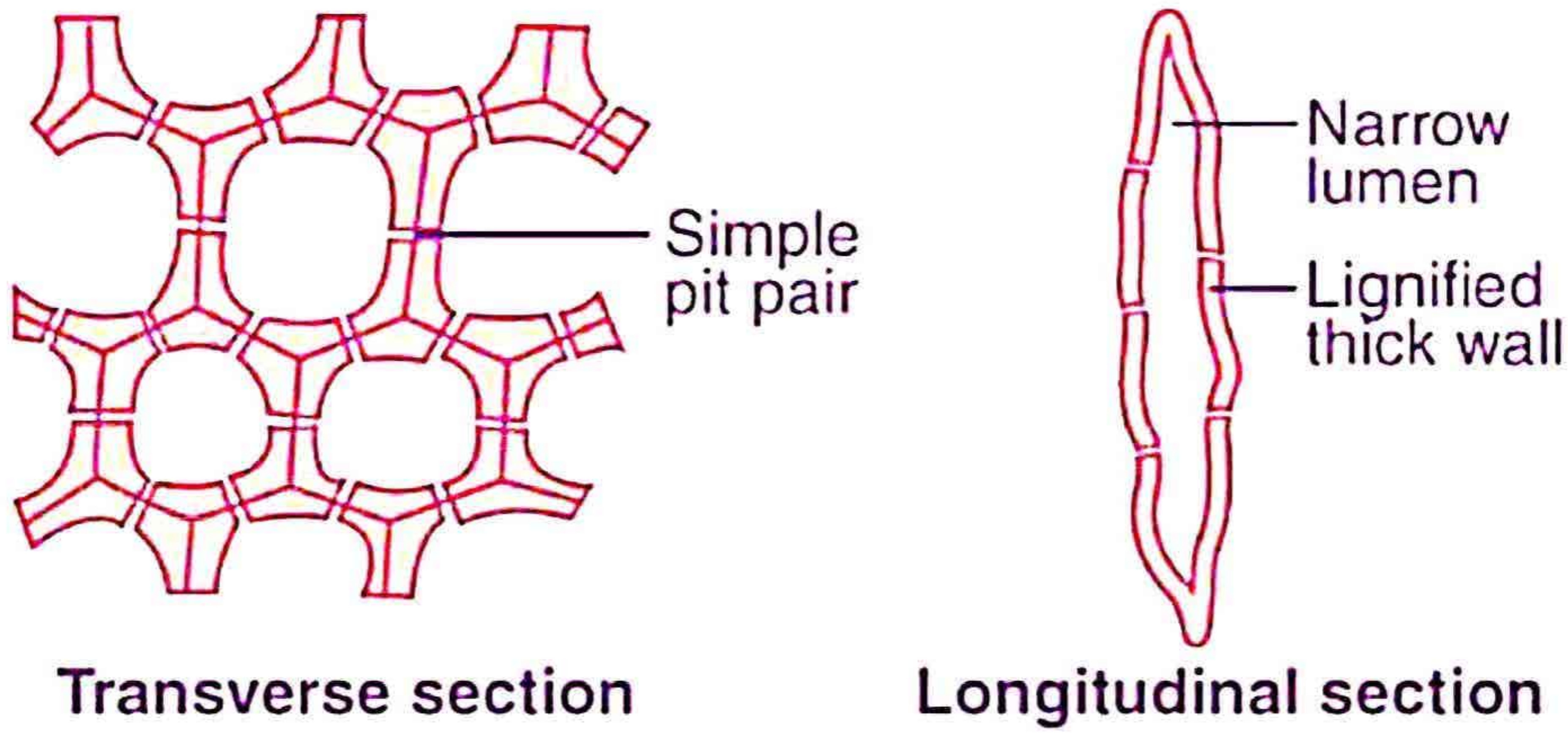


iii. Sclerenchyma:

Sclerenchyma is a simple permanent tissue. It is composed of long, narrow thick-walled cell. They have no intracellular spaces. They are dead cell without protoplasm. A thick material is deposit along the secondary wall of cell called pectin and lignin.

Location: Sclerenchyma tissues are found in xylem which is vascular tissue.

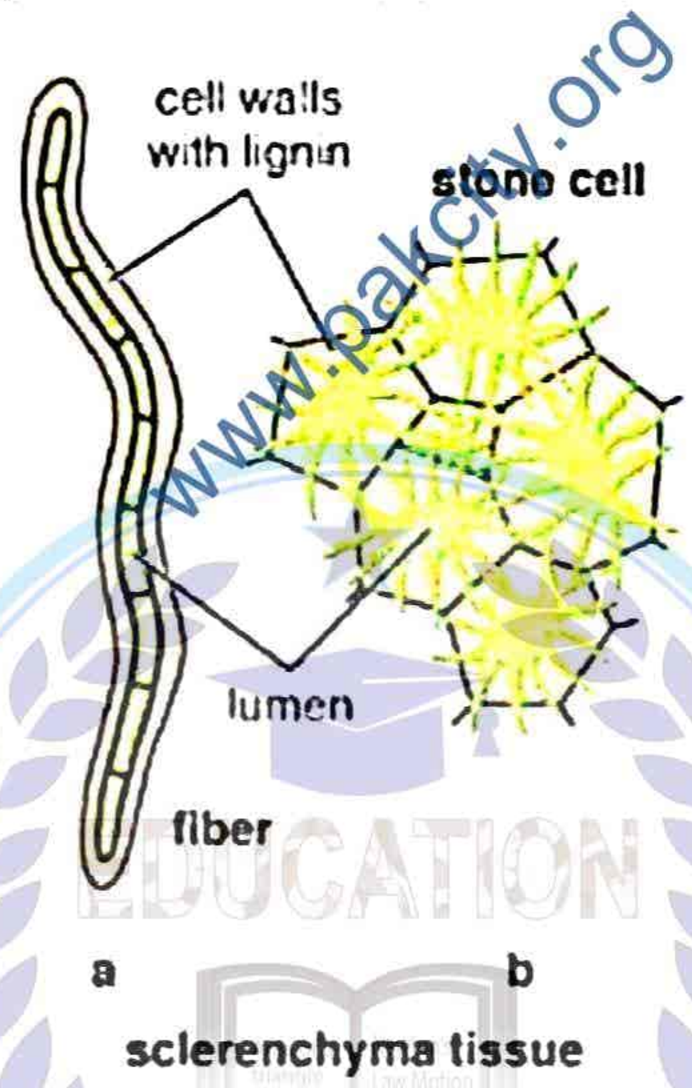
Functions: they provide strength and Mechanical support to the plant parts.



