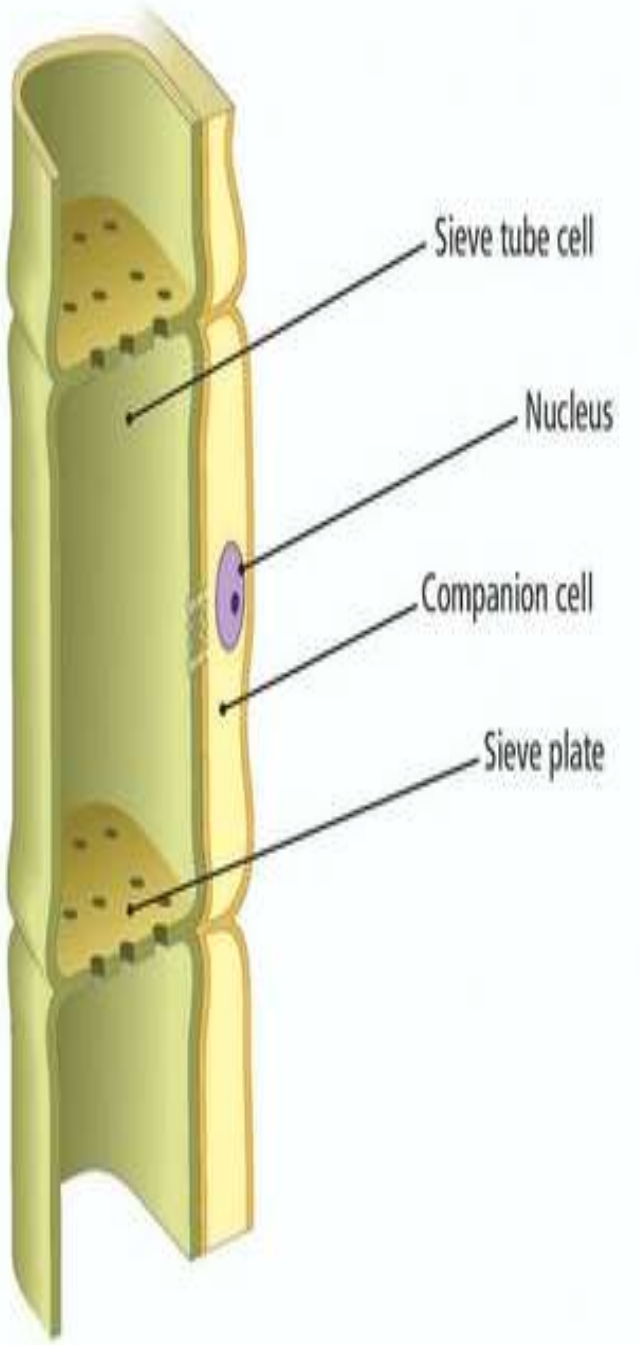
How FOOD is MOVED

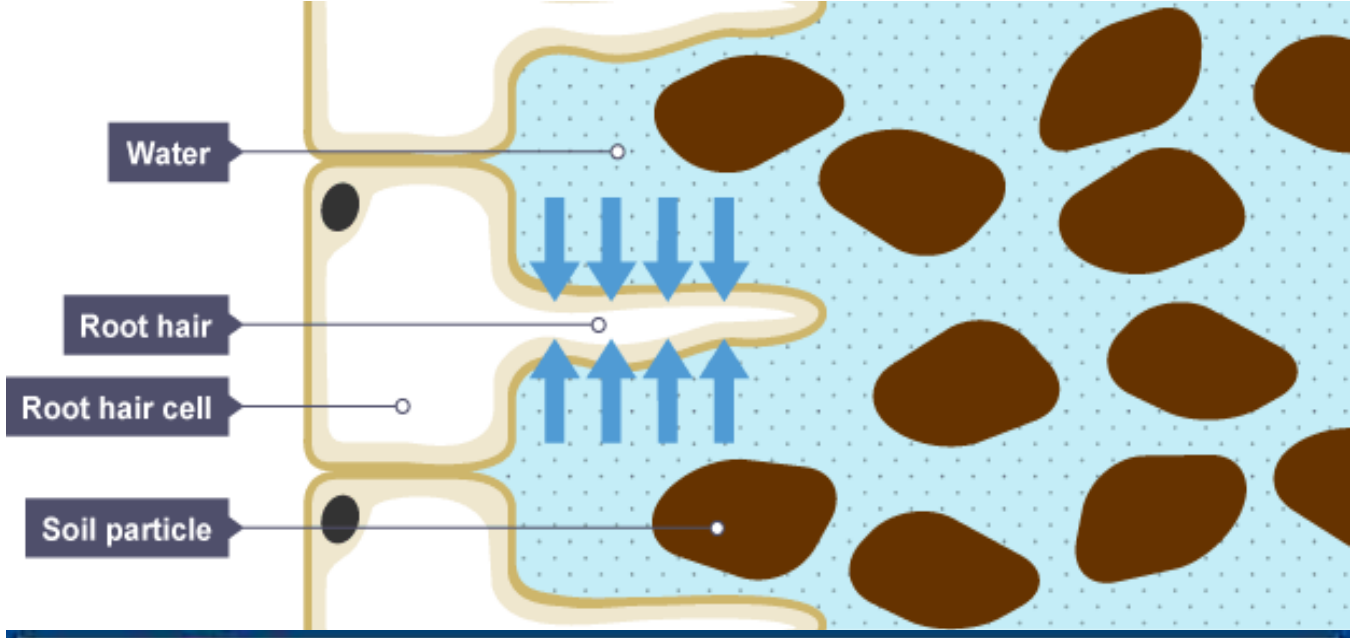
- **Phloem Tube Cells** have already been studied on Page 21 – summarised on Page 22.
- They are joined end-to-end to form a long tube of living cells.
- These go from the chloroplasts (where the food is made) to the different parts of the plant where the food is needed, or where it is stored for later use.
- These cells (and their ***nucleus*** in the **Companion Cells**) use energy to <u>actively</u> move the liquid food through them, to the next cell.
- This overall movement is called **TransLocation**.

