Ministry of Education and Science of the republic of Kazakhstan
SOUTH KAZAKHSTAN STATE PEDAGOGICAL UNIVERSITY

TRANSPIRATION IN PLANTS. THE RELEASE OF WATER FROM PLANT LEAVES

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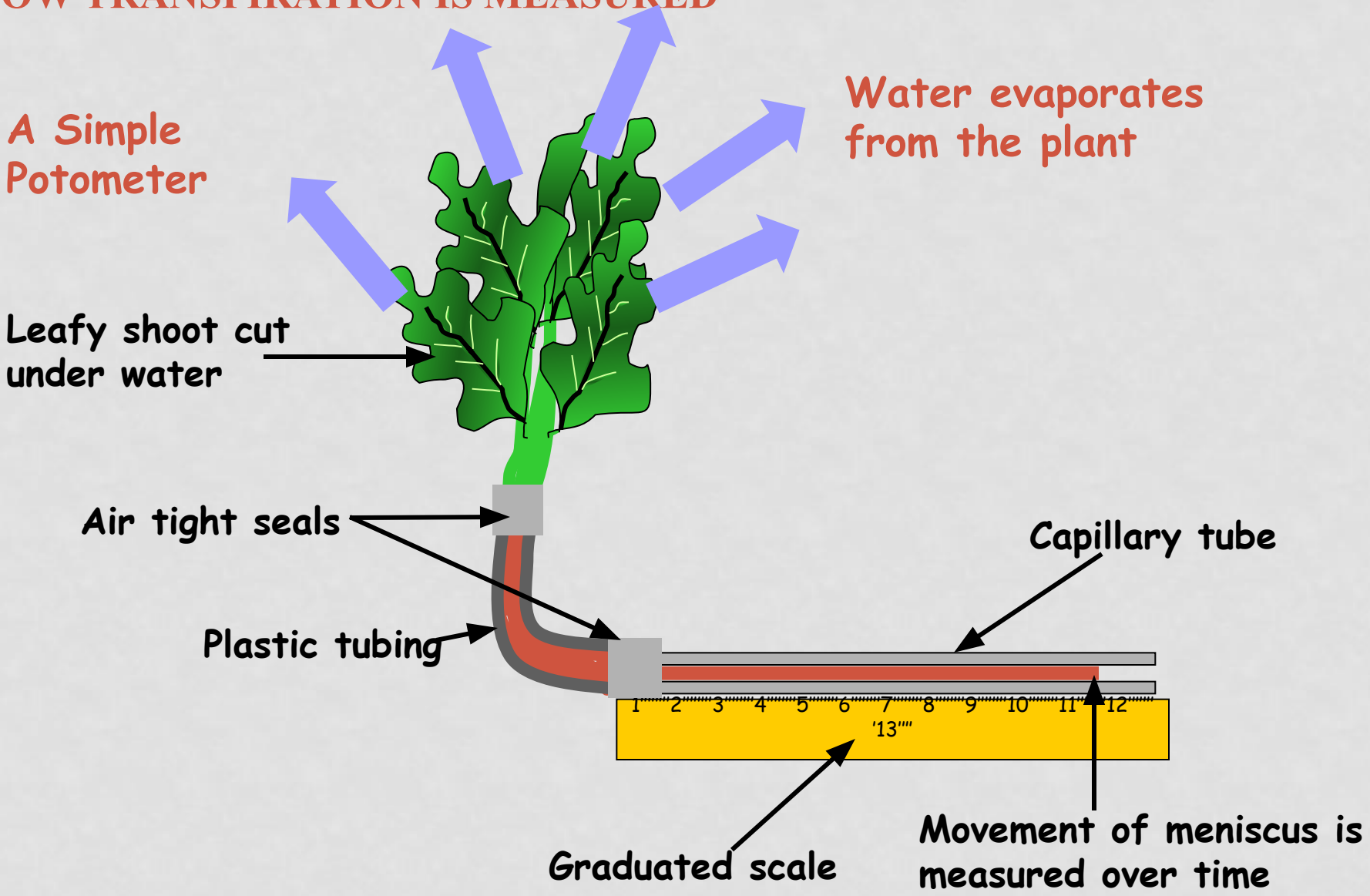
TRANSPIRATION