TYPES OF SCLERENCHYMA:

i. Fibers:

- Fibers are elongated, needle-like or slender like pointed sclerenchyma cells.
- They are long, tapered and pointed at the end.
- They are often dead at maturity and lack a nucleus and cytoplasm.
- They are tough and strong but flexible fibers found around xylem tissues.
- These are the source material of ropes and fabrics.



ii. Sclereids

- Sclereids are variable often irregular shape shorter than fibers.
- Simple un-branched sclereids are generally called stone cell.
- Sclereids are hard and inflexible.
- Location: cortex, pith, xylem and phloem, pulp of fleshy fruits, fruit walls and seed coats.
- Also found in shells of nuts.
- Function: provide structural support and mechanical strength to plant organs and form protective coverings as seed coats, shells of nuts, etc.

B-COMPLEX TISSUES

i. Xylem

Xylem conducts water, consists of tracheids and vessel.

a. Tracheids:

- Tracheids are single elongated tube-like structure, without protoplasm, dead cells.

• It has transverse wall making tracheids spindle shaped.
• Its secondary wall is made up of cellulose and Lignin.
• It acts as supporting and conducting tissue in all vascular plants..

b. Vessels (Tracheae):
• Vessels are long cylindrical structure, without protoplasm, have greater diameter than tracheids.
• Vessel consists of vessel member which are arranged one above other to form long straw like structures called vessels.
• It also acts as supporting and conducting tissue.
• At maturity, vessel elements became dead and hollow, lacking a living protoplast.

ANNUAL RING OR GROWTH RINGS
• Secondary Xylem increases the stem thickness.
• Over the year a woody stem get thicker and thicker as its vascular cambium produce layer upon layer of secondary Xylem.
• These layers are visible as rings.
• Annual ring has two regions.
• Outer region: Spring wood.
• Inner region: Summer wood/autumn wood.

GROWTH RESPONSES IN PLANT
PLANT HORMONES/GROWTH REGULATORS:
• Plant hormones are chemical signal molecules, produced within plants in extremely low concentrations.
• Plant hormones control all aspects of plant growth and development including;
• Embryogenesis.
• Regulation of organ size.
• Pathogen defence
• Stress tolerance.
• Went and Thimann coined the term "phytohormone" in the 1937.

KINDS OF HORMONES:
1) Auxin:
It is the main plant growth hormone. The term Auxin is derived from the Greek word Auxein which means to grow.

Types of Auxin
i. Indole-Acetic Acid (IAA)
ii. 4-Chloro-Indole Acetic Acid
iii. Phenyl Acetic Acid (PAA)
Iv. Indole-3 Butyric Acid (IBA)
V. 2-4-Dichlorophenoxy Acetic Acid.

ROLE OF AUXIN
A) Cell division and Cell Enlargement
• Stimulates cell division in the cambium ring and, in combination with cytokinin in tissue culture.
• Stimulates cell elongation.
• Stimulates differentiation of phloem and xylem.

B) Initiation of Root

Stimulates root initiation on stem cuttings and lateral root development in tissue culture.

C) Abscission

Auxin can inhibit or promote leaf and fruit abscission via ethylene stimulation.

D) Growth of fruit

Auxin can induce fruit setting and growth in some plants. Fruit set is defined as the transition of a quiescent ovary to a rapidly growing young fruit, which is an important process in the sexual reproduction of flowering plants.

E) Parthenocarpy

Auxin helps in producing seedless fruits. The development of a fruit without prior fertilization is known as parthenocarpy.

F) Apical dominance

Auxin has inhibitory effect on growth, although it promotes growth. Growth of apical bud inhibits growth of lateral bud. The removal of apical bud initiates growth of lateral bud with more leaves and axillary buds (a bud that grows from the axil of a leaf and may develop into a branch or flower cluster). In plant physiology, apical dominance is the phenomenon during which the main central stem of the plant is dominant over other side stems.

G) Weedicide

Auxin is also a weed killer such as 2-4-dichlorophenoxy acetic acid is used as to kill the weeds in lawn.

H) Stimulate Flowering

Auxin stimulates growth of flower parts.

2. Gibberellins

Gibberellins regulate various developmental processes, including stem elongation, germination, and dormancy, flowering, and leaf and fruit senescence.