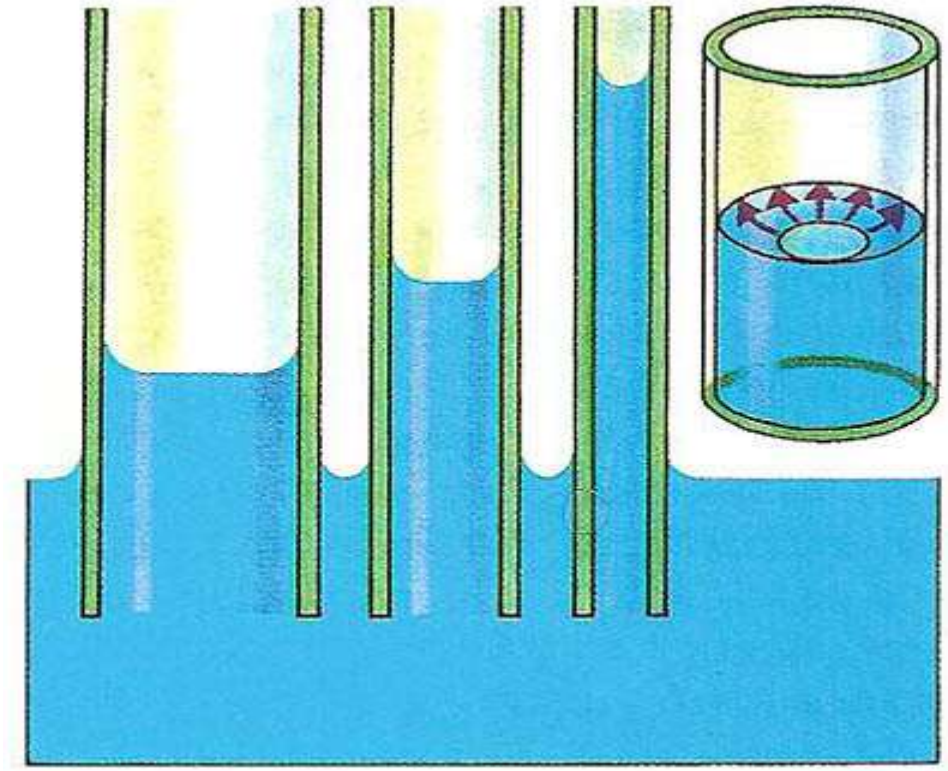


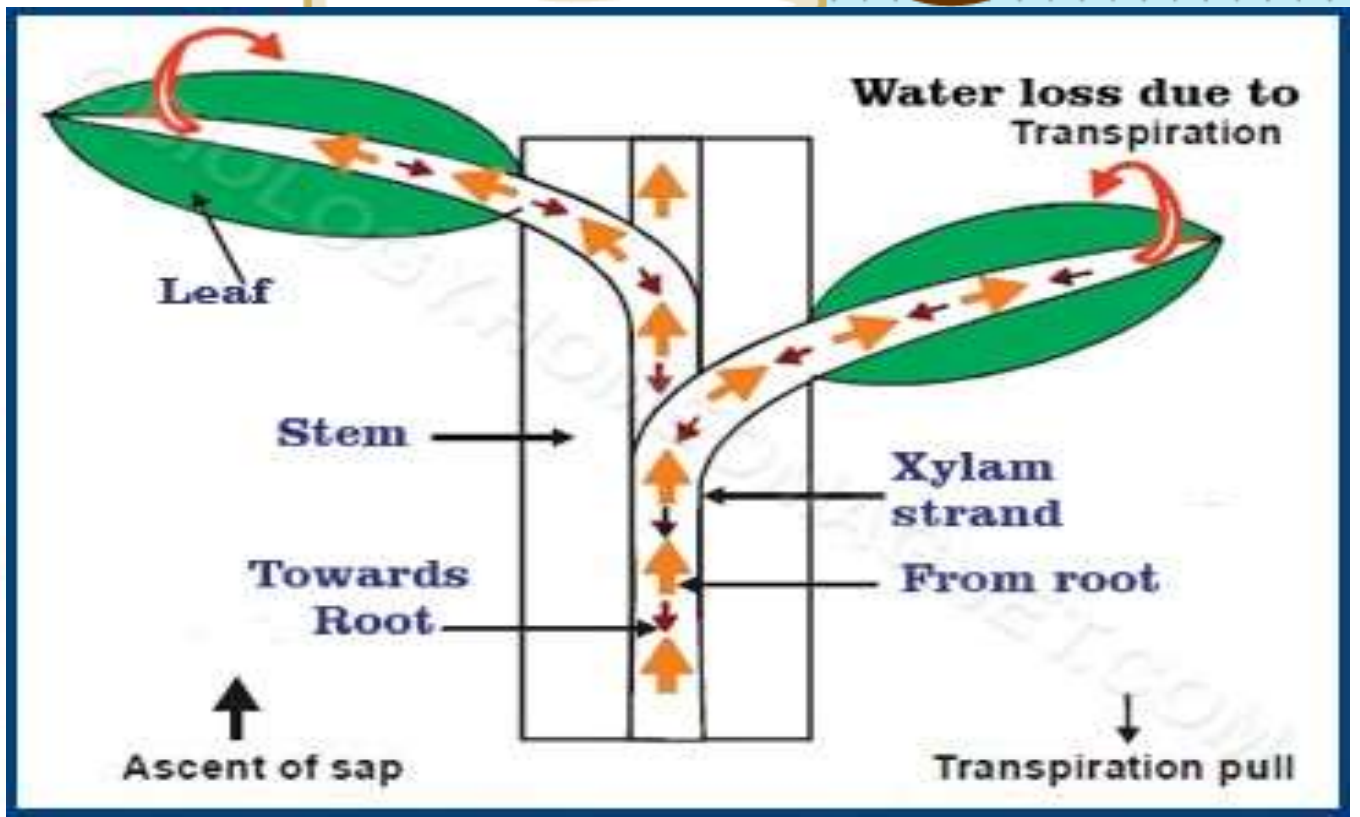
FORCES that MOVE WATER

1. **Diffusion** – when water moves **from** where there is lots of it (in the soil) **to** where there is less of it (in the root). Diffusion of water is called ***Osmosis***. They call this force **root pressure**. (*You can see this force when evaporation from the leaf is low – root pressure forces liquid droplets out of little holes called HydaThodes in the leaf.*)
2. **Capillarity** – with a straw in your cooldrink, you can see this force working. The level of liquid in your straw is higher than that in your glass. And **xylem** is simply the **straw** of the plant.
3. **TransPiration Pull** – Transpiration is the loss of water vapour through the leaf stomata. This sucks up more water from the soil through the xylem straw. ***This is the main force that pulls water through the plant***.


Water lost by transpiration
Suction pressure
Capilanty
Water absorbed by root hairs