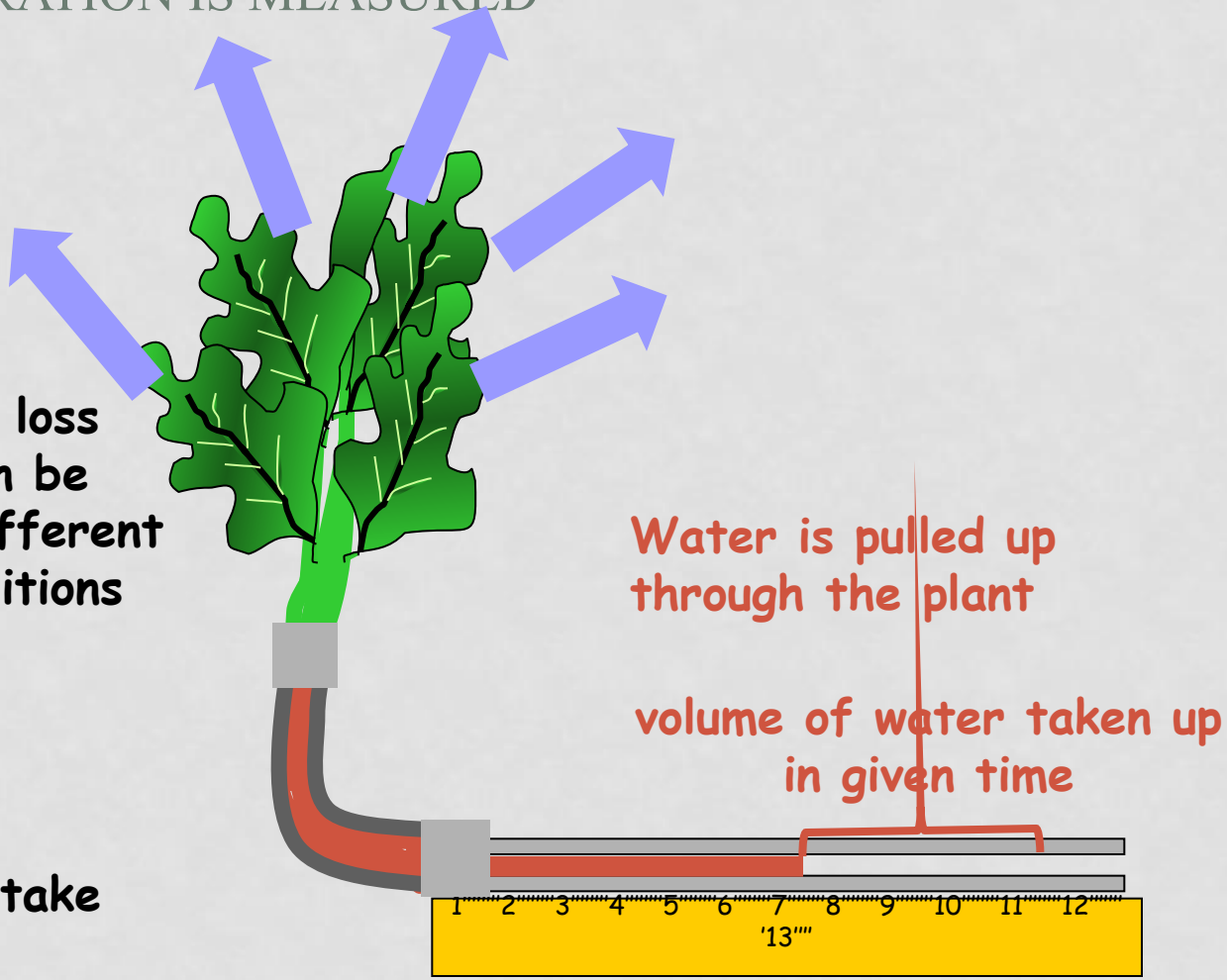
- Transpiration is the loss of water from a plant by **evaporation**
- Water can only evaporate from the plant if the **water potential** is **lower** in the **air** surrounding the plant
- Most transpiration occurs via the leaves
- **Most** of this transpiration is **via the stomata**.

HOW TRANSPIRATION IS MEASURED



HOW TRANSPIRATION IS MEASURED

The rate of water loss from the shoot can be measured under different environmental conditions



Limitations

- measures water uptake
- cutting plant shoot may damage plant
- plant has no roots so no resistance to water being pulled up

ENVIRONMENTAL FACTORS AFFECTING TRANSPIRATION

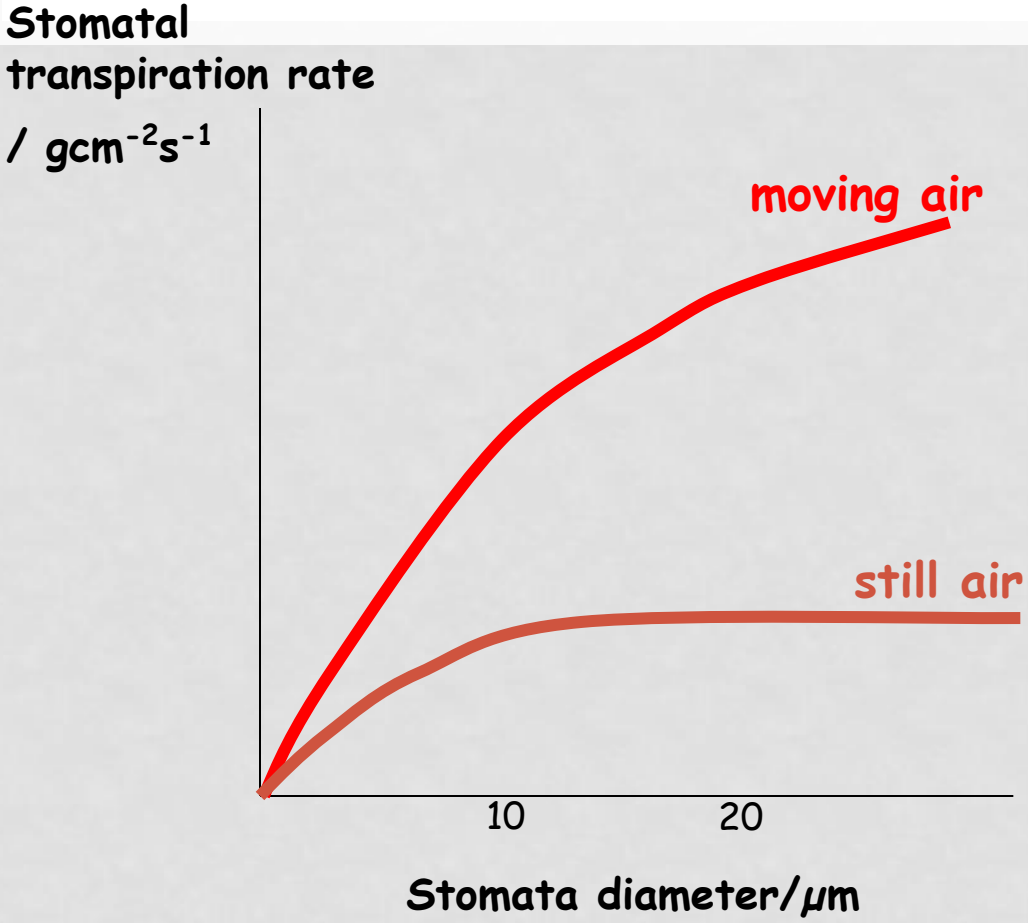
1. **Relative humidity**:- air inside leaf is saturated (RH=100%). The lower the relative humidity outside the leaf the faster the rate of transpiration as the Ψ gradient is steeper
2. **Air Movement**:- increase air movement increases the rate of transpiration as it moves the saturated air from around the leaf so the Ψ gradient is steeper.
3. **Temperature**:- increase in temperature increases the rate of transpiration as higher temperature
   - Provides the latent heat of vaporisation
   - Increases the kinetic energy so faster diffusion
   - Warms the air so lowers the Ψ of the air, so Ψ gradient is steeper

4. **Atmospheric pressure**:- decrease in atmospheric pressure increases the rate of transpiration.