Gibberellins was first noticed in a fungus Gibberella fujikuroi, which infects rice seed and causes a disease known as bakanae also known as foolish seedling or foot rot in which roots of rice damage or severe stem overgrowth.

Infected Healthy

ROLE OF GIBBERELLINS:

- Gibberellin stimulates cell division and cell elongation.
- Gibberellins stimulate the development of flowers and fruit.
- Gibberellins help in producing seedless fruits (Parthenocarpy).
- Stimulates growth of pollen tube.
- Mobilize Food-Gibberellins prepare food stored in endosperm by producing an enzyme called amylase so as to converts starch into sugar.

3. Cytokinin:

Cytokinin action is associated with Auxin, as it induces cell division along with auxin. Source of the cytokinin is coconut milk, herring sperm DNA, yeast extract, immature corn grains. Example; Zeatin, Kinetin.

ROLE OF CYTOKININ:

- Initiate fast cell division in combination with Auxin.
- Causes delayed senescence (Old age).
- Detached leaves that lack chlorophyll.
- Breaks seed dormancy.
- Promote fruit development.

4. Abscisic acid:

It is growth inhibitor hormone, during certain conditions such as, drought, onset of winter.

ROLE OF ABSCISIC ACID:

- Abscisic acid induce dormancy in buds and seeds.
- Close stomata.
- Turns leaf primordia (an organ, structure, or tissue in the earliest stage of development) into scale which protects the buds and promotes senescence.

5. Ethene:

It triggers ripening (maturation) of fruit. Ethane affects permeability of cell membrane. It increases the permeability of enzymes to membrane which is responsible for destroying chloroplast.

ROLE OF ETHANE:

- Red and yellow colors are disclosed.
- It contributes to leaf abscission.
- Breaks dormancy of buds and seeds.

MOVEMENT IN PLANTS:

Any action taken by living organs to reduce its irritability produce by stimuli is called Movement.

TYPES OF MOVEMENT:

There are two type of movement in plant.

1. Autonomic movement or spontaneous movement.
2. Paratonic movement or induced movement.

1. PARATONIC MOVEMENT OR INDUCED MOVEMENT:

The movement occurs due to external stimuli are called paratonic or Induce Movement.

Types of Paratonic Movement:

There are two types of paratonic movement.

A. Nastic movement (non-directional movement).

B. Tropic Movement (Non-directional movement).

A. Nastic Movement (non-directional):

- The non-directional movement of parts of plant in response to external stimuli is called Nastic Movement.
- Usually this movement occurs in leaves or petals of flower.

Type of Nastic Movement:

There are five types of nastic movement.

i. Photonastic.

ii. Thermonastic.

Iii. Seismonastic.

iv. Nyctinastic.

V. Haptonasticpic movement (directional movement).

B. Tropic Movement (Directional):

• The movement in response of growth of whole organ toward and away from stimuli is called tropic movement.

• It is also known as directional movement.

Type of Tropic Movement:

i. Phototropism.

ii. Geotropism.

iii. Chemotropism.

iv . Hydrotropism.

