



COMPILED AND CIRCULATED BY PROF. SANJAY KUMAR  
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## TRANSPIRATION

### **Definition :**

Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers. Water is necessary for plants but only a small amount of water taken up by the roots is used for growth and metabolism.

### **Types of Transpiration:**

Depending on the organ that performs transpiration, the different types are:

- ***Stomatal transpiration:*** It is the evaporation of water through stomata. Stomata are specialized pores in the leaves. They account for around 80 to 90% of the total water loss from the plants.
- ***Cuticular transpiration:*** Cuticle is an impermeable covering present on the leaves and stem. It causes around 20% of transpiration in plants. Cuticular transpiration is lesser in xerophytes because they have thicker cuticles.
- ***Lenticular Transpiration:*** It is the evaporation of water through lenticels. Lenticels are the tiny openings present on the woody bark.

### **Factors affecting transpiration**

The rate of transpiration is affected by several factors. These include:

- Temperature
- humidity



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- **air movement**
- **light intensity**

<b>Factor</b>	<b>Change in factor that increases transpiration rate</b>	<b>Explanation</b>
Temperature	Increase	Increases molecular movement so that more water molecules evaporate from cell surfaces. The rate of diffusion of water molecules from the leaf is increased.
Humidity	Decrease	Reduces the concentration of water molecules outside the leaf. Diffusion of water from the leaf increases.
Air movement	Increase	Removes water vapour from leaf surfaces. More water diffuses from the leaf.
Light intensity	Increase	Increases the rate of photosynthesis. Stomata open so that water diffuses out of the leaf.



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### **Opening and closing of stomata:**

The **opening and closing of stomata** depend on the turgor pressure, caused by the osmotic flow of water in the guard cells. When the guard cells are turgid, they expand resulting in the **opening of stomata**. When the guard cells lose water, they become flaccid leading to **stomatal closure**.

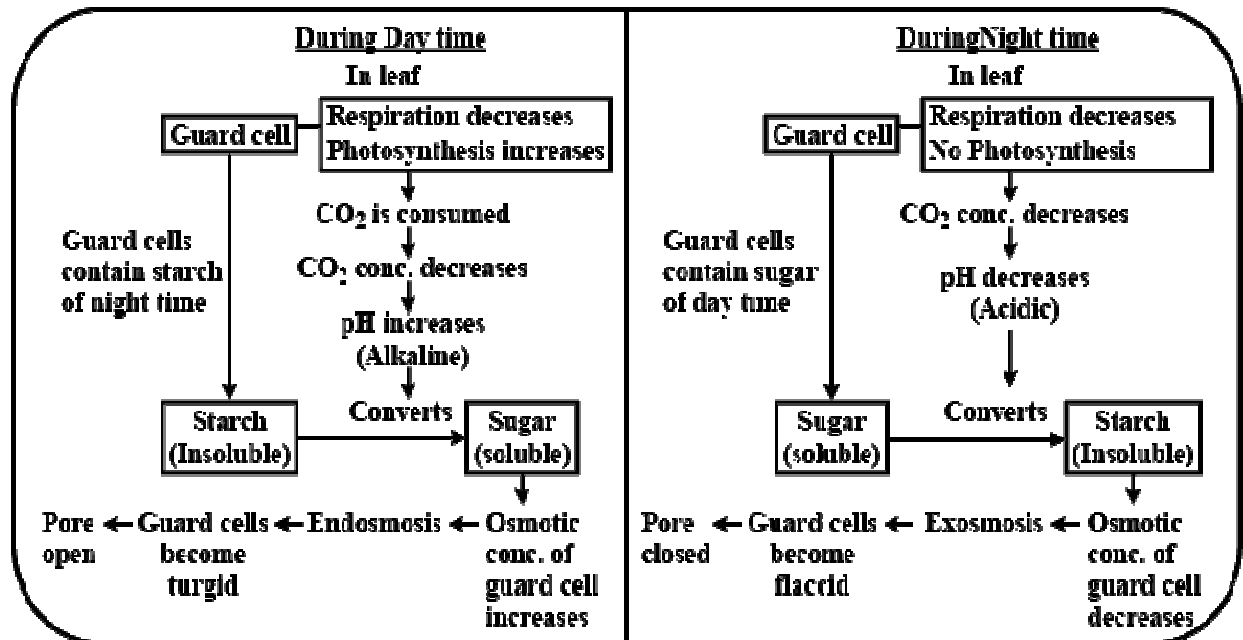
### **Starch - sugar interconversion hypothesis of stomatal opening and closing:**

**During day time:** According to this theory, the CO<sub>2</sub> released in respiration is utilized in the process of photosynthesis, which makes the medium of the guard cell alkaline. Due to this high pH, the starch produced in the night is converted into sugar in the presence of enzyme phosphorylase. Sugar is soluble in water and consequently increases to the OP of the guard cells. Therefore, the cells become turgid. In this state, the thin outer wall of guard cell stretches outward and opens the stomata.

