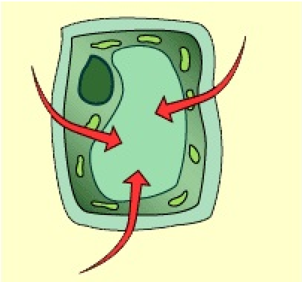
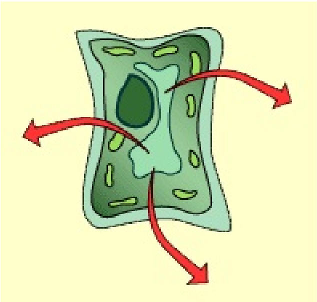
Revision Notes on Transport in Plants

(1) Types of osmosis



Depending upon the movement of water into or outward of the cell, osmosis is of two types.

(a) **Endosmosis:** The osmotic inflow of water into a cell, when it is placed in a solution, whose solute concentration is less than the cell sap, is called endosmosis *e.g.,* swelling of raisins, when they are placed in water.



(b) **Exosmosis:** The osmotic outflow of water from a cell, when it is placed in a solution, whose solute concentration is more than the cell sap, is called exosmosis. *e.g.,* shrinkage of grapes when they are placed in strong sugar solution.

(2) Osmotic concentrations (Types of solutions)

A solution can be termed as hypotonic, hypertonic and isotonic depending upon its osmotic concentration, with respect to another solution or cell sap.

(a) **Hypotonic solution** (*hypo* = less than). A solution, whose osmotic concentration (solute potential) is less than that of another solution or cell sap is called hypotonic solution. If a cell is placed in such a solution, water start moving into the cell by the process of endosmosis, and cell become turgid.

(b) **Hypertonic solution** (*hper* = more than). A solution, whose osmotic concentration (solute potential) is more than that of another solution or cell sap is called hypertonic solution. If a cell is placed in such a solution, water comes out of the cell by the process of exosmosis and cell become flaccid. If potato tuber is placed in concentrated salt solution it would become shrink due to loss of water from its cell.

(c) **Isotonic solution** (*iso* = the same). A solution, whose osmotic concentration (solute potential) is equal to that of another solution or cell sap, is called isotonic solution. If a cell is placed in isotonic solution, there is no net change of water between the cell and the solution and the shape of cell remain unchanged. The normal saline (0.85% solution of $NaCl$) and 0.4 m to 0.5 m solution of sucrose are isotonic to the cell sap.

(3) Significance of osmosis in plants

(a) The phenomenon of osmosis is important in the absorption of water by plants.

(b) Cell to cell movement of water occurs throughout the plant body due to osmosis.

(c) The rigidity of plant organs (*i.e.,* shape and form of organism) is maintained through osmosis.

(d) Leaves become turgid and expand due to their OP.

(e) Growing points of root remain turgid because of osmosis and are thus, able to penetrate the soil particles.

(f) The resistance of plants to drought and frost is brought about by osmotic pressure of their cells.

(g) Movement of plants and plant parts, for example, movement of leaflets of Indian telegraph plant, bursting of many fruits and sporangia, etc. occur due to osmosis.

(h) Opening and closing of stomata is affected by osmosis.

(4) Turgor pressure (TP)

The plant cell, when placed in pure water, swells but does not burst. Because of negative osmotic potential of the vacuolar solution (cell sap), water will move into the cell and will cause the plasmalemma be pressed against the cell wall.

(5) Wall pressure (WP)

Due to turgor pressure, the protoplast of a plant cell will press the cell wall to the outside. The cell wall being elastic, presses back the protoplast with a pressure equal in magnitude but opposite in direction. This pressure is called **wall pressure**. Wall pressure (WP) may, therefore, be defined as '*the pressure exerted by the cell wall over the protoplast to counter the turgor pressure*.

(6) Plasmolysis (Gr. Plasma = something formed; lysis = loosing)

If a living plant cell is placed in a highly concentrated solution (*i.e.* hypertonic solution), water comes out of the cell due to exosmosis, through the plasmamembrane. The loss of water from the cell sap causes shrinkage of the protoplast away from the cell wall in the form of a round mass in the centre. "*The shrinkage of the protoplast of a living cell from its cell wall due to exosmosis under the influence of a hypertonic solution is called plasmolysis*".

(8) **Water potential (*y*)**

The movement of water in plants cannot be accurately explained in terms of difference in concentration or in any other linear expression. The best way to express spontaneous movement of water from one region to another is in terms of the difference of free energy of water between two regions. Free energy is the thermodynamic parameter that determines the direction in which physical and chemical changes must occur. The potential energy of water is called water potential. *e.g.,* water is stored behind a dam.

(9) Differences between diffusion pressure deficit and water potential

S.No.	Diffusion Pressure Deficit (DPD)	Water Potential (*y*)
(1)	The DPD was originally described by the term suction force (*Saugkraft*) by Renner. Other synonyms of the term are suction pressure (SP), enter tendency (E) and osmotic equivalent (E).	Water potential is the chemical potential of water which is equivalent to DPD with negative sign. The term water potential was coined by Slatyer and Taylor (1960).
(2)	The diffusion pressure deficit is abbreviated as DPD. The term was coined by Meyer (1938).	The symbol for water potential is a Greek letter *psi*, which is designated as *y*.