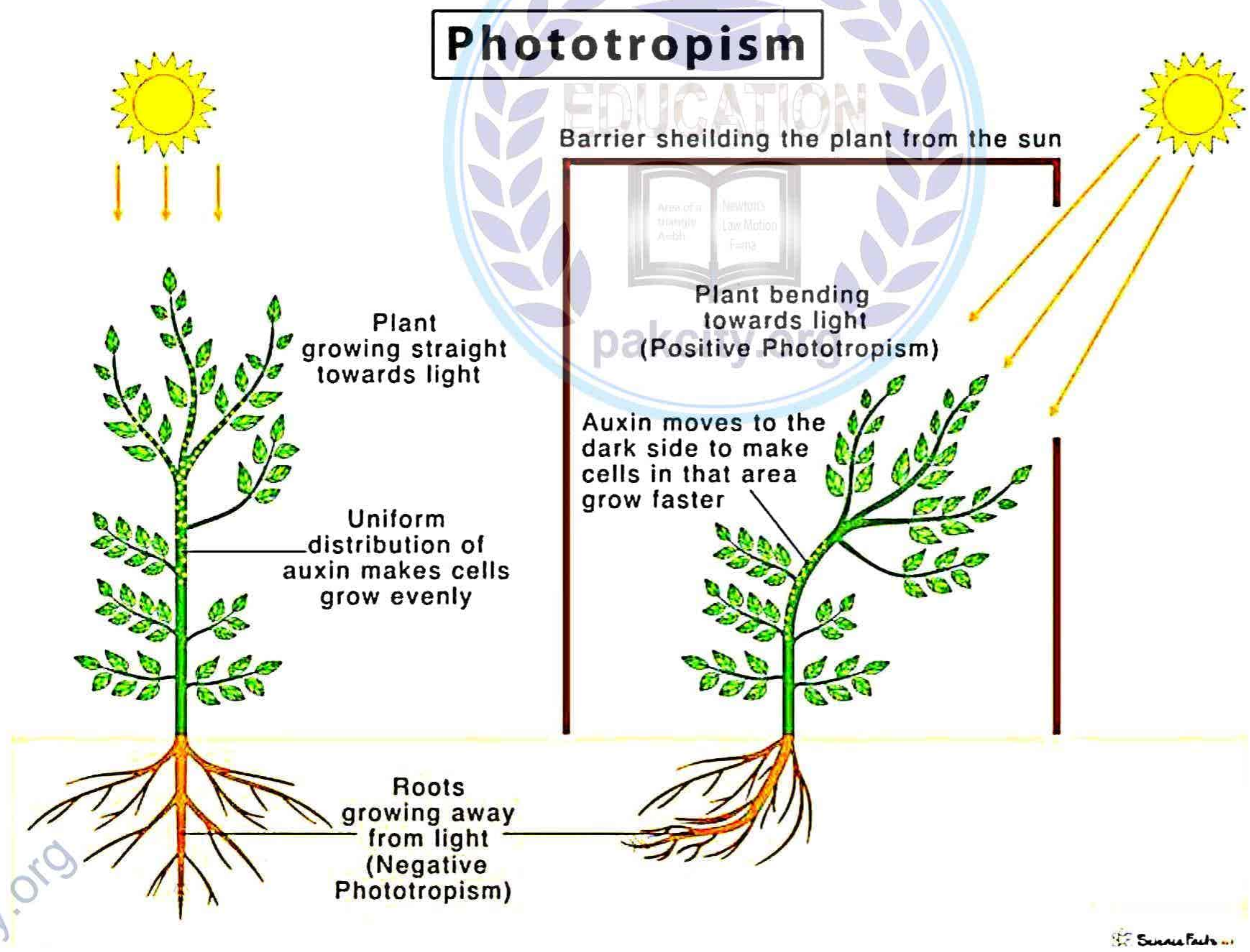
V. Thigmotropism

i. Phototropism:

The movement of part of plant in response to stimulus of light is called phototropism.

Examples: 1. Positive phototropism in stem.

2. Negative phototropism in root.



ii. Geotropism:

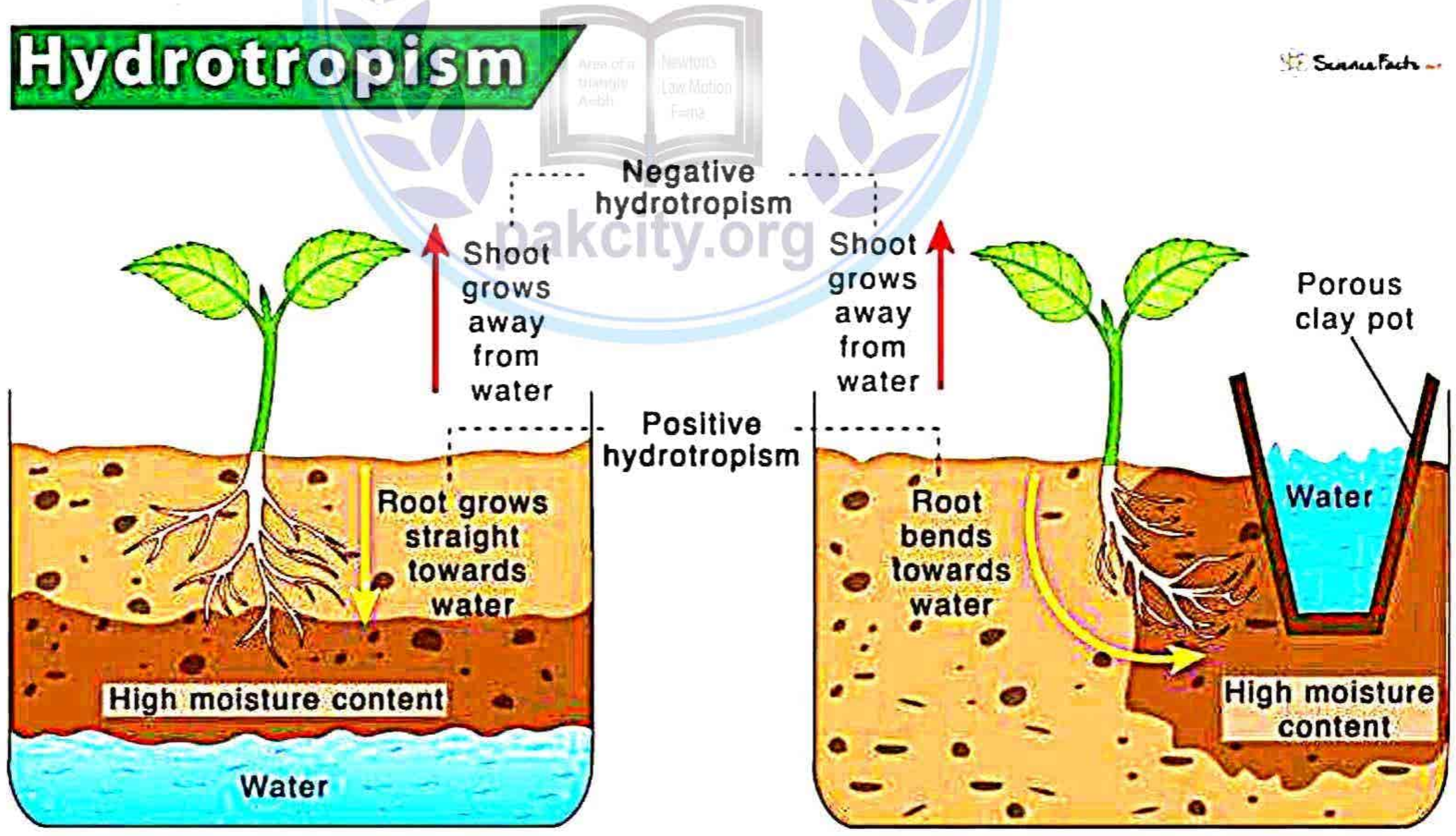
The movement of part of plant in response to force of gravity is called Geotropism. Example: Root display positive Geotropism and shoots negative geotropism.

ii. Chemotropism:

The movement in response to some chemicals is called Chemotropism. Example: The Hyphae of fungi show chemotropism.

