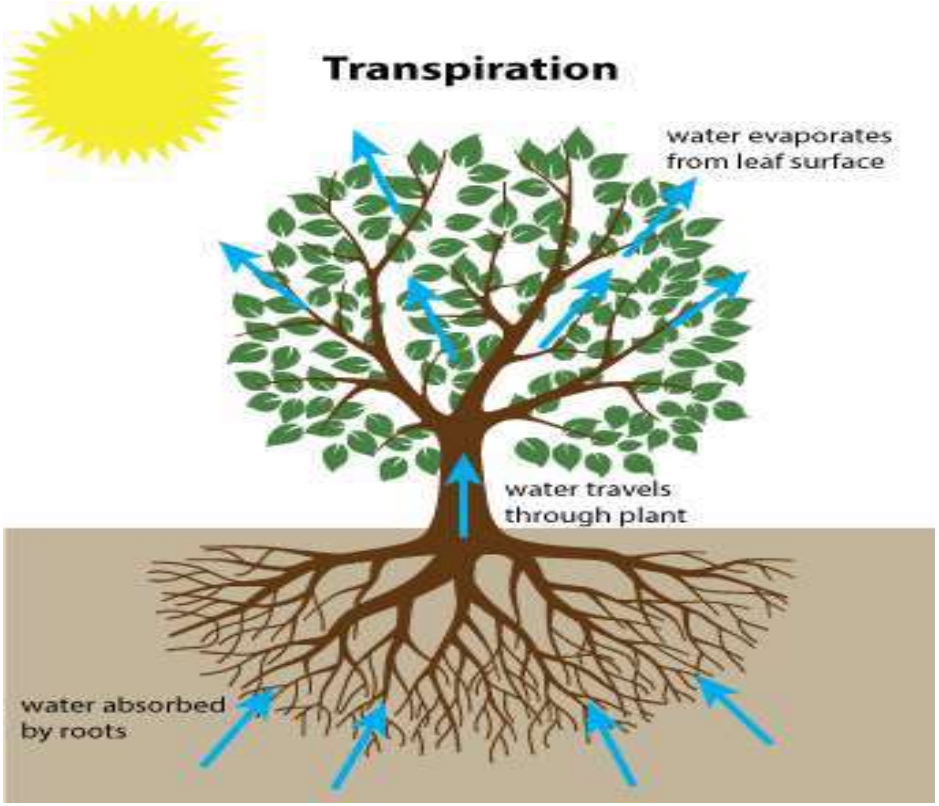
TRANSPIRATION

For B.Sc. Part II (Subs) Group C (Plant Physiology)



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Lecture No.03

Transpiration ????

The loss of water from the aerial parts of the plant in the form of water vapours is called transpiration. Leaves are the principal organs of transpiration and most of the transpiration takes place through their stomata

- Large quantities of water are absorbed by the plants from the soil but a small amount of it is utilized.
- The excess amount of water is lost from the aerial parts of the plants in the form of vapour.
- Transpiration was first worked out by *Stephen Hales.* Transpiration is the process by which water vapour leaves the living plants body and enters the atmosphere. (Michel,1978)