5. **Water supply**:- transpiration rate is lower if there is little water available as transpiration depends on the mesophyll cell walls being wet (dry cell walls have a lower Ψ). When cells are flaccid the stomata close.

6. **Light intensity** :- greater light intensity increases the rate of transpiration because it causes the stomata to open, so increasing evaporation through the stomata.

THE EFFECT OF WIND SPEED ON THE RATE OF TRANSPIRATION



In still air closing the stomata is less effective in controlling the transpiration rate

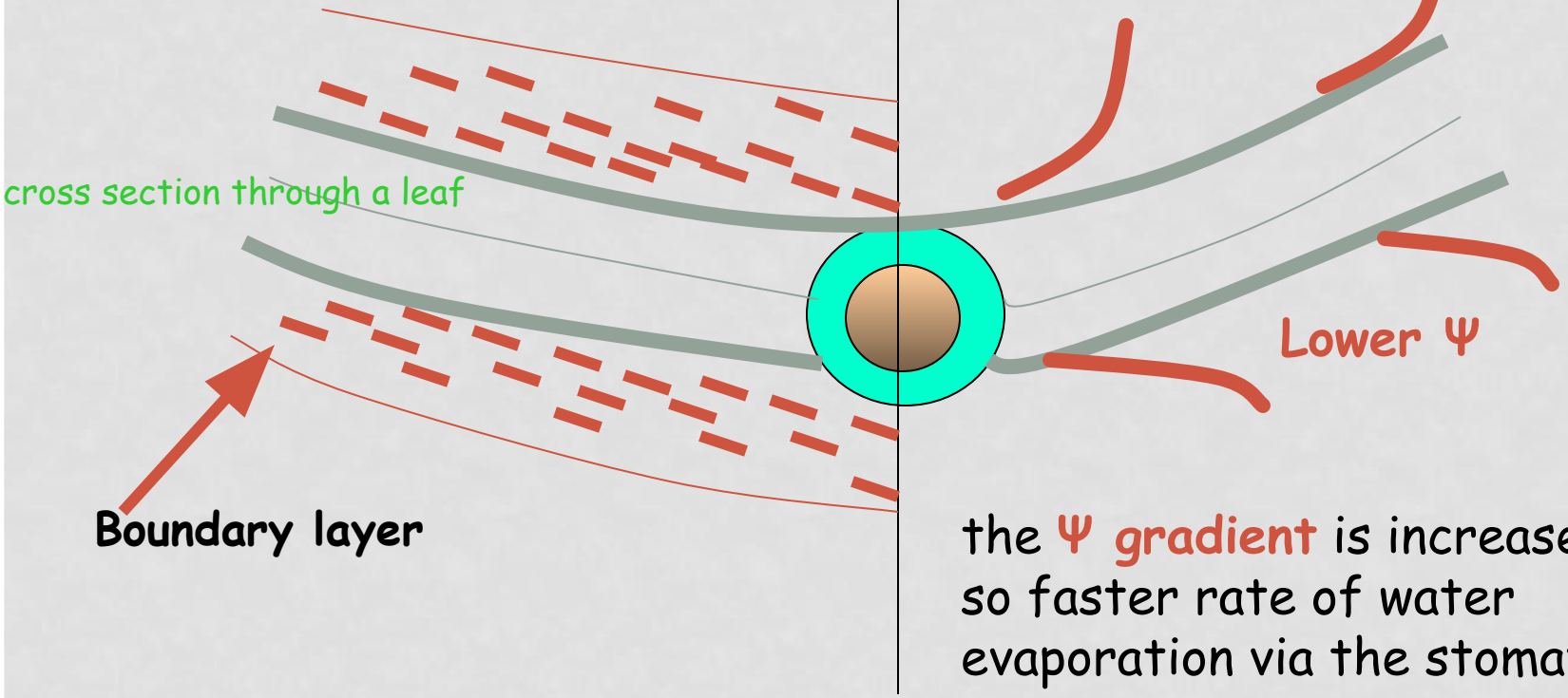
MOVING AIR REMOVES THE BOUNDARY LAYER OF WATER VAPOUR FROM THE LEAF

Still air

Moving air

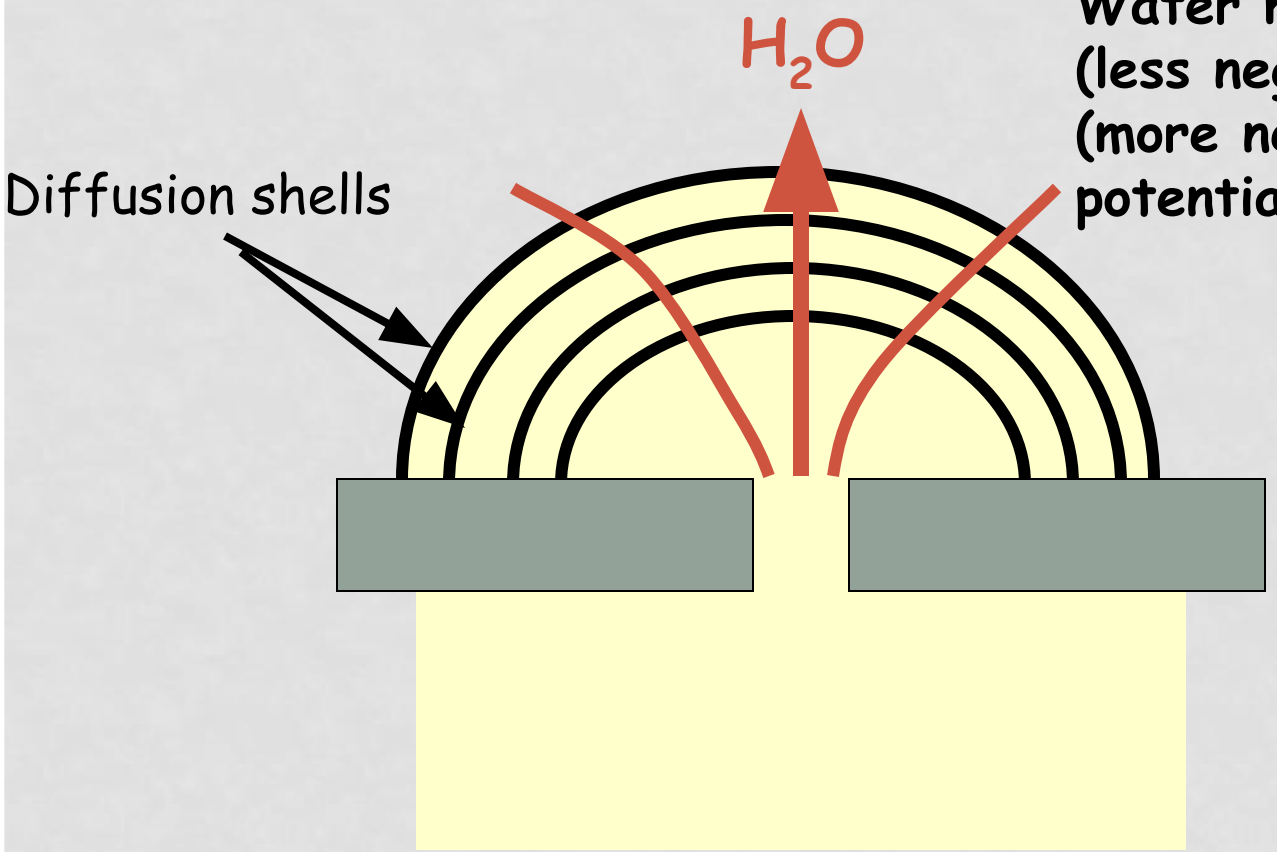
Saturated air accumulates around leaf

Water vapour is removed from the leaf surface



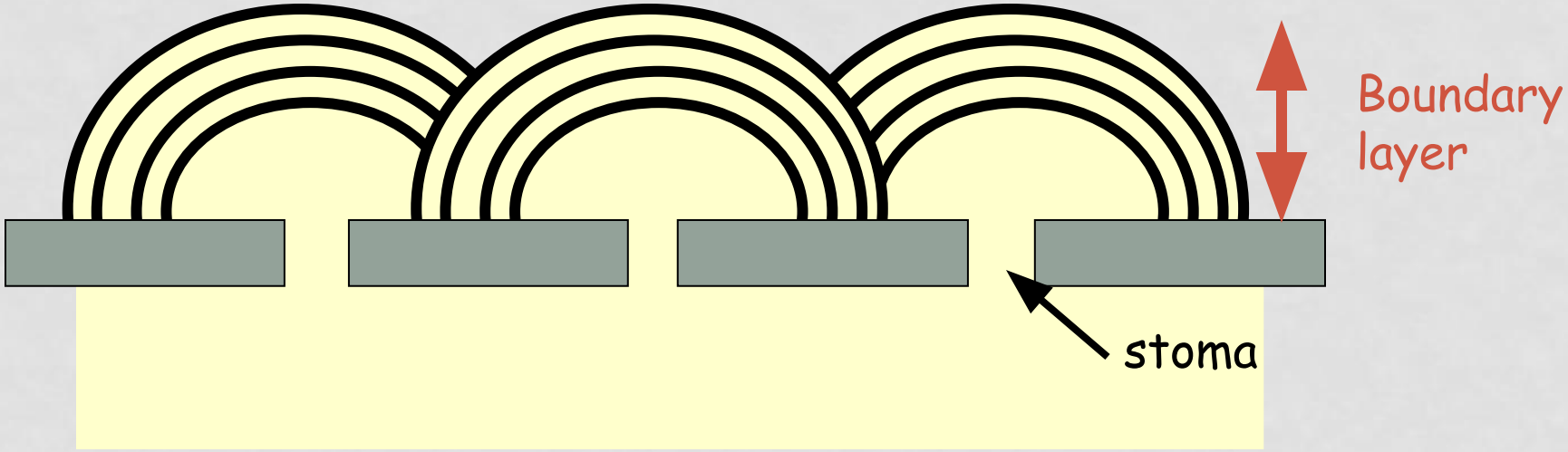
the Ψ gradient is increased, so faster rate of water evaporation via the stomata

MOVEMENT OF WATER THROUGH THE STOMATA



Water moves from a higher (less negative) to a lower (more negative) water potential