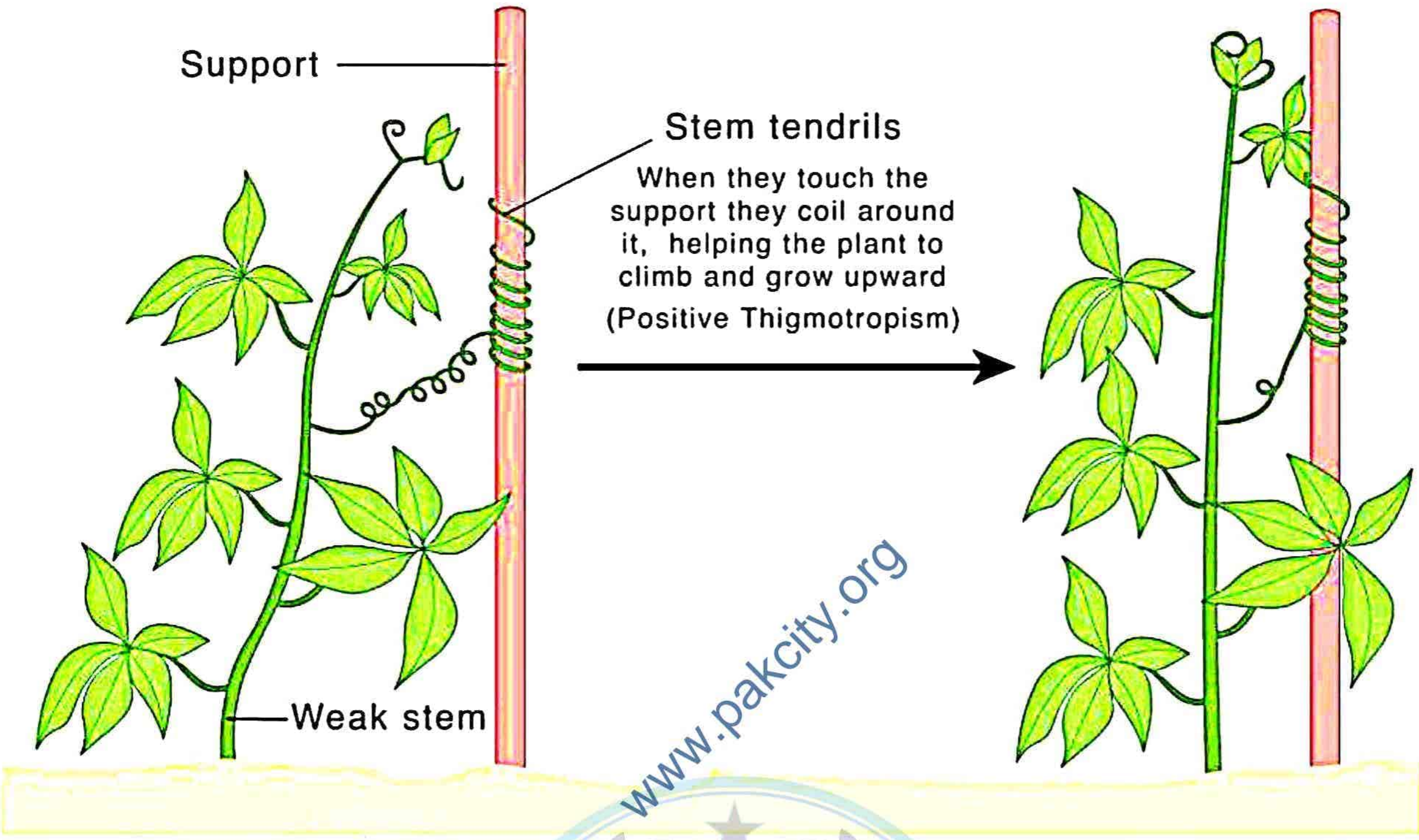
iv. Hydrotropism:

The movement of plant parts in response to stimulus of water is called hydrotropism. Example: The growth of root toward water is due to positive hydrotropism and shoots negative hydrotropism.



v. Thigmotropism:

• Movement of plant parts in response to stimulus of touch is called Thigmotropism.
• Some plants possess modified leaves, stipules or stems called tendrils.
• When the tendril touches surface rapid growth begins from its opposite end and the plants begins to curve around structure.
• The tendril provides support to plant by coiling around structure as they grow.
Example: Climber plants such as Morning Glory Ipomea nil.



PHOTOPERIODISM:
• It is defined as "the response of plants to relative lengths of day and night ".
• The relative length of day and night affects the activities of organisms e.g. flowering in plants.
• The illuminated period is called photo period.
• Photo period affects the flowering in plants.
• The plants are divided into three types on the basis of production of flowers.

TYPES OF PLANT ON THE BASIS OF LENGTH OF DAY AND NIGHT:

1) Long Day Plants:
• These plants produce flower in long photo period i.e. they require long days and short nights.
• The long day plants produce flowers when length of photo period is more than critical length in each 24 hours cycle.
• In these plants critical length varies from 11 hours to 14 hours.
E.g. Hibiscus, Spinach, Radishes, Lettuce and Sugar beet.