Types of Transpiration

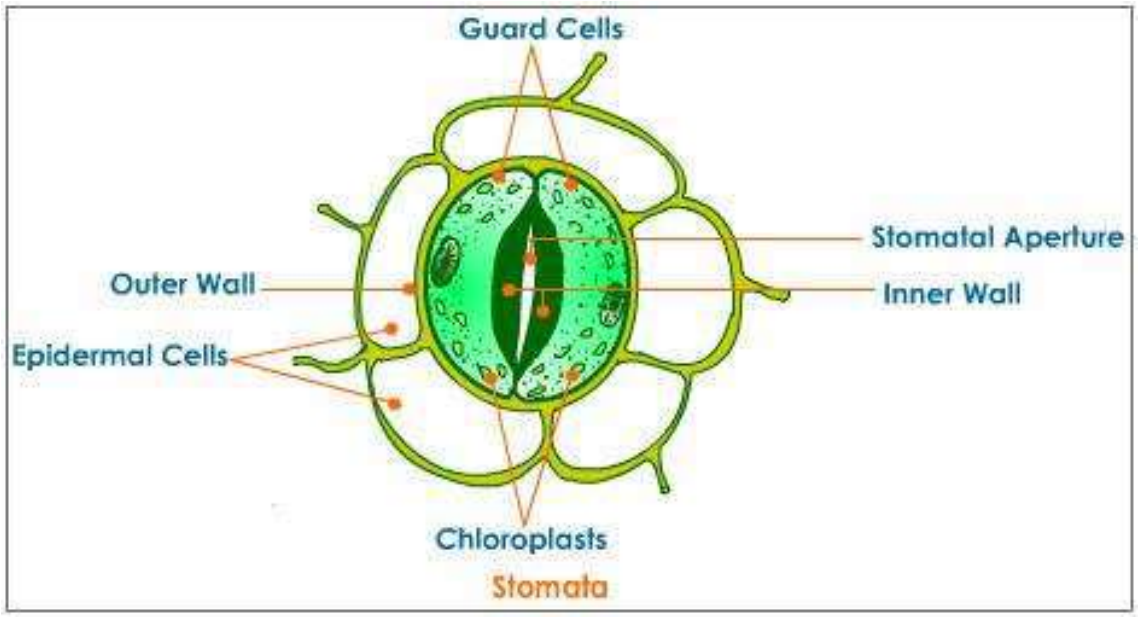
On the basis of the passages through which plants give out water in the form of vapor transpiration is of following types

1. Stomatal transpiration
2. Cuticular transpiration
3. Lenticular transpiration

1. Stomatal transpiration: The transpiration process which occurs through stomata is called Stomatal transpiration.

- It is most important type of transpiration constitutes 50-97% of total transpiration.
- The stomata are found numerously on the leaf surface. Few stomata also found on green stem, flower and fruits.
- This type of transpiration only occurs in its presence of sunlight (in daytime). Because stomata open in the present of sunlight and close in the darkness.

Structure of stomata



- ✓ Each stomata is surrounded by two small specialized cells called guard cells .
- ✓Guard cells are connected to adjacent epidermal cells by plasmodesmata .
- ✓ They are rapidly influenced by turgor changes .
- ✓ Microfibrils are oriented in a specific way to allow the opening and closing of stomata .

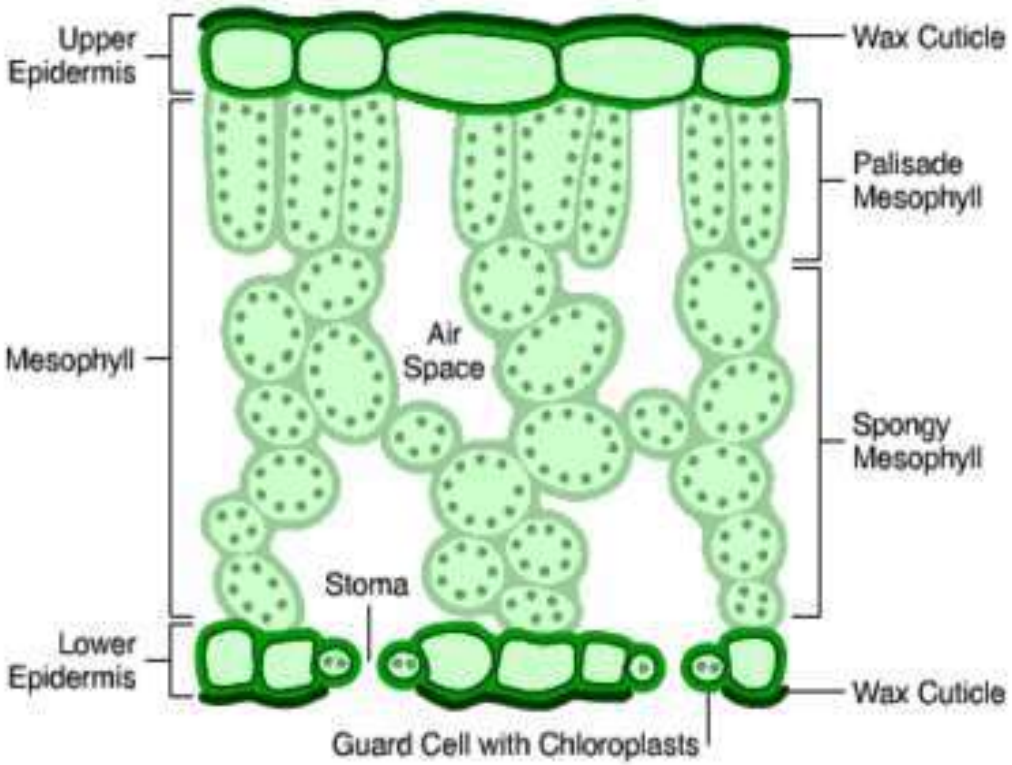
Inner walls (concave side) of guard cells is thick and outer wall (convex side) is thin ,hence they are kidney shaped .