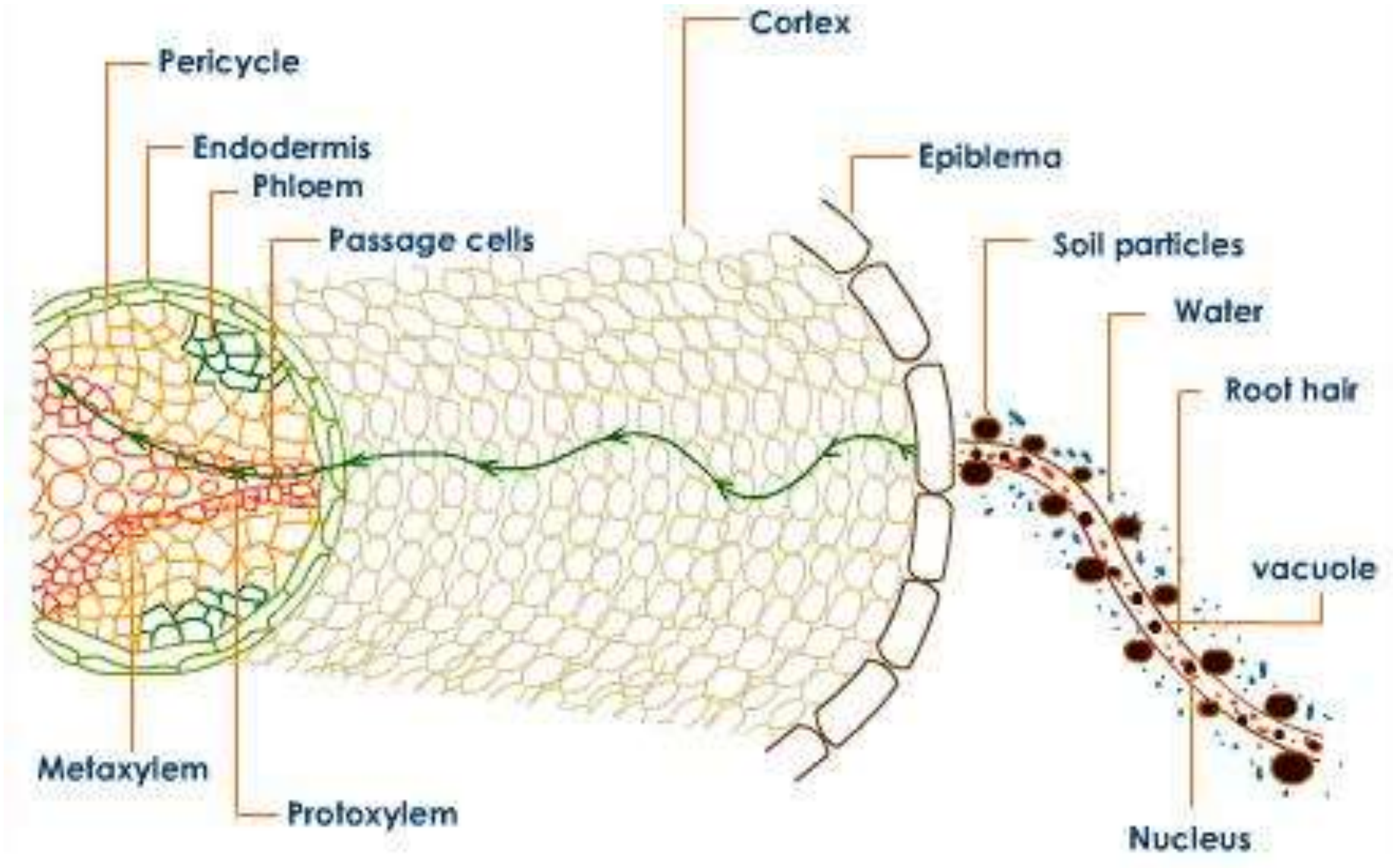

Water
Root hair
Root hair cell
Soil particle

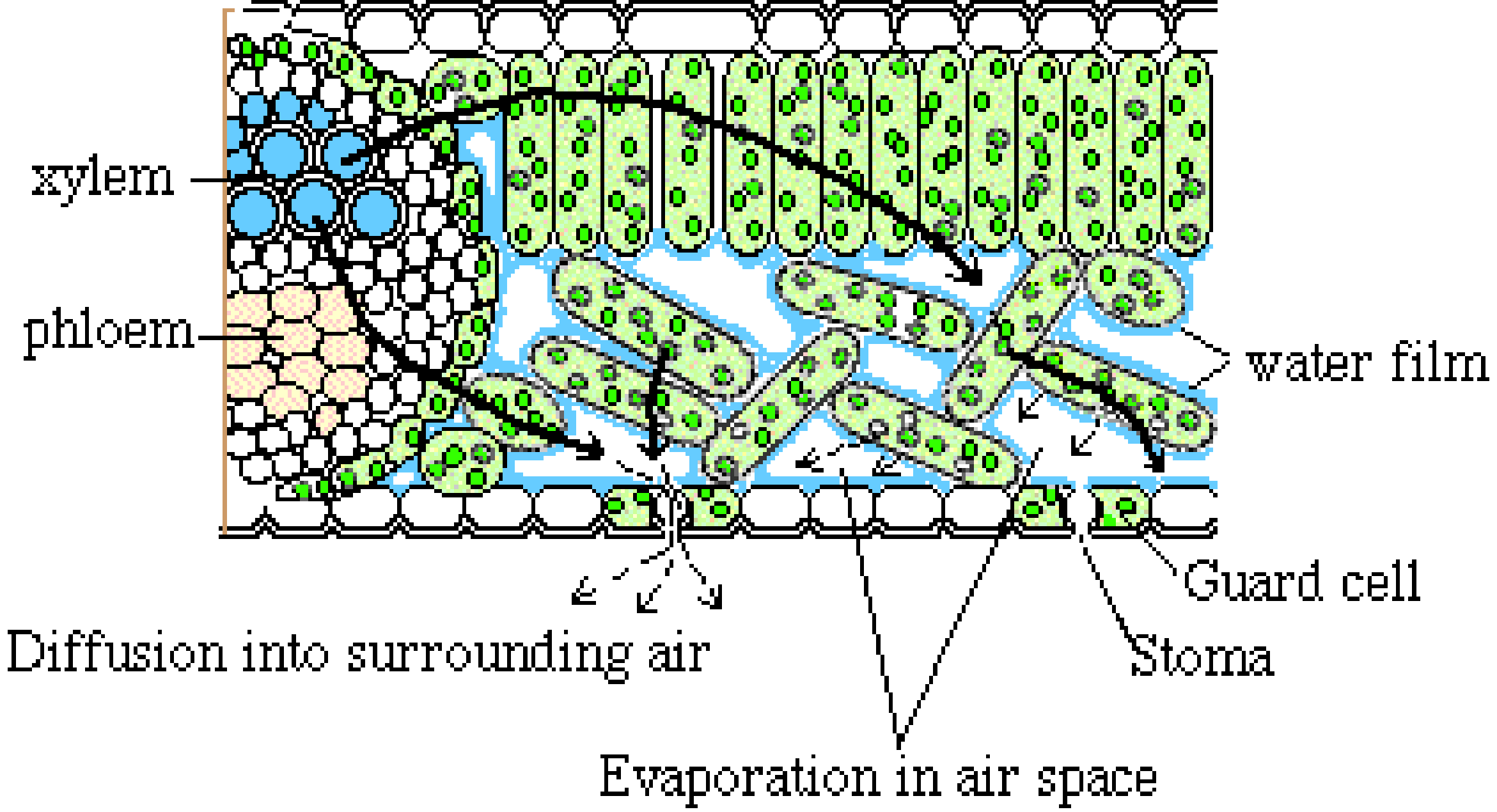



Water loss due to Transpiration
Leaf
Stem
Xylam strand
Towards Root
From root
Ascent of sap
Transpiration pull