2) Short Day Plants:
• These plants produce flower in short photo period i.e. they require short days and long night.
• These plants produce flower only when the photo period is shorter than critical length in each 24 hours.
• The critical length for cockle bur is 14/2 i.e. 7 hours.
E.g. Chrysanthemums (Gull-e-Daodi/sada bahar), Poinsettias (Phool wali jhari), cockle bur (Gokhro).

3) Day Neutral Plants

- Those plants which are different in day length are called day neutral plant.
- They produce flower in both long and short photo period.
- They require only five hours continuously.

E.g. Tomato, Cotton.

ROLE OF PHYTOCHROME IN PHOTOPERIODISM:

A cytoplasmic pigment of green plants that absorbs light and regulates dormancy, seed germination, and flowering is called phytochrome.

Types of phytochrome:

There are two interconvertable forms of phytochromes i.e. phytochrome 660 and phytochrome 730.

1) Phytochrome 660 (P_R):

This photoreceptor absorbs red light at a wave length of 660 nm. It can convert into phytochrome 730 when it absorbs far red light at 730 nm.

2) Phytochrome 730 (P_{ER}) :

This photoreceptor absorbs light in the far red region of the spectrum at a wavelength of 730 nm. It can change into phytochrome 660 when it absorb red light at 660 nm.

Phytochrome is a family of proteins with a small covalently-bound pigment molecule. It is distributed throughout in plants but most concentrated in growing tips. These two forms act in antagonistic way i.e. when P660 induces a response, P730 inhibits it.

DIFFERENCE BETWEEN RED LIGHT EFFECTS AND FAR- RED LIGHT EFFECTS:

Red light effects	Far-red light effects
Phytochrome 660 changes to phytochrome 730.	Phytochrome 730 changes to phytochrome 660.
Stimulates: Germination of some seeds (lettuce) and flowering in long day plants.	Inhibits: Germination of some seeds (lettuce), and flowering in long day plants.
Induces: Formation of anthocynin (plant pigment) and increase in leaf area.	Prevent: Formation of anthocynin and increase in leaf area.
Inhibits: Flowering in short day plants and elongation of internodes.	Stimulates: Flowering in short day plants and elongation of internodes.
Causes epicotyl hook to unbend.	Maintain epicotyl hook bend.

VERNALIZATION:

"Promotion of flowering by a cold treatment given to the imbibed seeds or young plants".

"The phenomenon which shortens the vegetative period and hastens flowering, is known as Vernalization".

EFFECT OF VERNALIZATION ON FLOWERING:

The effect of low temp. treatment applied in the earlier stages of plants development has an after effect on the later stages of the development of a plant.

Many plants require cold treatment for germination.

EXAMPLE:

i. Pine seeds will not germinate if not exposed cold temperature.
ii. Many cereals like wheat and rice exist in two varieties or races, the Annual or Spring and biennial or winter variety.

ANNUAL OR SPRING VARIETY:
The spring or annual variety is sown in spring and yield is obtained/ flowers in summer of the same year.
BIENNIAL OR WINTER VARIETY:
The biennial or Winter variety is sown in fall and the yield is obtained in the summer of next year.

Practical Uses OR Importance Of Vernalization:
i. It is used in the improvement of crop production.
ii. Out of season flowers can be produced by vernalization.
iii. Shortening of vegetative period of cereal crops by low temperature treatment is an important method to protect from drought conditions.
Types of plants flower production:
i. Annual plant: complete growth cycle within single year.
ii. Biennial plant: complete growth cycle within two years i.e. produce flowers only once within two growth seasons.
iii. Perennial plant: produce flowers repeatedly.

DIFFERENTIATE BETWEEN APOPLAST AND SYMPLAST PATHWAY:

APOPLAST PATHWAY	SYMPLAST PATHWAY
The movement of the ions in plants through the extracellular pathway between the cell walls of the adjacent cells is called Apoplast.	The movement of minerals in plants through the plasmodesmata of the cells is called Symplast pathway.
Ions easily reaches the endodermis cells by Apoplast pathways.	There is a concentration gradient (higher to lower) down the cells of cortex, endodermis, pericycle and sap of xylem cell.
But the Casparian strips of the endodermis prevent the further movement. Thus these ions must enter into the endodermal cells by diffusion or active transport.	So the minerals move down through Plasmodesmata into the cells of cortex, endodermis, Pericycle and then to the sap of the xylem.

DIFFERENTIATE BETWEEN COHESION AND ADHESION:

COHESION	ADHESION
It is the attraction among similar type of molecules like water which holds water together.	It is the attraction between different types of molecules like water molecules and some other different molecule or walls of vessel or container.
As a result a solid chain-like column is formed within the xylem tubes.	The cellulose component of the cell wall has great affinity with water. It can imbibe water.) Therefore the cell walls of xylem help to adhere and creep up water molecules.

Hydrogen bonds are formed between the water molecules & helps to maintain the column of water.	As a result the column of water in xylem tissue does not break.

DIFFERENTIATE BETWEEN MESOPHYTES AND XEROPHYTES:

MESOPHYTES	XEROPHYTES
The plants that are found in the area where moderate supply of water is available are called mesophytes.	The plants that are found in the area where very little amount of water is available are called xerophytes
Common crop plants such as wheat, rice com are example of such plants.	Desert plants such as cactus, opuntia are example of such plants.
These plants are exposed in nearly isotonic conditions so face no drastic problem of flooding (excess of water) or dehydration (deficiency of water).	These plansts are exposed to severely hypertonic conditions so face extreme degree of dehydration. Such plants show very reduced rate of transpiration due to narrow needle like leaves or due to complete modification of leaves into spines.
However, these plants can close their stomata even in day.	These plants store a very high amount of water therefore, they are also called succulent plants.