- ✓ Guardcell contain chloroplast, nucleus, contractile vacule.
- ✓ Subsidary cell does not contain chloroplast .

2. Cuticular transpiration

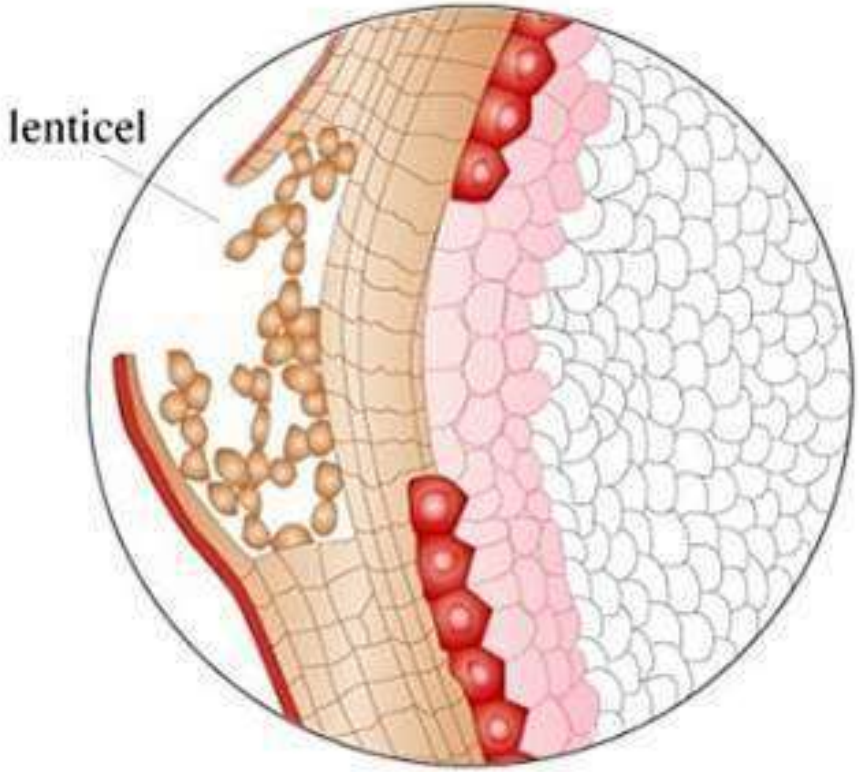
Transpiration that occurs through the cuticle or cracks of thin cuticle layer of leaves and stems is known as cuticular transpiration. This is a day-night process. In this process, 5-10% water is given out in the form of vapor.

- This transpiration continues throughout day and night.
- In common land plants cuticular transpiration is only 3-10% of the total transpiration.