Reminder: From the SOIL to the XYLEM

- The xylem straw is in the middle of the root. We have already studied the **FORCES** (of ***diffusion***, ***capillarity***, and ***transpiration***) pulling the water in.
- The root hairs of the EpiDermis give a wider area for water to be collected, as they spread out into the soil.
- Water diffuses into this EpiDermis, and most of it is pulled through the **air-spaces** between the ParenChyma cells towards the xylem. But some of the water moves **through** the actual ParenChyma cells.
- When the water reaches the middle, it hits the water-proof **Casparian Strip**. It can now only move sideways until it reaches a **Passage Cell**, into the Xylem's *ray*.


Cortex
Pericycle
Epiblema
Endodermis
Phloem
Passage cells
Soil particles
Water
Root hair
vacuole
Metaxylem
Protoxylem
Nucleus

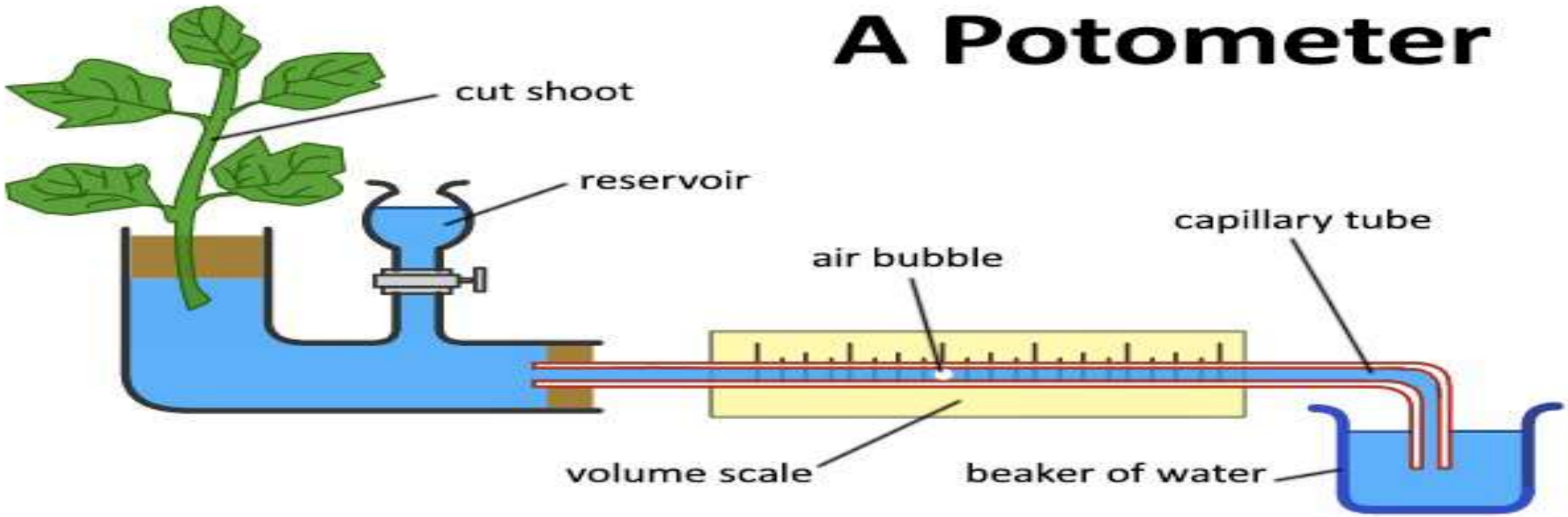


The PATH OF WATER VAPOUR in TRANSPIRATION

TRANSPIRATION

Conditions around the plant will decide how fast water moves through it.

(*See Experiments on Page 38*.)