DIFFERENTIATE BETWEEN COLLENCYMA CELLS AND SCLERENCHYMA CELLS:

COLLENCYMA CELLS	SCLERENCHYMA CELLS
They have protoplasts.	The lose their protoplast after maturity.
They are living usually lack secondary walls.	They have thick secondary cell walls with no angular thickening.
They have angular thickening in their primary walls	They are seen in only woody dicots.
They provide support to young herbaceous parts of the plants.	These are rigid, elongate circular cells promoting growth of stems and roots.
They collenchyma cells are elastic, elongate with the growth of stems and leaves.	

SHORT QUESTIONS

i. Why mineral nutrients are necessary for plants?
Answer: Plants require minerals to grow leaves, stems, and roots, to produce chlorophyll and carry out photosynthesis. Mineral nutrients enhance the plants resistance under high temperature and other environmental stresses. Such as for many physiological processes like maintenance of turgidity, photosynthesis and enzyme activation, etc., potassium (K) is an essential nutrient.

ii. Why Nz is included in mineral nutrients although it is not mineral?
Answer: Plants cannot absorb N from the atmosphere instead they absorb N from soil in the form of nitrates. Nitrates are soluble solid compounds thus, the nitrates are similar to the other mineral nutrients, and presumably that's why nitrogen can be classed as a mineral nutrient.

iii. Why desert plants reduce their leaf size?
Answer: stomata are present on the surface of leaves which help in the transpiration. In deserts, plants face water shortage so, desert plants modify their leaves into spines. Spines lea

surface area and less stomata hence reduce water loss by transpiration. Thus, they help in conserving water.

iv. Why carnivorous plants use insect as food?
Answer: carnivorous plants grow in such areas where there is depletion of Nitrogen, sulfur and phosphorous. Nitrogen is the component of protein and nucleic acid. Since nitrogen is essential for all living things, the plants must have an alternate way to acquire the element. These plants capture insects and obtain their nitrogen from the proteins of the insects to increase their nutritional levels.

v. Why phytochrome pigments are important to photoperiodism?
Phytochrome is a photoreceptor that allows plants to regulate many growth and development processes by detecting light and darkness. For example, some flowers bloom based on changes to day length over the course of their growing season in a phenomenon known as photoperiodism. The active Pfr form mediates light signals to control various physiological traits.

vi. How annual rings are formed?
Answer: Annual rings are growth rings that show one year growth of plants. It is formed by the secondary xylem. Annual rings consist of springwood (earlywood) - the lighter appearing ring made up of larger, thin-walled cells, and summerwood (latewood) - the darker appearing ring made up of small, thicker-walled cells.

vii. Why cold treatment is necessary for the germination of seed in some plants?
Answer: Many plants require a period of cold temperatures to break their dormancy cycle so it can sprout. For example many garden plants need low temperature near 30 °C. Temperature above this can cause diseases and rot because seed can absorb water but cannot start growth. e.g. herbaceous perennials.

viii. How osmotic adjustment is beneficial for plants?
Answer: lowering of osmotic potential due to accumulation of low molecular weight solutes and inorganic ions in response to water stress, has been considered to be a beneficial drought tolerance mechanism in some crop species. Osmotic adjustment allows water to enter the roots, and take part in the maintenance of stomatal conductance, turgor pressure and to restore the cell activities, photosynthesis, and finally improved plant growth and yield.

ix. What is the purpose of gaseous exchange in plants?
The purpose of gaseous exchange is to enable the organism to perform cellular respiration, which utilizes oxygen and releases CO_2 during the breakdown of complex organic compounds. Exchange of gases between organism and its environment is carried out by diffusion. In the absence of special organs, every cell of plant carries out the exchange of O_2 and CO_2 according to its needs. This exchange of gases mainly occurs through two main openings, the stomata and lenticels.

x. Why support is needed in terrestrial life?
When the life started on land from water, one of the very important needs for the organisms was to gain some sort of support and strength for keeping their bodies in shapes. Plants also have variety of support mechanisms.

Such as turgor mechanisms in parenchyma cells, mechanical tissues (collenchyma, sclerenchyma), arrangement of vascular bundles and secondary growth.

xi.Describe the types of plants growth.

Primary growth:

After germination of seed plant starts its life, it begins to increase its length first, this increase in length of root and shoot is therefore, called primary growth. It remains continue throughout the life of a plant.

Secondary growth:

The increase in thickness and diameter of a plant is called secondary growth. This is characteristic of stems and roots of dicots and gymnosperms where it contributes a significant role in support of the plant body. The tissues which are produced during secondary growth are called secondary tissues.

xii. What is growth response in plants?

Many plants grow primarily at a single apical meristem and have limited lateral branches. This phenomenon is called apical dominance, and is regulated by the presence of auxin at the apical meristem. Auxin is required for the function of other growth-regulating hormones such as cytokinins; cytokinins promote cell division, but only in the presence of auxin. Abscisic acid in the lateral buds inhibits production of a uxin, and removal of the apical bud will release this inhibition of auxin, allowing the lateral buds to begin growing.

xiii. How water move in the xylem at night?

Answer: At night, when stomata close and transpiration stops, the water is held in the stem and leaf by the cohesion of water molecules to each other as well as the adhesion of water molecules to the cellulose in cell walls of the xylem vessels and tracheids.

xiv. Why translocation of organic solutes is essential in higher plants?