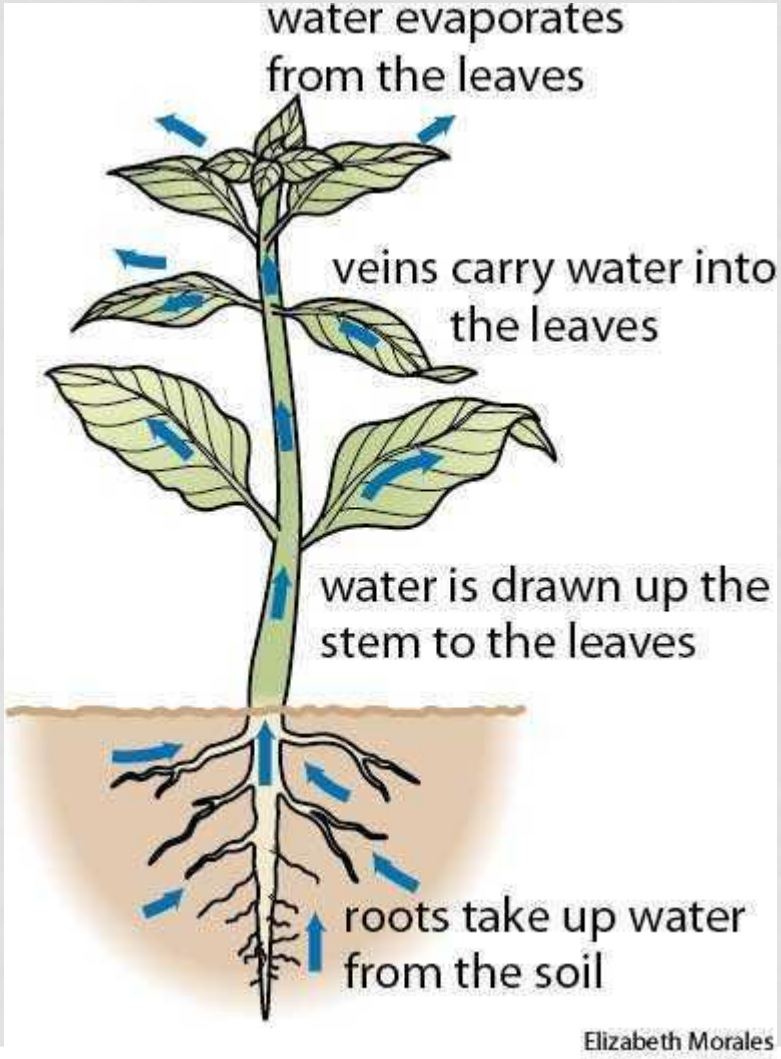
INCREASE IN STOMATAL FREQUENCY INCREASES THE RATE OF TRANSPIRATION



If the distance between the stomata is less than 10 X the pore diameter the diffusion shells overlap

So increasing the number of stomata per unit area will have no further effect on transpiration

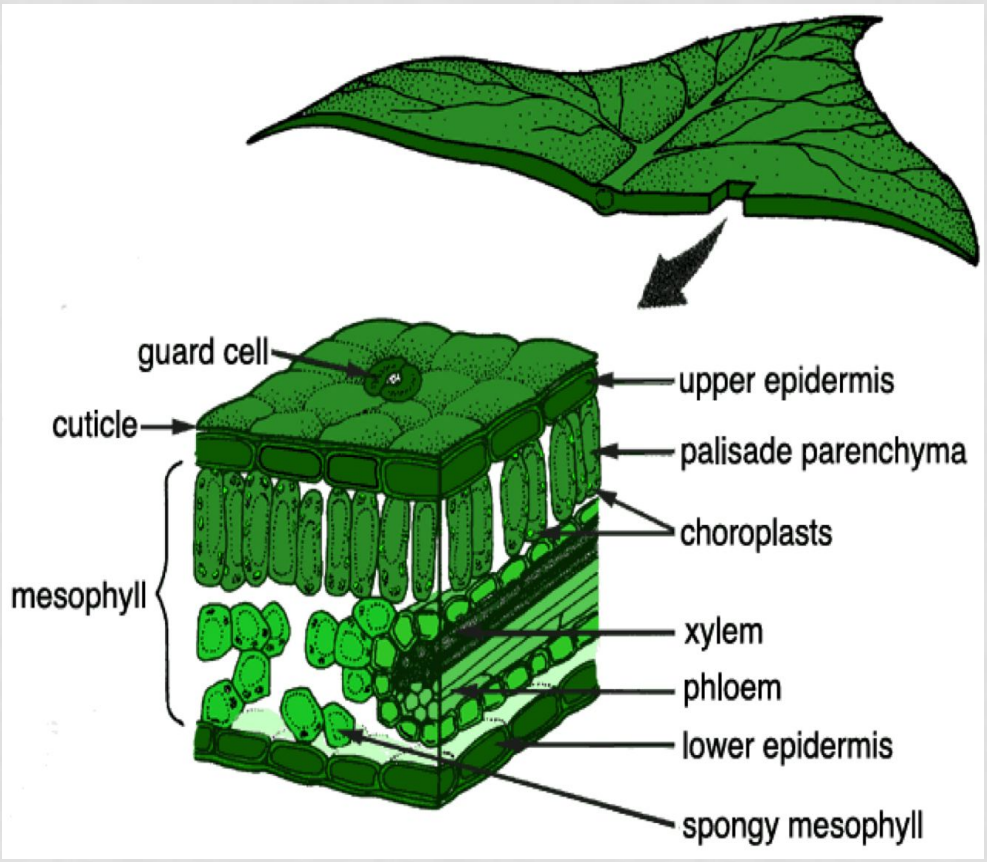
WILTING



If water lost by transpiration is greater than water uptake via the roots the **plant cells** become **flaccid** and the plant wilts.