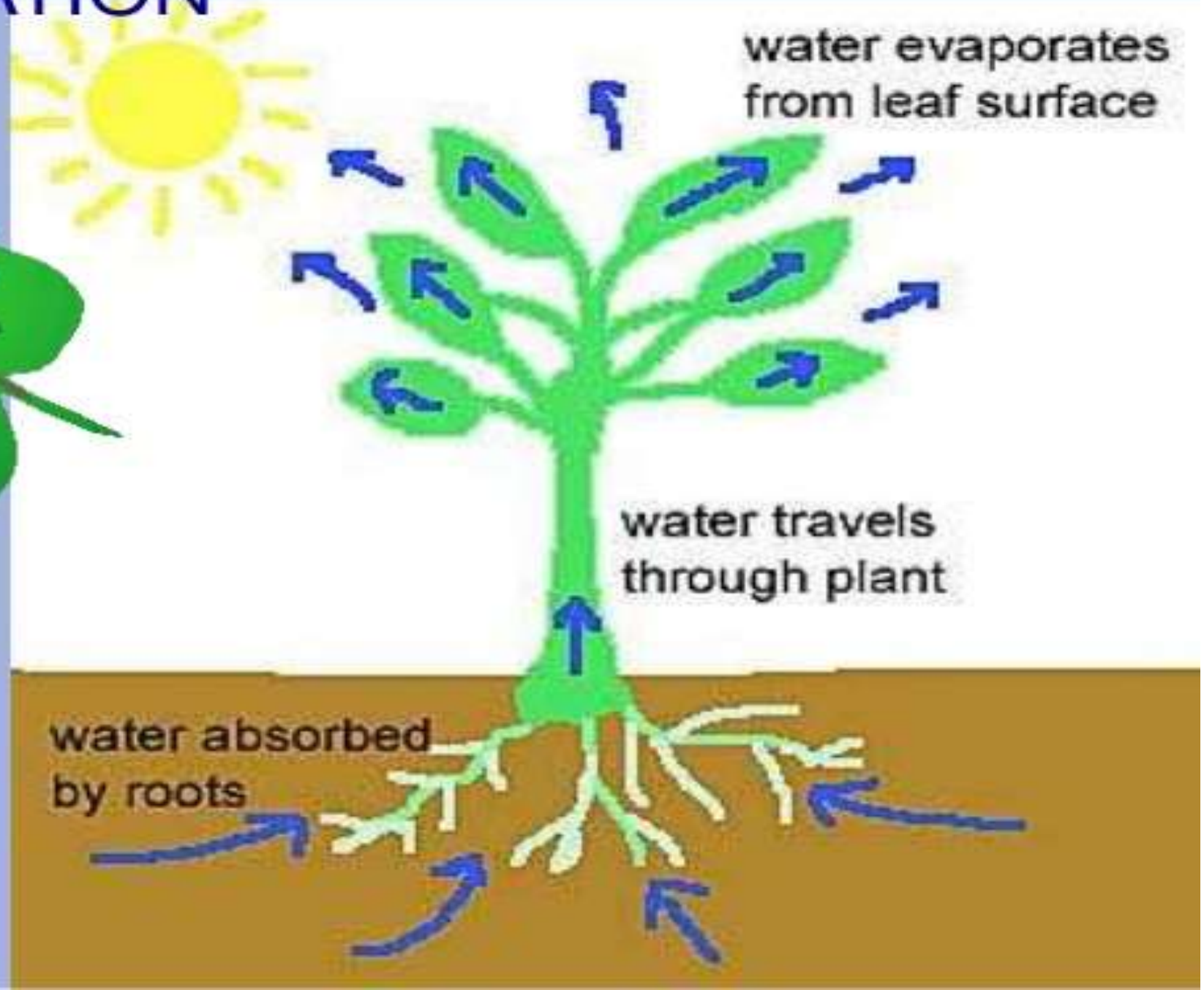
1. **Temperature** – the hotter the air, the more water is evaporated from the stoma, so the more water passes through the plant.

2. **Wind** – the more moving air, the more water-vapour will be blown away from the stoma, and the more water will pass through the plant.
3. **Humidity** – the dryer the air, the more water will leave the stoma, and the more water will pass through the plant.

4. **Light** – the more light, the more photosynthesis can happen, and the more water is needed to pass through to the leaf for the process to happen.

