MSC BOTANY

IIISEMESTER

PHYSIOLOGY:

TRANSPIRATION

PREPARED BY:

RAMYA.M,

DEPT OF BOTANY,

LF COLLEGE, GURUVAYOOR

TRANSPIRATION

- Although a large quantity of water are absorbed by plants from soil only a small amount is utilised .
- The excess of water is lost from aerial parts of plants in the form of water vapours.
- This is called transpiration.

If a bell jar is placed on a pot, a film of moisture appears on its dry inner surface indicating loss of water as vapours which condense on the cool inner surface of the bell jar. 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.

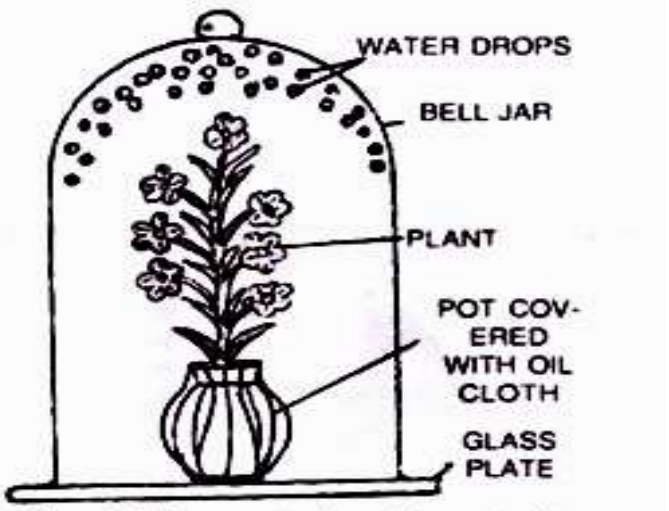


Fig. 4.1. Demonstration of transpiration by Bell Jar Experiment.

Depending upon the plant surface, transpiration is classified into three types:

1. Stomatal transpiration
2. Cuticular transpiration (peristomatal transpiration)
3. Lenticular transpiration

Type # 1. Stomatal Transpiration:

- Water vapour diffuses out through minute pore (stomata) present in soft aerial part of plant is known as Stomatal Transpiration.
- Of the total water loosed, near about 85 – 90% of water loosed by the stomatal transpiration.

Type # 2. Lenticular Transpiration:

Sometimes water may evaporate through certain other openings present on the older stems. These openings are called Lenticels and the transpiration that takes place through term is known as Lenticular Transpiration.

Huber observed in some plants that water lost by lenticular transpiration was about 0.1% of the total transpiration loss. He further noted that coating the bark of the trees reduced the total loss by 20% from total bark surface, showing that some water loss was taking place through general surface of the bark also.

Type # 3. Cuticular Transpiration:

Loss of water may also take place through cuticle, but the amount so lost is relatively small and make up only about 5 to 10 percent of the total transpiration. This type of transpiration depends upon the thickness of the cuticle and presence or absence of wax coating on the surface of the leaves. Xerophytic plants generally have very thick cuticle and wax coating on the leaves and stem in order to check cuticular transpiration.