3. Lenticular transpiration

- It is found only in woody stems and some fruits where lenticels occurs.
- Constitutes major part of water loss by deciduous trees during leafless stage.
- Occurs continuously day and night and there is no mechanism to stop or reduce it.
- Total water loss through them is only fraction of total i.e. 0.1%.



Opening and closing of Stomata (Mechenism of stomatal movement)

- Opening and closing of stomata is governed by turgor changes of the guard cells.
- Three main theories explains the stomatal movements

1. Hypothesis of guard cell photosynthesis

2. Starch sugar Interconversion Theory

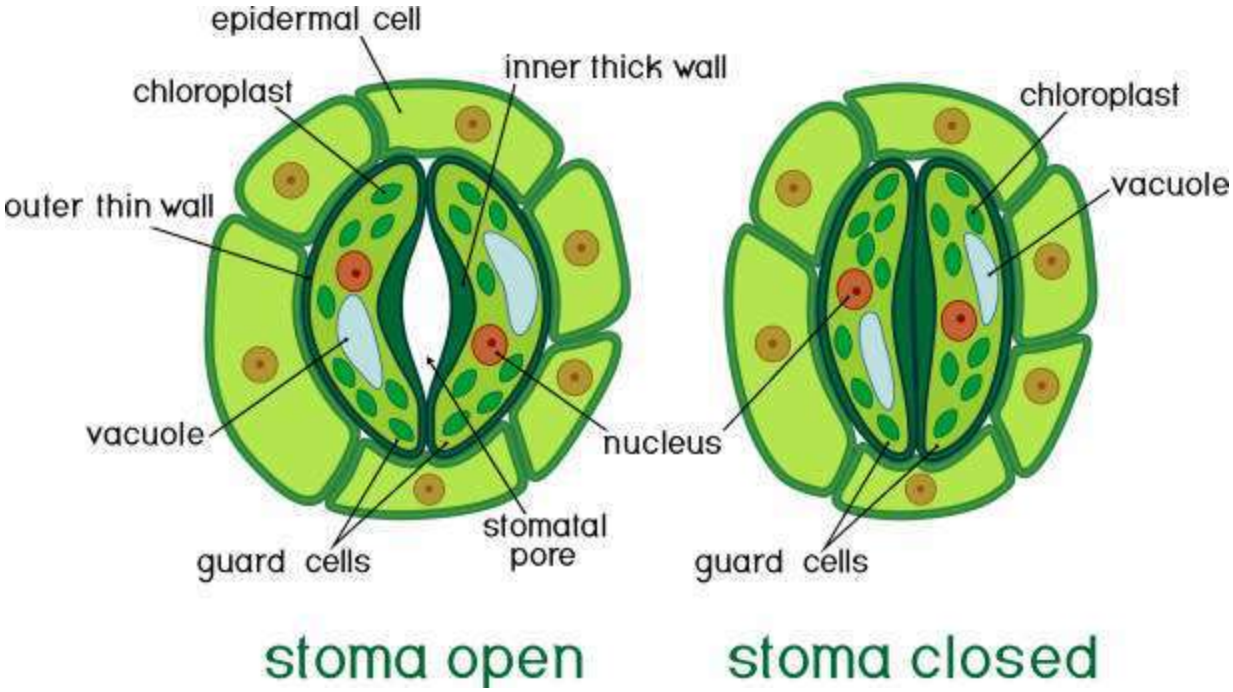
3. ATP-driven proton- K+ Exchange pump

1. Hypothesis of guard cell photosynthesis

✓ Guard cell contain chloroplast . Chloroplast perform photosynthesis during day time and thus produces sugar .

✓ Solute concentration of guard cells increases due to sugar as compared adjacent epidermal cells .

✓ Thus absorption of water by guard cells from epidermal cells . Turgid guard cells bent outwardly and stomata open.