(10) Differences between active and passive absorption of water

S.No.	Active absorption	Passive absorption
(1)	Force for absorption of water is generated in the cells of root itself.	Force for absorption of water is created in the mesophyll cells.
(2)	Osmotic and non-osmotic forces are involved in water absorption.	Water is absorbed due to transpiration pull.
(3)	Water is absorbed according to DPD changes.	Water is absorbed due to tension created in xylem sap by transpiration pull.
(4)	Water moves through symplast.	Water moves mainly through apoplast.
(5)	Rate of absorption is not affected significantly by temperature and humidity.	Its rate is significantly affected by all those factors which influence the rate of transpiration.
(6)	Metabolic inhibitors if applied in root cells decrease the rate of water absorption.	No effect of metabolic inhibitors if applied in root cells.
(7)	Occurs in slow transpiring plants which are well watered.	Occurs in rapidly transpiring plants.
(8)	Rate of absorption is slow.	Very fast rate of water absorption.

(11) Differences between transpiration and evaporation

S.No.	Transpiration	Evaporation
(1)	It is a physiological process and occurs in plants.	It is a physical process and occurs on any free surface.
(2)	The water moves through the epidermis with its cuticle or through the stomata.	Any liquid can evaporate. The living epidermis and stomata are not involved.
(3)	Living cells are involved.	It can occur from both living and non-living surfaces.
(4)	Various forces (such as vapour pressure, diffusion pressure, osmotic pressure, etc) are involved.	Not much forces are involved.
(5)	It provides the surface of leaf and young stem wet and protects from sun burning.	It causes dryness of the free surface.

(12) **Number of stomata on leaves**

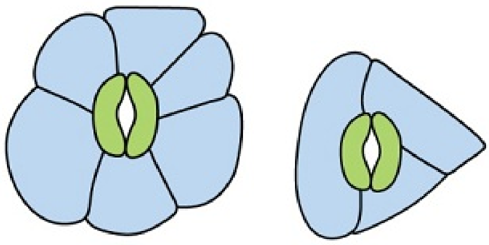
The number of stomata is not equal on both surface of leaves in different plants.

Name of the plant	Number of stomata/mm^2	
	Upper surface	Lower surface
Helianthus annuus	58	156
Lycopersicum esculantum	12	130
Phaseolus vulgaris	40	281
Solanum tuberosum	51	161
Zea mays	52	68
Avena sativa	40	43

(13) **Types of stomata**

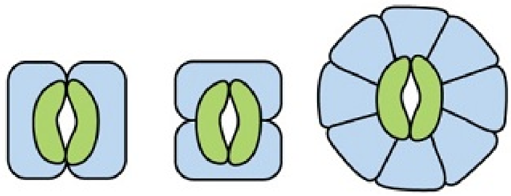
On the basis of orientation of subsidiary cells around the guard cells, **Metcalfe** and **Chalk** classified stomata into following types :

(i) **Anomocytic :** The guard cells are surrounded by a limited number of unspecialised subsidiary cells which appear similar to other epidermal cells. *e.g.*, in Ranunculaceae family.



(ii) **Anisocytic :** The guard cells are surrounded by three subsidiary cells, two of which are large and one is very small. *e.g.,* in Solanaceae and Cruciferae families.

(iii) **Paracytic :** The guard cells are surrounded by only two subsidiary cells lying parallel to the guard cells *e.g.*, Magnoliaceae family.



(iv) **Diacytic :** The guard cells are surrounded by only two subsidiary cells lying at right angles to the longitudinal axis of the guard cells. *e.g*., Acanthaceae and Labiatae families.

(v) **Actinocytic :** The guard cells are surrounded by four or more subsidiary cells and which are elongated radially to stomata.

(14) Differences between transpiration and guttation

S.No.	Transpiration	Guttation
(1)	It occurs during day time	It usually occurs in the night.
(2)	The water is given out in the form of vapour.	The water is given out in the form of liquid.
(3)	The transpired water is pure.	Guttated water contains dissolved salts and sugar.
(4)	It takes place through stomata lenticel or cuticle.	It occurs through special structure called hydathode found only on leaf tips or margin.
(5)	It is a controlled process.	It is uncontrolled process.
(6)	It lowers down the temperature of the surface.	It lacks such relationship.

(15) Differences between stomata and hydathode

S.No.	Stomata	Hydathode
(1)	Stomata occur on epidermis of leaves, young stems, etc.	Hydathodes generally occur at the tip or margins of leaves of those plants that grow in moist shady places.
(2)	Stomatal aperture is guarded by two kidney shaped guard cells.	The aperture of hydathode is surrounded by a ring of cuticularised cells.
(3)	The two guard cells are generally surrounded by subsidiary cells.	The subsidiary cells are absent.
(4)	The opening and closing of stomatal aperture is regulated by guard cells.	Hydathode pore remains always open.
(5)	These are the structure involved in transpiration and exchange of gases.	Hydathodes are involved in guttation.