MECHANISM OF STOMATAL TRANSPIRTAION

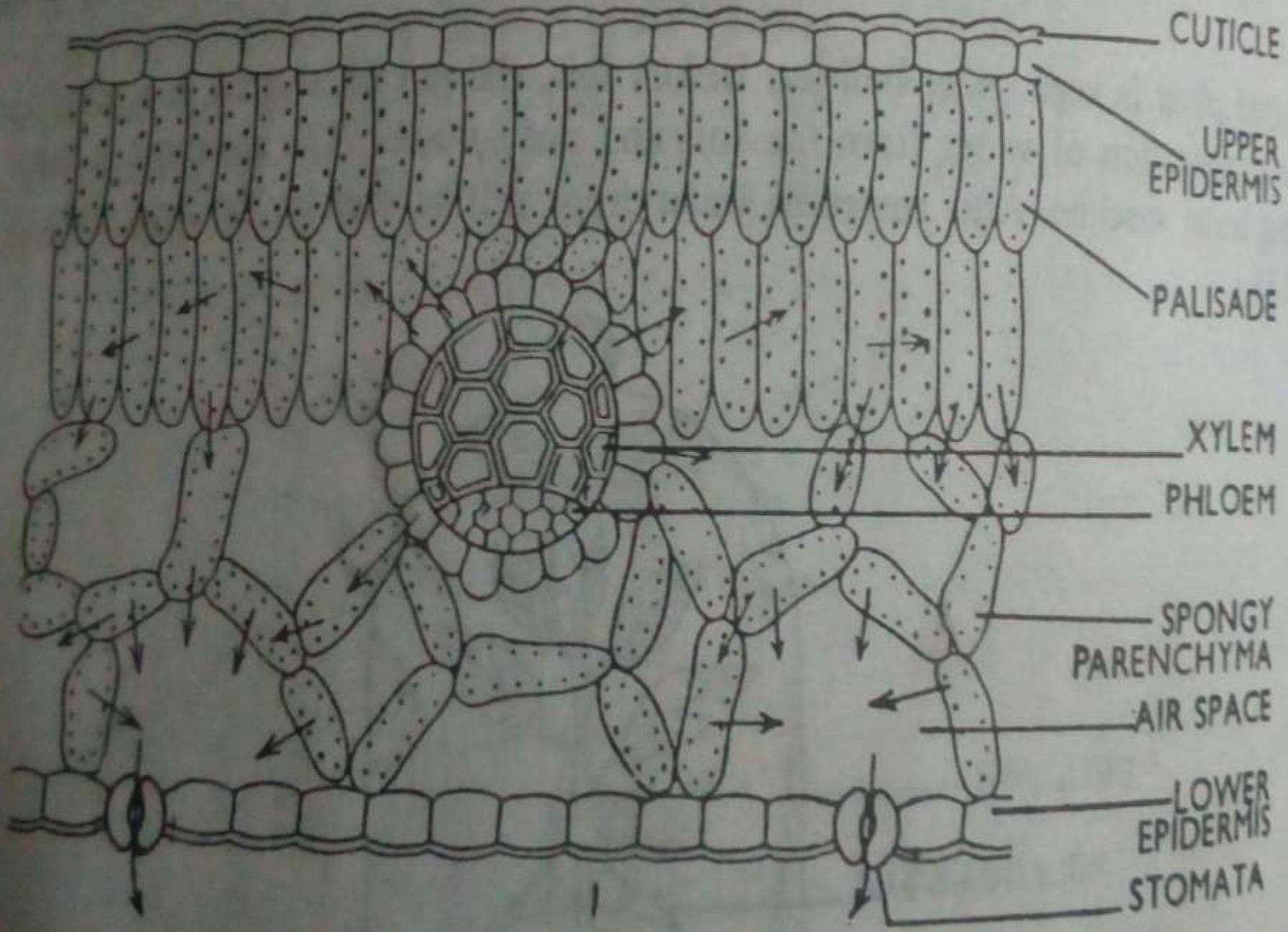
The mechanism of stomatal transpiration which takes place during the day time can be studied in three steps:

1. Osmotic diffusion of water in the leaf from xylem to intercellular spaces above the stomata through the mesophyll cells
2. Opening and closing of stomata
3. Simple diffusion of water vapours from intercellular spaces to outer atmosphere through open stomata

1. Inside the leaf , mesophyll cells are in contact with xylem, and on the other hand with intercellular spaces above the stomata.

When mesophyll cells draw water from the xylem they become turgid and their diffusion pressure deficit(DPD) and osmotic pressure (OP) decrease with the result that they release water in the form of vapours in intercellular spaces close to stomata by osmotic diffusion .

Now in turn the OP and DPD of the mesophyll cells become higher and hence , they draw water from xylem by osmotic diffusion


CUTICLE
UPPER EPIDERMIS
PALISADE
XYLEM
PHLOEM
SPONGY PARENCHYMA
AIR SPACE
LOWER EPIDERMIS
STOMATA

2.Opening and closing of stomata (stomatal movement)

The stomata are easily recognised from the surrounding epidermal cells by their peculiar shape .