2. Starch sugar Interconversion Theory

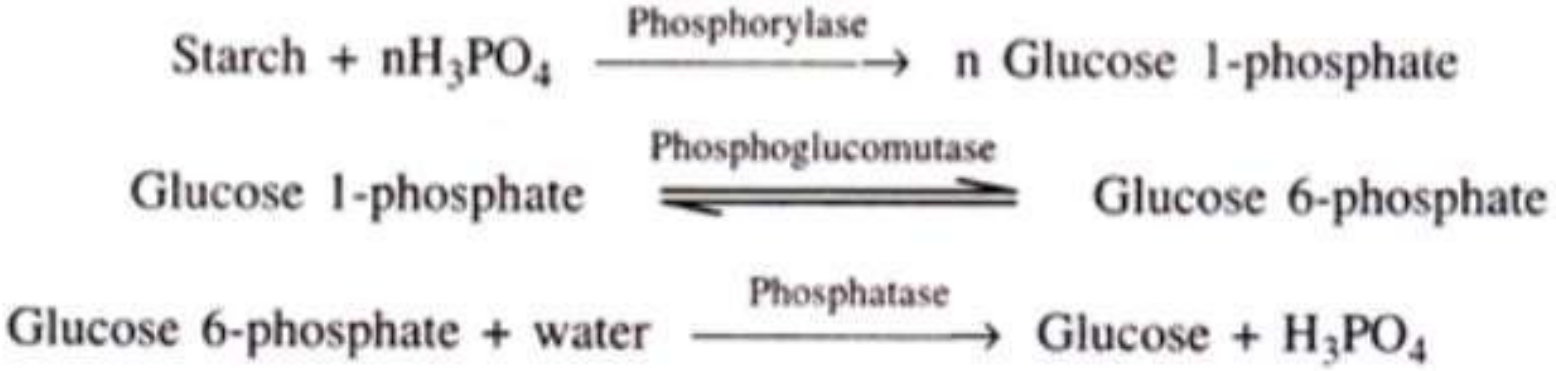
✓ Proposed by Sayre

✓ Guard cells contains starch when stomata are closed

✓ Starch is changed to sugar

✓ In the morning carbon dioxide concentration is low (due to increase in rate of photosynthesis).

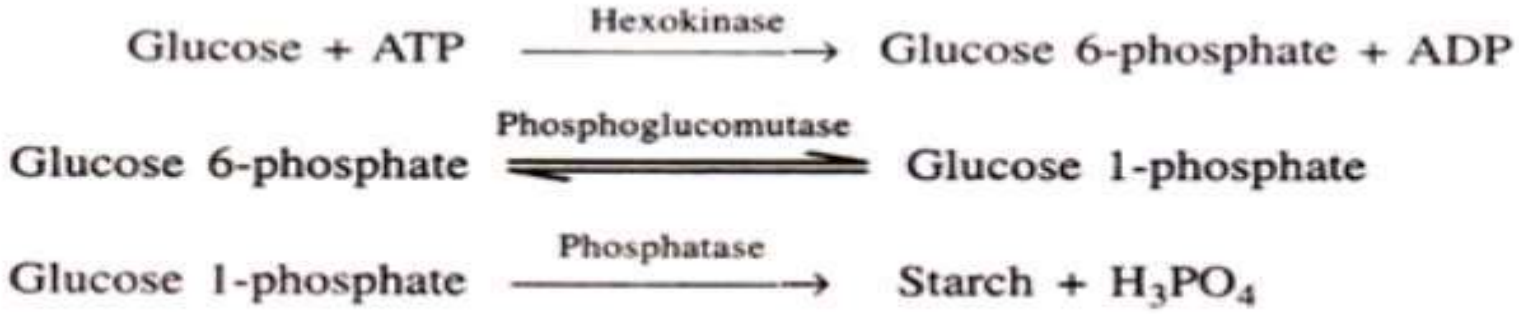
✓ Reduced carbon dioxide leads to increase in PH (due to loss of carbonic acid).