**During the night:** During the night, the CO<sub>2</sub> produced in respiration is not utilized and diffuses into the cytoplasm of guard cells. It makes the medium of the guard cells acidic (low pH). At this low pH, the sugar made during daytime is also converted into starch. Starch being insoluble in water reduces the osmotic pressure of the guard cell. Consequently, water moves from guard cells to the attached subsidiary cells. It makes the guard cells flaccid and therefore, stomata close.



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### Stomatal movement based on K<sup>+</sup> ion-transport:

Malate or K<sup>+</sup> ion pump hypothesis was proposed by Levitt. According to this theory, the change that takes place in the turgor pressure of the guard cells that open and close the stomata causes the absorption and loss of K<sup>+</sup> ions by guard cells.

### Opening of stomata in light:

Starch in guard cells is metabolised into phosphoenol pyruvate (PEP) and later converted into malic acid by the enzyme PEP carboxylase. Malic acid dissociates into H<sup>+</sup> and malate ions in the guard cells. These H<sup>+</sup> ions are transported to the epidermal cells and K<sup>+</sup> ions moves from these epidermal cells to the guard cells through the hydrogen - potassium ion exchange pump in the plasma membrane. It is an active process and requires ATP. In the guard cells, K<sup>+</sup> ions are balanced by malate ions and a small amount of Cl<sup>-</sup> ions are also absorbed to neutralize a small percentage





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## **Significance of Transpiration:**

- Plants waste much of their energy in absorbing large quantities of water and most of which is ultimately lost through transpiration.
- Transpiration is a unique feature in the plant system and referred as necessary evil as it is advantageous to plant under certain circumstances and harmful in some other situations.

- ***Transpiration is necessary***

### ***1. Role in the movement of water***

Water plays an important role in the upward movement of water i.e. Ascent of sap in plants.

But, it does not mean that the translocation of water will be stopped without it.

### ***2. Role in the absorption and translocation of mineral salts***

- Absorption of water and mineral salts are entirely independent process.
- Therefore transpiration has nothing to do with the absorption of mineral salts.
- However, once mineral salts have been absorbed by the plants, their further translocation and distribution may be facilitated by transpiration through translocation of water in the xylem elements.

### ***3. Role of regulation of temperature***

Some of the light energy absorbed by the leaves is utilized in photosynthesis, rest is converted into heat energy which raise the leaf temperature.

- Transpiration plays an important role in controlling the temperature of the plants.



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- Rapid evaporation of water from the aerial parts of the plant through transpiration brings down the temperature and thus prevents them from excessive heating.
- Transpiration is one of the chief ways for the dissipation of excess energy, which the plant receives from the sun.
- Shull (1930) estimated that approximately 0.8 cal of energy is received upon each square cm of leaf surface per minute, of which about 10% is reflected and 25% is transmitted.
- The remaining 65% (0.52 cal) will increase the temperature of the leaves very rapidly.
- If the weight of the leaf tissue is 0.02g/cm<sup>2</sup> with the specific heat of 0.879, then the rise in temperature would be at 32°C per minute.
- With this rate of increase in temperature, the plants will be killed in less than two minutes, if there is no dissipation of energy.
- Transpiration plays a significant role here.
- It helps in dissipating this excess energy which will otherwise raise the temperature.

***4. Role on growth and development:***

- Winneberger (1958) has observed that the buds of hardy pear cease to grow under conditions of high humidity and that under the same conditions growth of the sunflower plant is reduced to about half of the normal.



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- So it is clear that transpiration necessary factor in the normal growth of these two plants.
- Most important point is that cell growth depends on absorption of water which is passively absorbed by the roots of plants due to transpiration pull.
- Plants showing high rate of transpiration exhibit adequate development of mechanical tissues. Transpiration also shows that plants showing high rate of transpiration exhibit extensive root system.

***5. Involves in improvement in the quality of fruits:***

- Increased sugar and mineral contents of fruits follows high rate of transpiration.

***6. Transpiration help in hardening process:***

- Transpiration induces hardening which imparts resistance of plant to drought.

***7. Transpiration help in removal of excess water:***

- It has been held that plants absorb far more amount of water than is actually used by the plant by the plant. Transpiration removes excess of water.

**PROBABLE QUESTIONS :**

- 1. Define Transpiration.**
- 2. Mention the types of Transpiration.**
- 3. What are the major factors which controlling Transpiration, explain in brief ?**
- 4. Mention the role of Stomata in controlling Transpiration.**
- 5. What are the significance of Transpiration?**





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