(i) In higher plants, only the green parts can manufacture food and it must be supplied to other non-green parts for consumption and also for storage.

(ii) During the germination of the seeds, the insoluble reserve food material of the seed is converted into soluble form and is supplied to the growing regions of young seedling till it has developed its own photosynthetic system i.e., leaves.

Translocation of organic solutes always takes place from the region of higher concentra-tion of soluble form i.e., the supply end (source) to the region of lower concentration of its soluble form i.e., the consumption end (sink).

xv. Why apical meristem is known as primary meristem?

Since these meristems are present in plants right from embryonic life therefore they are also known as primary meristem.

xvi. How gases exchange take place in plants?

In Plants gaseous exchange takes place through diffusion via stomata. Exchange of gases occurs with the closing and opening of the stomata b/w the inferior of leaves and the atmosphere.

DEFINITIONS:

MONOFACIAL LEAF:

Monofacial leaf is also known as isolateral leaf. In monofacial leaf upper and lower surface cannot be distinguished. In monofacial leaves stomata are present only on lower surface.

BIFACIAL LEAF:
Bifacial leaf is also known as dorsiventral leaf. In bifacial leaf upper and lower surfaces can be distinguished, means upper palisade and lower spongy mesophyll cells. In bifacial leaves stomata are present on both upper and lower surfaces.

TRACHEIDS:
Tracheids are dead elongated, narrow tube-like cells of xylem that provide support and as well as transport water and minerals within the plant. Tracheids are found in gymnosperms and lower angiosperms plants.

WATER POTENTIAL:
Free energy associated with water molecule responsible for movement of water is called water potential. Water potential is the potential energy of water which makes the water molecules to move from higher concentration of water to lower concentration of water.

OSMOTIC PRESSURE:
The pressure exerted upon a solution to keep it with equilibrium with pure water is called osmotic pressure. Or tendency of water to move into solution by osmosis.

OSMOTIC POTENTIAL:
The tendency of a solution to attract the water molecules is called osmotic potential. It is the potential of water molecules to move from a hypotonic solution to a hypertonic solution across a semi-permeable membrane.

SOLUTE POTENTIAL:
The concentration of solute particles in a solution is known as solute potential Solutes reduce the water potential by consuming some of the potential energy available in the water. This measure of decrease in water potential of a medium due to the addition of solutes is called solute potential.

PRESSURE POTENTIAL:
Pressure potential is the pressure which develops in an osmotic system due to osmotic entry or exit of water from it. Measure of increase in water potential of a medium due to the addition of water or due to the pressure greater than atmospheric pressure is called pressure potential.

LATERAL TRANSPORT:
Short distance transport of water and minerals in the plants from one tissue of the plant to other tissue within the plant is known as lateral transport. Lateral transportation occurs via 2 methods- Symplast pathway and apoplastic pathway.

PLASMODESMATA:
Plasmodesmata are the microscopic channels that traverse the cell walls of plant cells and allow transport and communication between the adjacent cells. They connect the cytoplasm of neighboring cells causing an exchange of materials and communication between the cells.
TRANSPIRATION:

Transpiration is the process in which water is lost as water vapor from the aerial parts of the plants through stomata. This process removes excess water, creates a suction pull to helpin transport of water upwards, and cools down the plant.

TRANSLOCATION:

Translocation is the process of transport of nutrients such as sucrose and amino acids throughout the plant via the phloem from their source of production to non-photosynthetic cells or side of storage.

HOMEOSTASIS:

Homeostasis, from the Greek words for "same" and "steady," refers to any process that living things use to actively maintain a constant and balanced internal environment necessary for survival.

PLASMOLYSIS:

Plasmolysis is the process in which cells lose water when they are placed in a hypertonic solution. It causes contraction or shrinking of the plasma membrane away from the cell wall.

HYPERTONIC SOLUTION:

A type of solution that has a high solute concentration and low water concentration compared to body fluids. In a hypertonic solution, the net movement of water will be out of the body and into the solution.

HYPOTONIC SOLUTION:

A type of solution that has a low solute concentration and high water concentration compared to body fluids. In hypotonic solutions, there is a net movement of water from the solution into the body.

CYTOSOL:

Cytosol is known as the matrix of the cytoplasm. It surrounds the cell organelles in eukaryotes. In prokaryotes, all the metabolic reactions occur here. Thus, we can infer that while cytosol is the fluid contained in the cell cytoplasm, cytoplasm is the entire content within the cell membrane.

TURGOR PRESSURE:

Turgor pressure is the pressure that is exerted by water to the wall of a cell. OR Pressure built inside the cell due to entry of water by endosmosis is called turgor pressure.

Turgor pressure specially built in parenchyma cells of lower plants plays an important role in support of plant. Parenchyma cells have thin primary cell wall and chloroplast hence, water move inside the parenchyma cells and extended. Due to turgor pressure plants cells remain firm and rigid.

PHOTOPERIODISM:

It is defined as "the response of plants to relative lengths of day and night ". The relative length of day and night affects the activities of organisms e.g. flowering in plants.

VERNALIZATION:

Vernalization is the cooling of seed during germination in order to accelerate flowering, when it is planted or subjection of seeds or seedlings to low temperature in order to fasten plant development and flowering is called vernalization.

HYDATHODES:

Hydathode is a plant organ responsible for guttation in vascular plants, i.e. the release of droplets at leaf margin or surface. Because this organ connects the plant vasculature to the external environment. Hydathodes are mainly found in aquatic plants and in some herbaceous plants growing in moist places.