The epidermal cells that immediately surround the stomata may be similar to other epidermal cells or may be different and specalised .

In the later case they are called as subsidiary cells

The guard cells differ from other epidermal cells also in containing chloroplasts and other peculiar thickenings on their surface.

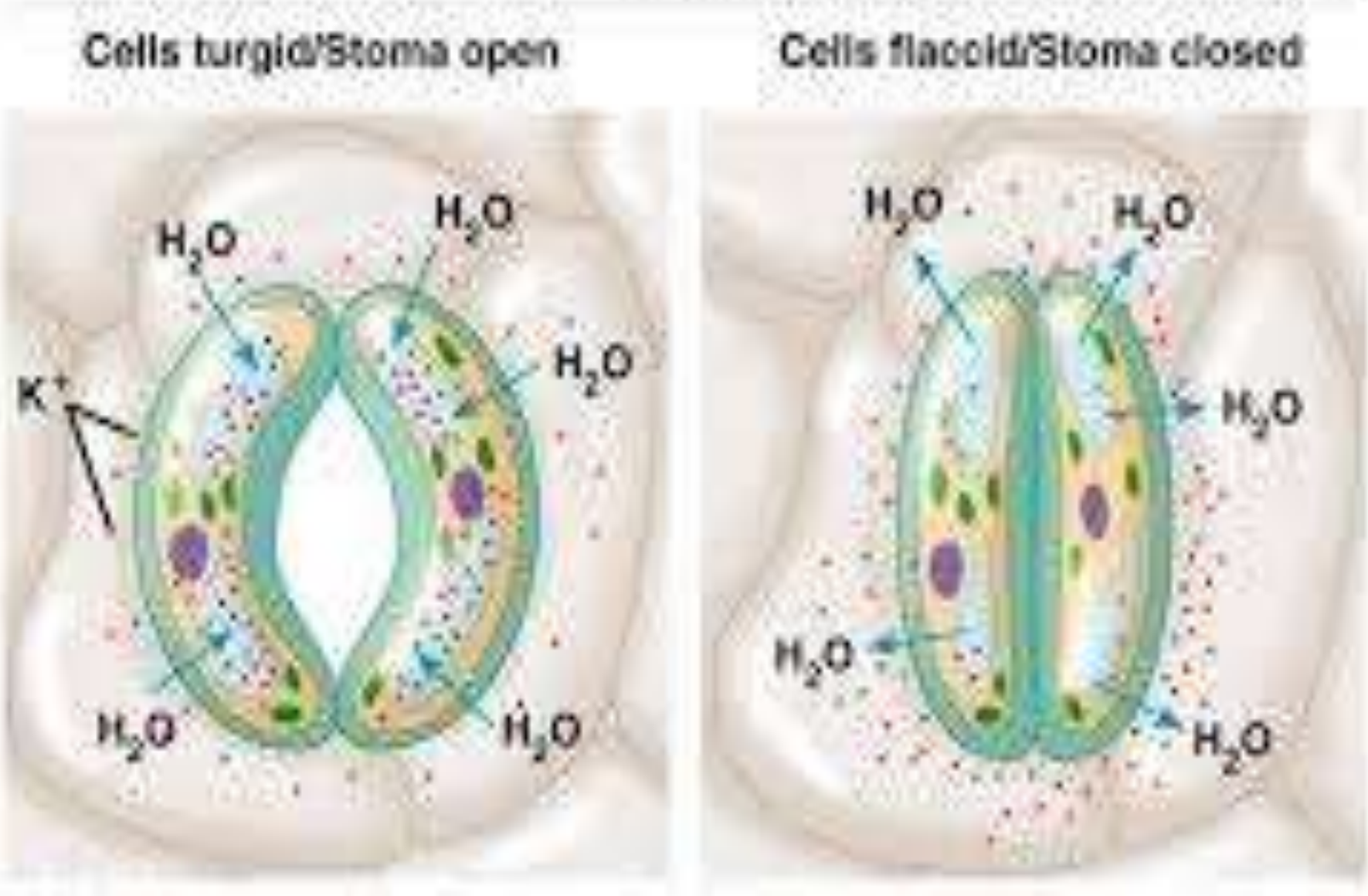
Consequent to an increase in the osmotic pressure (OP) and diffusion pressure deficit(DPD) of the guard cells (which is due to accumulation of osmotically active substances).