✓ Hence glucose increases the Osmotic Pressure of guard cells , withdraw water from epidermal and subsidiary cells .

✓ On absorption of water guard cells swell up and stomata open.

➢ Above reaction is reversible.



✓ Reversible reaction requires the lowering of PH.

✓Decrease PH leads to phsphorylation of glucose.

✓As a result of osmotic concentration of guard cell is falls and loss of turgidity of guard cell hence stomata closed.

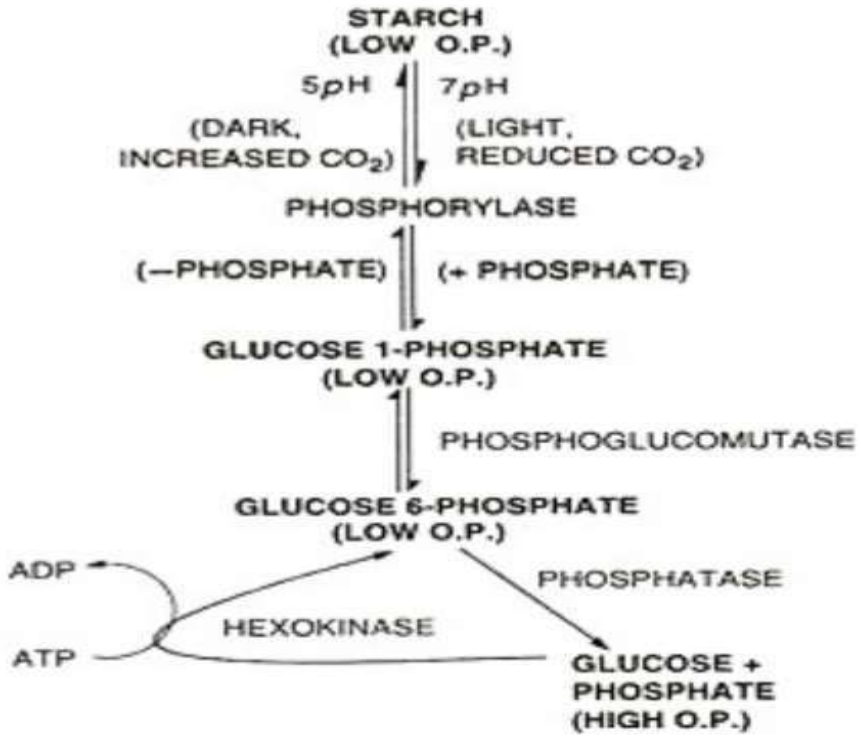


Fig: Development of high and low osmotic pressure in guard cell through starch hydrolysis theory

Objection:

✓Starch and sugar conversion is chemically slow while stomata opening is rapid process.

✓ Blue light is more effective for stomatal opening not explained by starch sugar conversion theory

3. ATP-driven proton- K+ Exchange pump

✓ Proposed by Levitt, 1974.

✓ Opening of stomata is accompanied by increase in K+ ion concentration.

During day:-

$6CO2$ + 12 H20 → $C6H12O6$ + $6O2$

$C6H12O6$ → Malic Acid

Malic Acid → Malate ion + $H+$

During night :-

As $CO2$ is not utilized by photosynthesis during night hence;

$6CO2$ + 12 H20 → Carbonic acid

Then it forms ABA (Abscisic acid).

The $k+$ are transported back to the guard cell.

✓ Stomatal opening is stimulated by sunlight, cytokinin cAMP and other factors

Factor affecting rate of Transpiration

✓ Atmospheric Humidity is inversely proportional to rate of transpiration.

✓ Temperature is directly proportional to rate of transpiration.

✓ Light intensity is directly proportional to rate of transpiration.

✓ Wind velocity is directly proportional to rate of transpiration.

✓Carbon dioxide concentration is inversely proportional to rate of transpiration.

✓ The factors like structure of leaf area of transpiring surface, number of stomata, orientation of leaf are included in the category.

Thank You !!