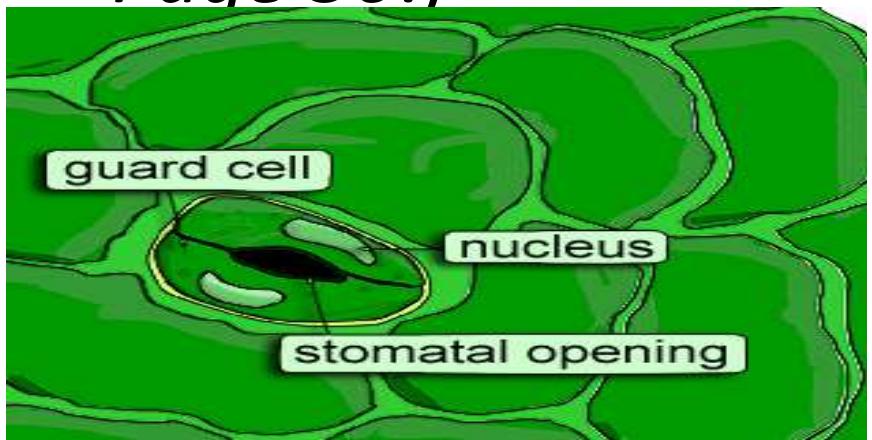
TRANSPIRATION

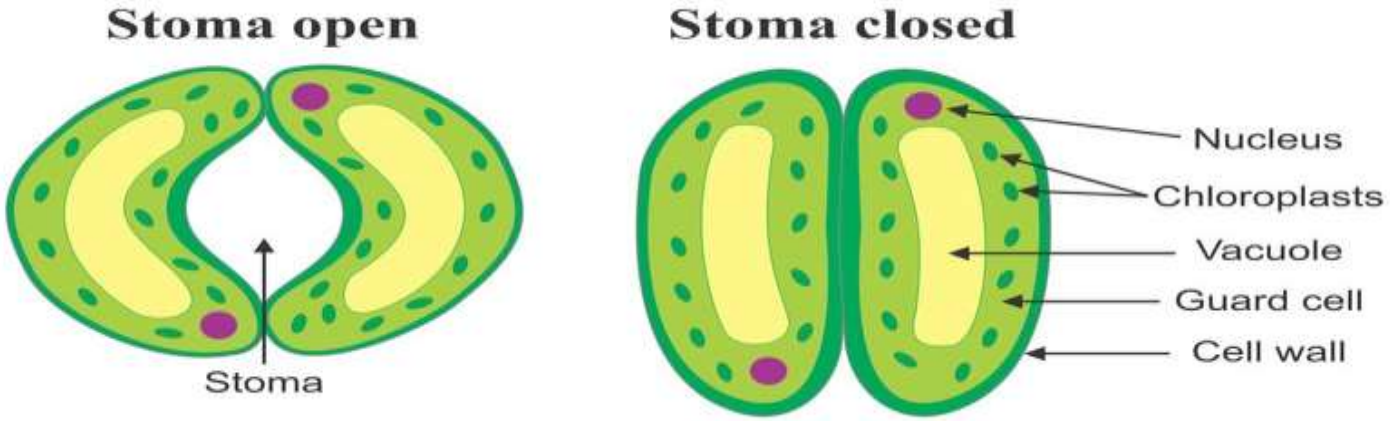
The small openings on the underside of leaves are called stomata



GUARD CELLS controlling the STOMA

- Each stoma has two bean-shaped Guard Cells.
- These Guard cells have ChloroPhyll, and so can PhotoSynthesise.
- So when conditions are good for photosynthesis, these cells are attracting water, and storing food – they thus swell up.
- This expands them away from each other, and explains why the hole between them (stoma) gets bigger. (*See diagram, Page 36.*)





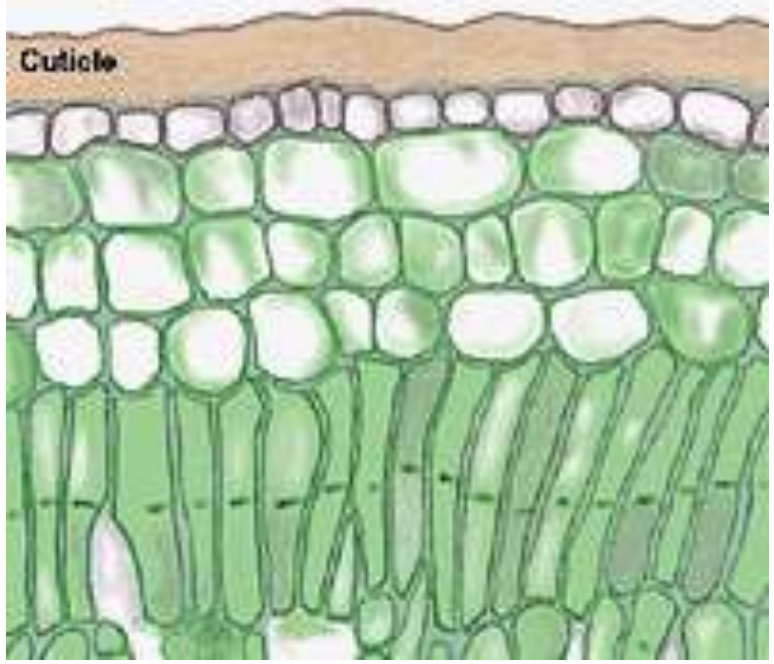
Ways to lose even LESS water

If plants lose too much water, a shortage results, and the plants **wilt**.

To prevent this:

1. The stomata of the leaf are small, or sunken deep into the leaf.
2. The waxy cuticle on the leaf is very thick.
3. Hairs over the stoma can keep it cooler by reflecting the sunshine away, or by stopping the water-vapour from being taken away from the stoma.
4. The pine tree has leaves shaped like tiny needles, so not much of it is exposed for transpiration.
5. Leaves of some plants overlap each other for even greater protection from the sun.