- So ,Osmotic diffusion of water from surrounding epidermal cells and mesophyll cells into the guard cell follows .
- This increases the turgor pressure (TP) of the guard cells and they become turgid .

- The guard cells swell , increase in length and their adjacent thickened surface stretch **forming a pore and thus the stomata open**

Cells Turgid/Stoma Open

Cells Flaccid/Stoma Closed



- On the other hand when OP and DPD of guard cells decrease (due to depletion of osmotically active substances) relative to surrounding epidermal and mesophyll cells ,water is released back into the latter by osmotic diffusion and the guard cells becomes flaccid .
- The thickened surface of the guard cells come close to each other , thereby **closing the stomatal pore and stomata**

Using thermodynamic terminology , osmotic diffusion of water into guard cells occur when their osmotic potential and water potential decrease (becomes more negative) relative to those of surrounding mesophyll and epidermal cells .

The guard cells become flaccid when their osmotic potential and water potential increase (become less negative) relative to surrounding cells

(movement of water takes place from a region of higher water potential ie, less negative to a region of lower water potential ,ie more negative

Factors Affecting Transpiration:

Water Stress:

- Whenever the rate of transpiration exceeds the rate of absorption, a water deficit is created in the plants and results in the incipient wilting of leaves.

Carbon Dioxide:

Stomatal mechanism is sensitive to carbon dioxide concentration. Stomata close in the presence of high concentrations of CO_2.

Oxygen:

This gas is essential for the opening of stomata. Its deficiency quickens stomatal closure.

Hormones:

ABA causes stomatal closure whereas cytokinins are essential for the intake of K^+. Moreover, ABA works only in the presence of CO_2.

Light:

Generally, stomata open when exposed to illumination and close in the dark. In majority of the cases, blue light absorbed by a special pigment system, affects opening.

Similarly the phytochrome system may also lead to opening of the stomata.

Temperature:

When all other factors are equal, stomatal opening increases with rise in temperature up to 25°- 30°C and decreases at still higher temperatures.

In most species stomata fail to open at or near 0°C.

In some species high temperatures of about 40°C cause stomatal opening instead of closing even in the dark.

Mineral deficiencies:

With the deficiency of any of minerals such as, nitrogen, phosphorus and potassium, the stomatal movements become sluggish. Different ions affect the stomatal aperture differently.

Wind:

Stomata close when the leaf is exposed to high wind velocities.

Internal factors:

Root-shoot ratio:

Parker (1949) found that the rate of transpiration increased with an increase in root-shoot ratio, provided other conditions were favourable for transpiration.

Sorghum with more extensive root system than that of corn, transpired at a higher rate per unit of leaf surface than corn. The sorghum root system provides more water to the shoot than the corn root system

Leaf area:

- Greater the leaf area more will be the magnitude of water loss
- but there is no proportionality between the leaf area and the water loss.
- Although the greater amount of water was lost by the larger corn plant, the amount of water lost per unit area was greater in the smaller plant.

Leaf structure:

Plants growing in dry areas show a number of structural modifications, especially in leaves, such as thick cuticle, thick cell well, well-developed palisade, sunken stomata, a covering of hairs, etc. These features reduce water loss. Under dry conditions the stomata are closed and cuticular transpiration is the main source of water loss.

The rate of transpiration was greatly enhanced in the diseased plants as compared to the healthy ones.

Availability of soil water:

If the supply of water to the leaves is not adequate the rate of transpiration decreases. If this condition is prolonged, a water deficit will result and the plant will appear wilted.

The supply of water can be inadequate due to the following reasons:

(i) Root system is not adequate to supply the top,

(ii) A low soil temperature, and

(iii) A high concentration of soil solution.


Thank you!