When the guard cells are flaccid the stomata close

LEAF SECTION

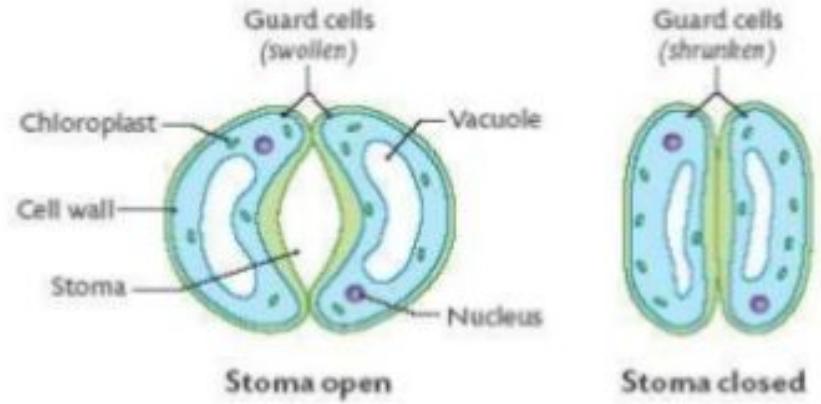


The upper epidermis has no stomata

The lower epidermis has stomata.

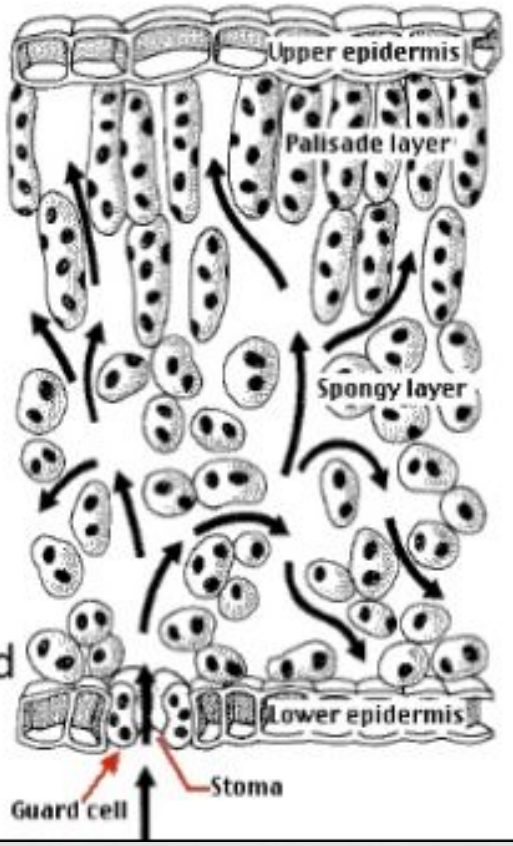
The guard cells control the opening and closing of the stomata

SURFACE VIEW OF LEAF EPIDERMIS SHOWING THE GUARD CELLS WHICH ARE FLACCID AND THE STOMA CLOSED.

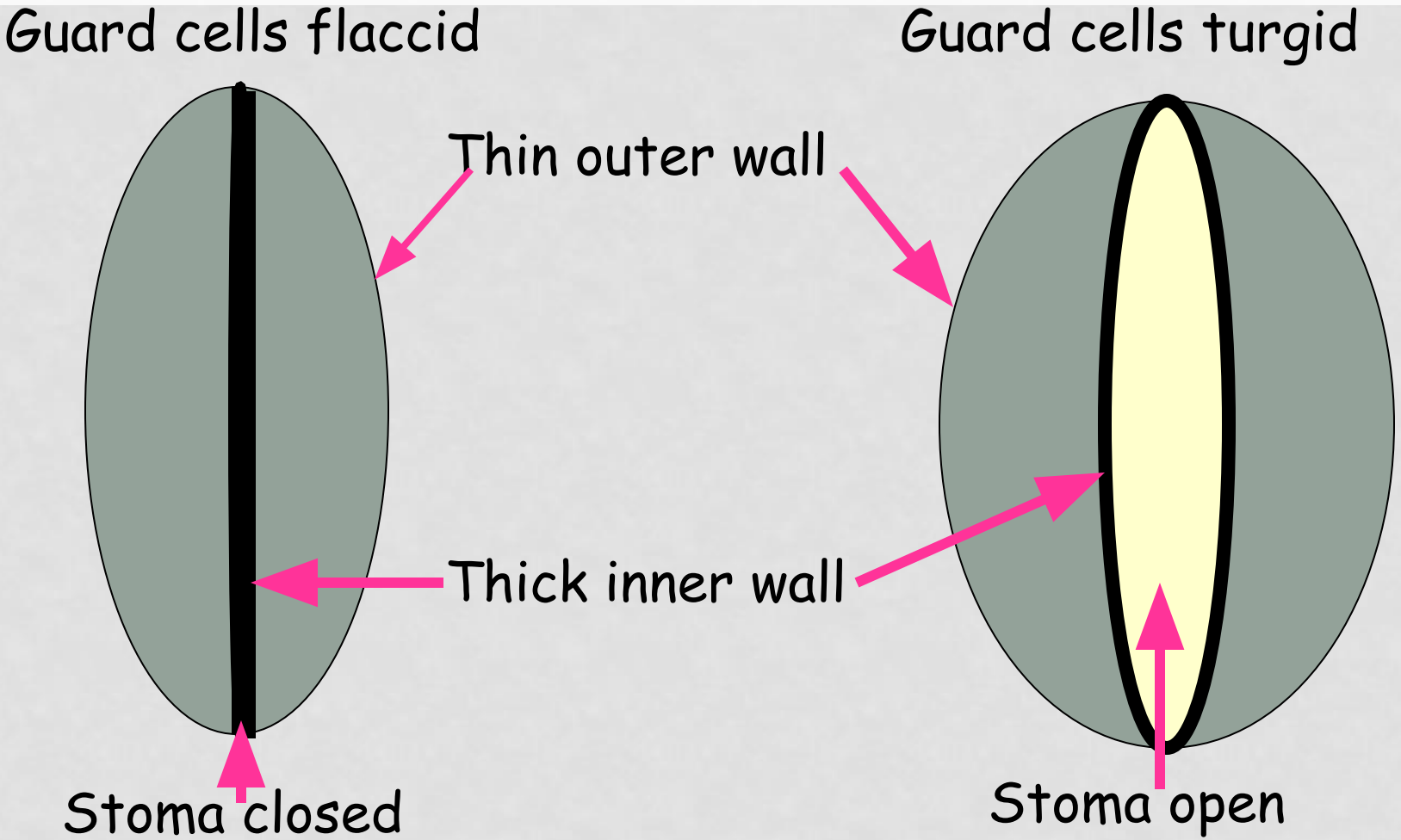


In sunlight the guard cell becomes turgid
Turgid guard cells open the stoma
Increases gas exchange