SCIENCE PHOTO LIBRARY


Cuticle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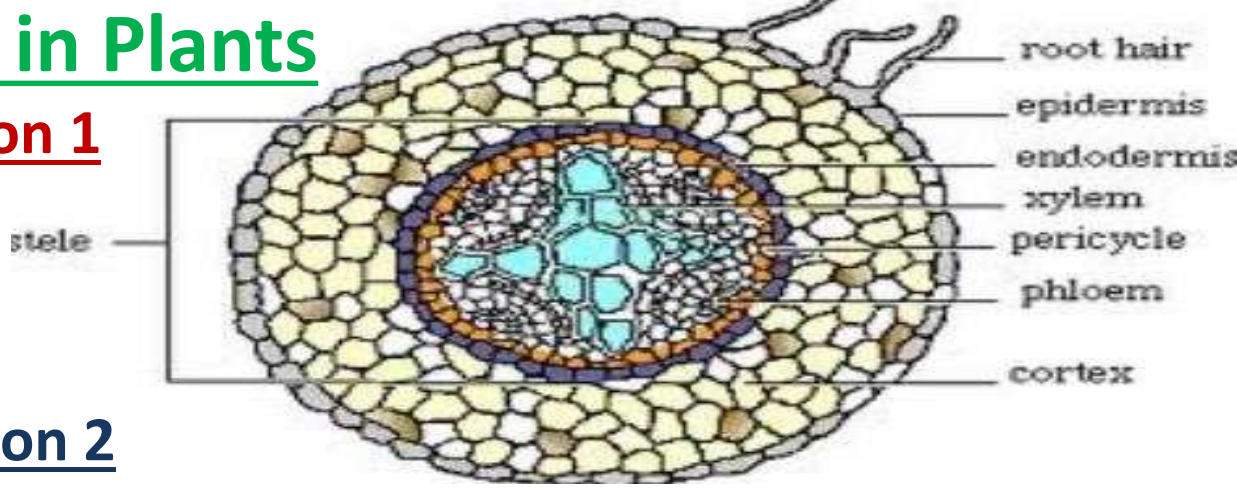
C. Transport in Plants

Question 1



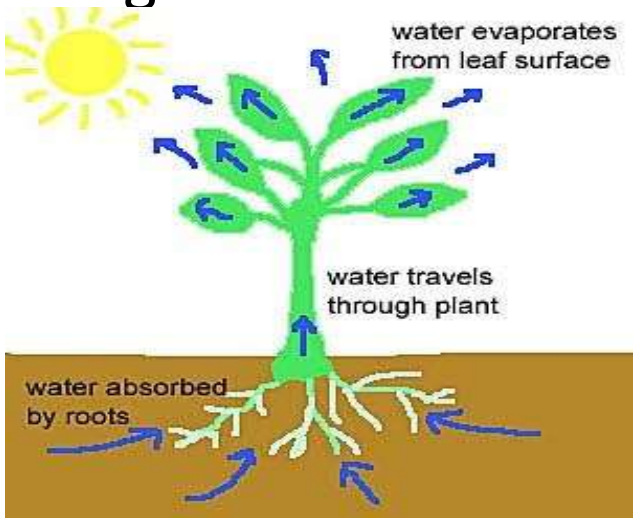
1. REFER TO STUDY GUIDE
2. Major pathway, Minor pathway
3. C – endodermis

Question 2

1. Root pressure occurs in the xylem of plants when the soil moisture level is high or when transpiration is low during the day. Water then diffuses from the soil into the root xylem due to osmosis. Root pressure is caused by this accumulation of water in the xylem of the root.
2. Guttation is the loss of water in the form of tiny droplets through tiny openings in the margins of leaves called hydothodes.
3. High humidity. High soil water. Very low transpiration rate
4. Capillarity is the ability of water to move spontaneously up narrow tubes.
5. Adhesive and cohesive forces
6. Transpiration is the loss of water through the stomata. Transpiration pull is the suction force by which the water absorbed by roots is drawn up to the leaves. This force is produced as a result of loss of water from the underside of leaves (stomatal openings) by evaporation in the form of water vapour.

Question 3

1. High **humidity** reduces transpiration rate. Low humidity (when the air is drier) increases transpiration rate.
2. **Wind** removes the water vapour around the leaves and increase transpiration rate.
3. High **temperatures** increases the kinetic energy of the water molecules causing them to leave the leaf at a faster rate, this results in an increase in transpiration rate.
4. Plants transpire more rapidly in the **light** than in the dark because light stimulates the opening of the stomata.



Question 4

Sunken stomata – away from direct light, reduces transpiration.

Thickened cuticle – on the surface of leaves reduces evaporation.

Hairs on leaves – reflect sunlight away from the leaf and reduces transpiration.

Shape of leaves - needle shaped leaves reduces surface area of leaf, reducing transpiration rate.

Question 5

Experiment - Tiny droplets of water appear on the inside surface of the bell jar. Cobalt chloride paper (blue) turns pink.

Control –Absence of any moisture on inside surface of bell jar. Cobalt chloride paper remains blue.

Question 6

1. To prevent air bubbles from clogging the xylem vessels.
2. To move the air bubble to the original starting point.
3. -surface of leaves must be free of any moisture.
   - leafless twigs must have vaseline at the areas where the leaves were removed.
   - pour a layer of oil on the surface of water in the beakers.
   - cut stems under water.
4. Warm temperature, high light intensity, low humidity, windy conditions
5. This will not hinder/influence the movement of the air bubble.
6. That the rate at which the air bubble moves is an indication of the rate of transpiration.

Question 7

1. Xylem
2. It transports water
3. Root hair, parenchyma, passage cells, pericycle