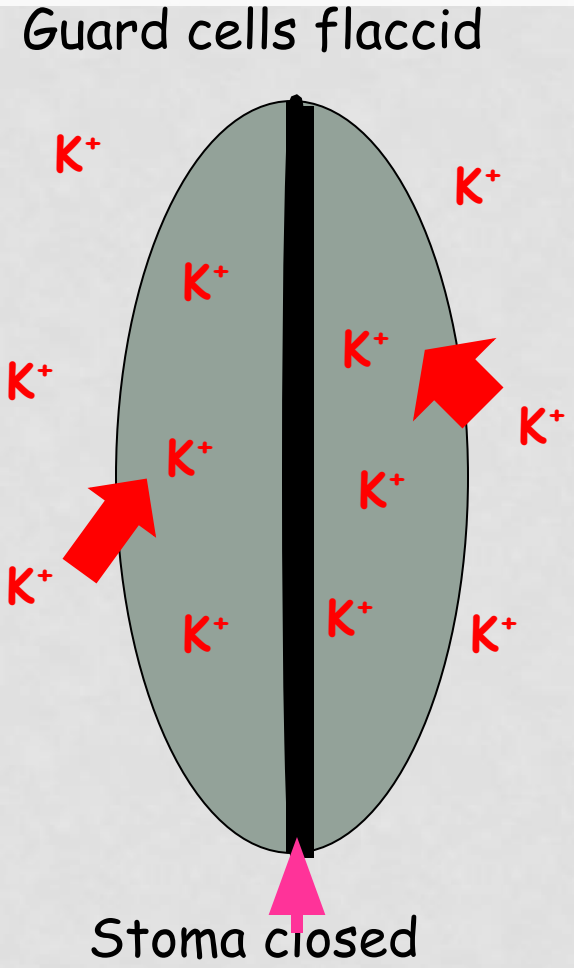
Low light causes guard cells to become flaccid
Flaccid guard cells close the stoma
Decreases water loss



THE GUARD CELLS CONTROL THE OPENING AND CLOSING OF THE STOMATA



REGULATING STOMATAL OPENING:-THE POTASSIUM ION PUMP HYPOTHESIS



K^+ ions have the same concentration in guard cells and epidermal cells

Light activates K^+ pumps which actively transport K^+ from the epidermal cells into the guard cells

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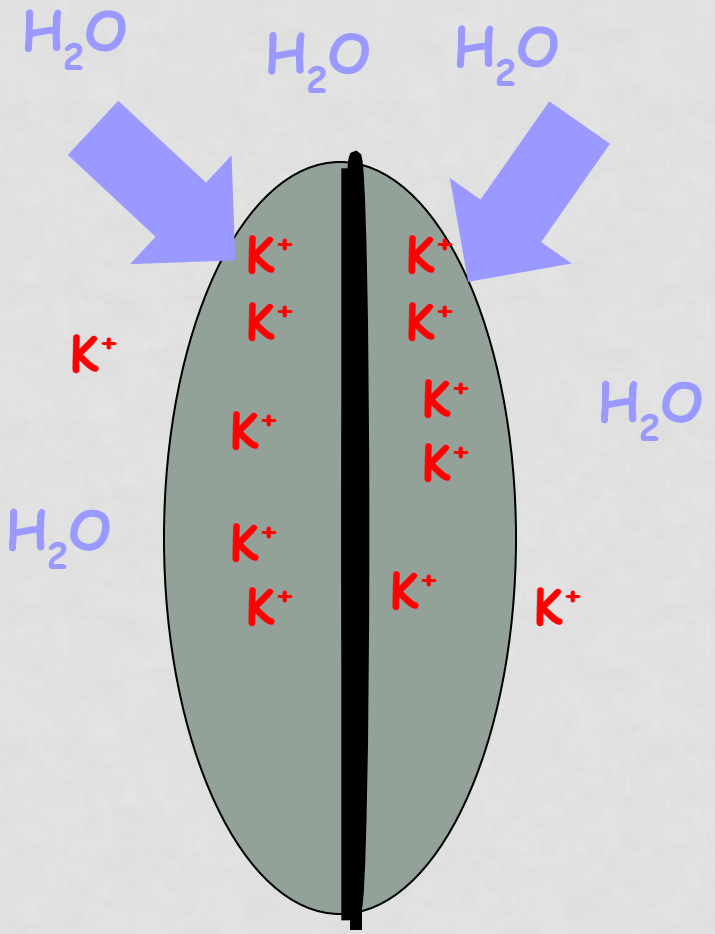
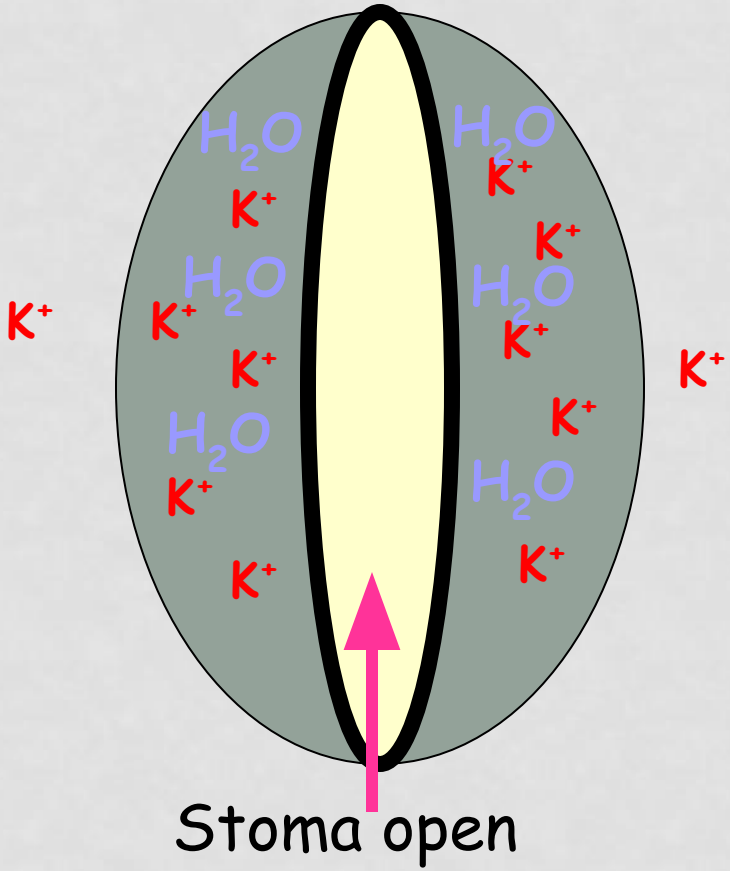


Increased concentration of K^+ in guard cells

Lowers the Ψ in the guard cells

Water moves in by osmosis, down Ψ gradient

Guard cells turgid



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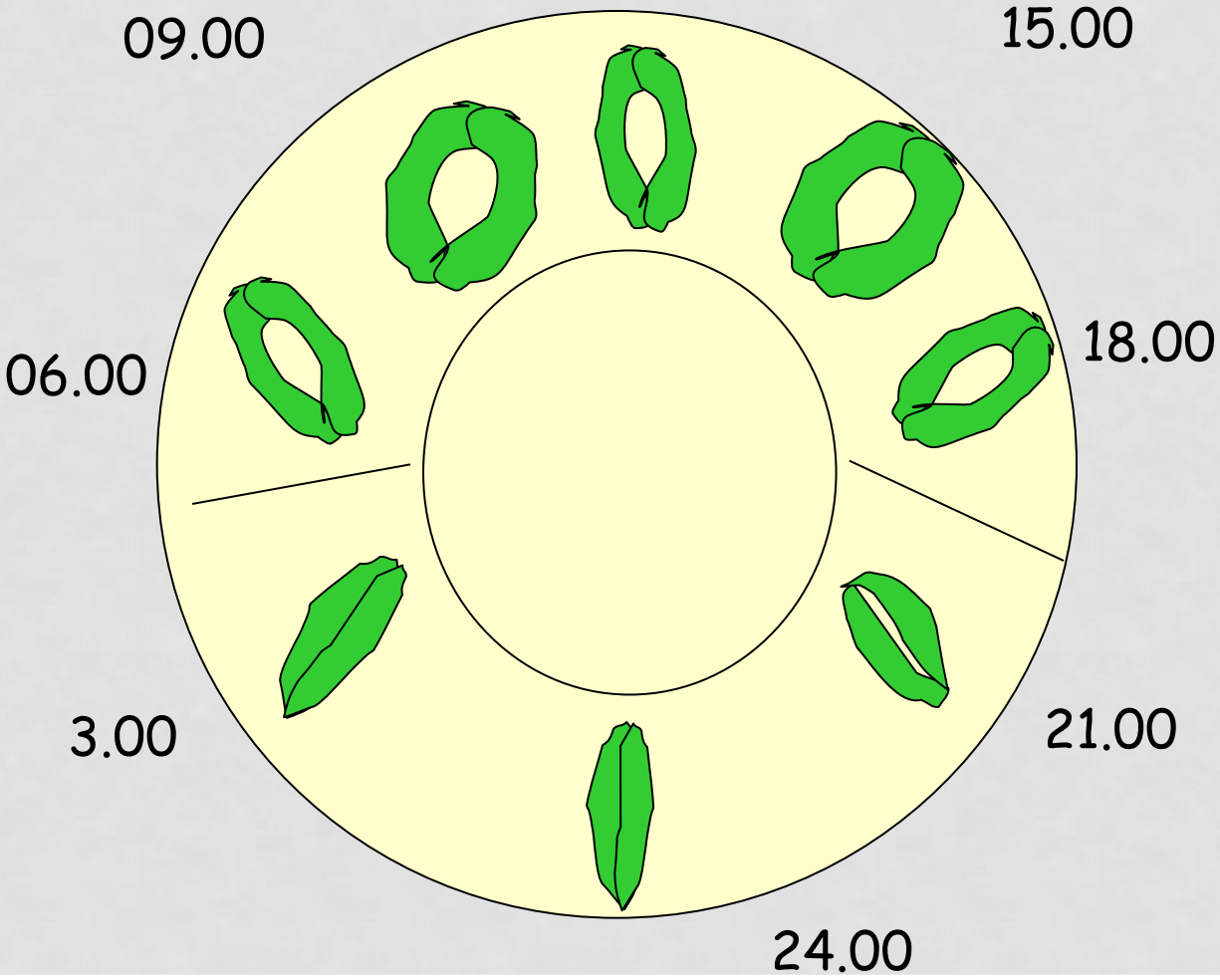
24H CYCLE OF STOMATAL OPENING AND CLOSING

Why is this cycle an advantage to most plants?



QUESTIONS

1. What is transpiration? Give three environmental factors which will increase transpiration rate. (2marks)
2. Explain how potassium ions are moved into the guard cells in light, and how this affects the guard cells and stomata. (6marks)
3. Give three adaptations a xerophyte may have to reduce transpiration and explain how they do this. (4marks)
4. Plants close their stomata at night and some also close their stomata around mid day. Explain why this is advantageous to the plant (2marks)