Edexcel GCSE Biology

Your notes

Plant Structure

Contents

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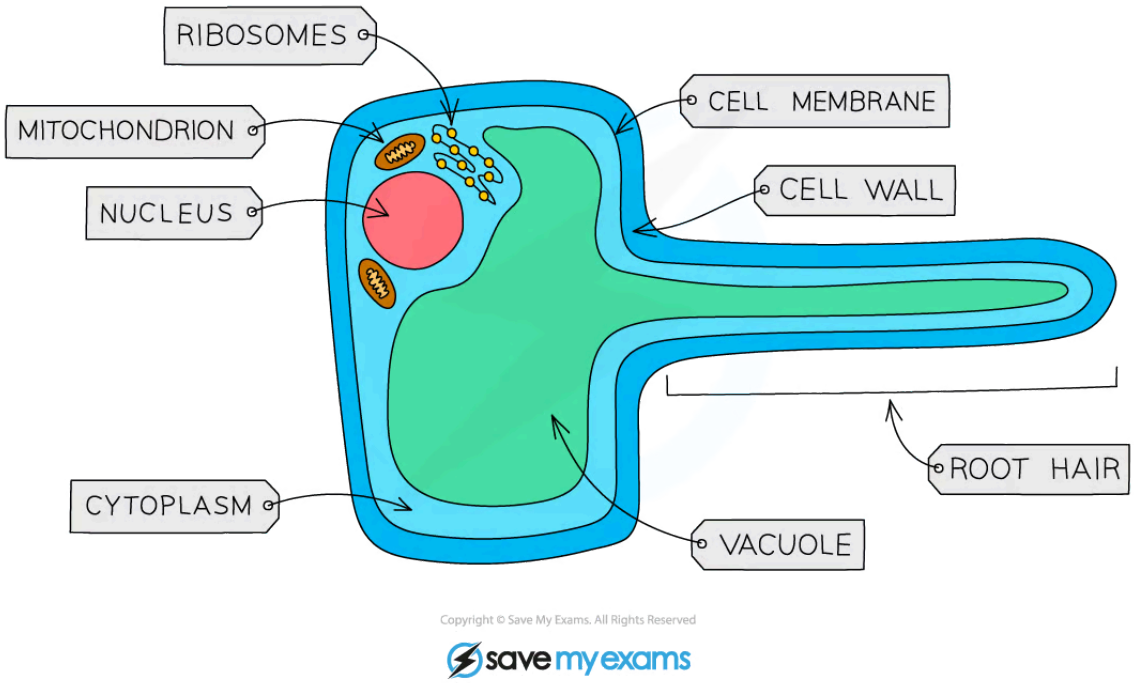
Root Hair Cells

Root hair cell function

- **Root hair cells** are adapted for the efficient uptake of water (by osmosis) and mineral ions (by active transport)
- Root hairs are single-celled extensions of epidermis cells in the root
- They grow between soil particles and absorb water and minerals from the soil
- Root hairs increase the **surface area to volume ratio significantly**
  - This increases the rate of the absorption of **mineral ions by active transport**
- The high proportion of dissolved minerals and sugars in the cytoplasm (of the root hair cell) gives it a low water potential (less watery)
  - This causes water to move into the root hair cell by **osmosis**

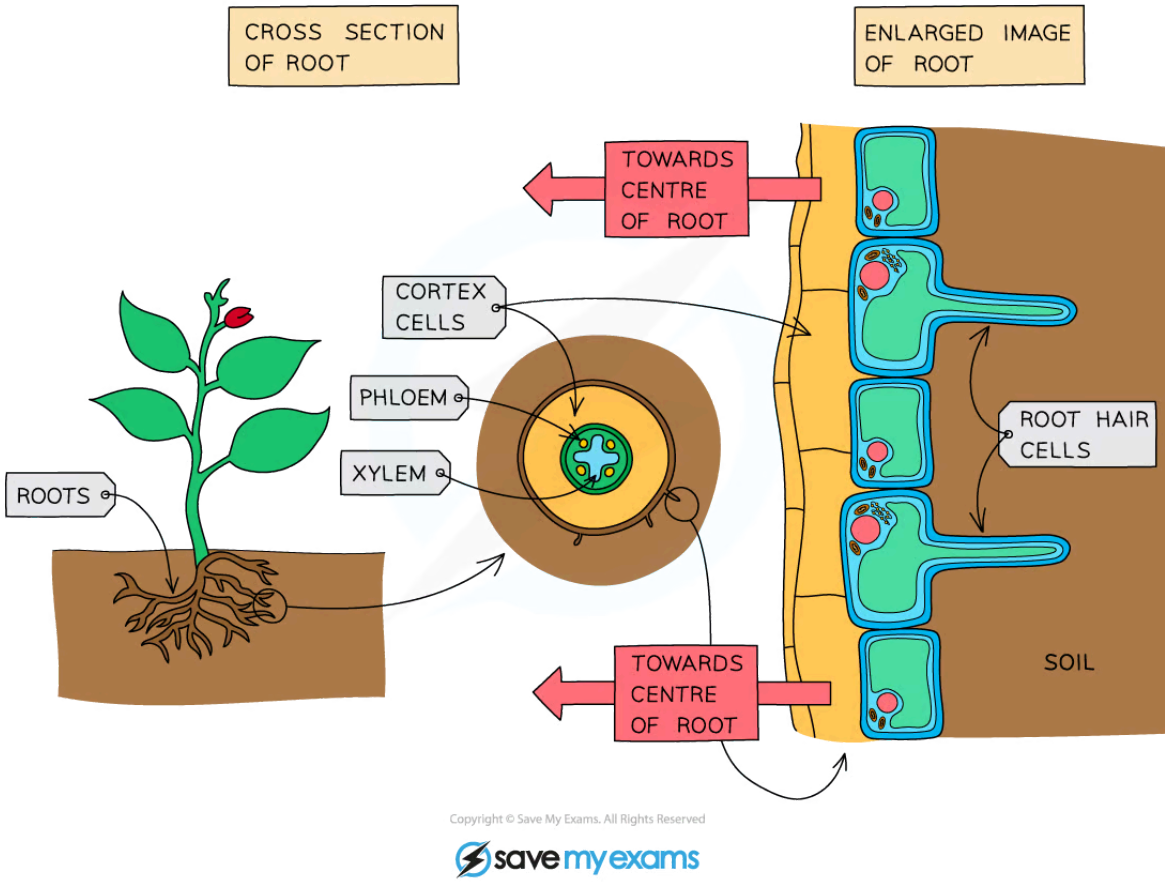
Root Hair Cell Diagram



A root hair cell.

Root Hair Cells and the Uptake of Water

Your notes



The structure of a root specifically allows it to maximise absorption of water by osmosis and mineral ions by active transport.

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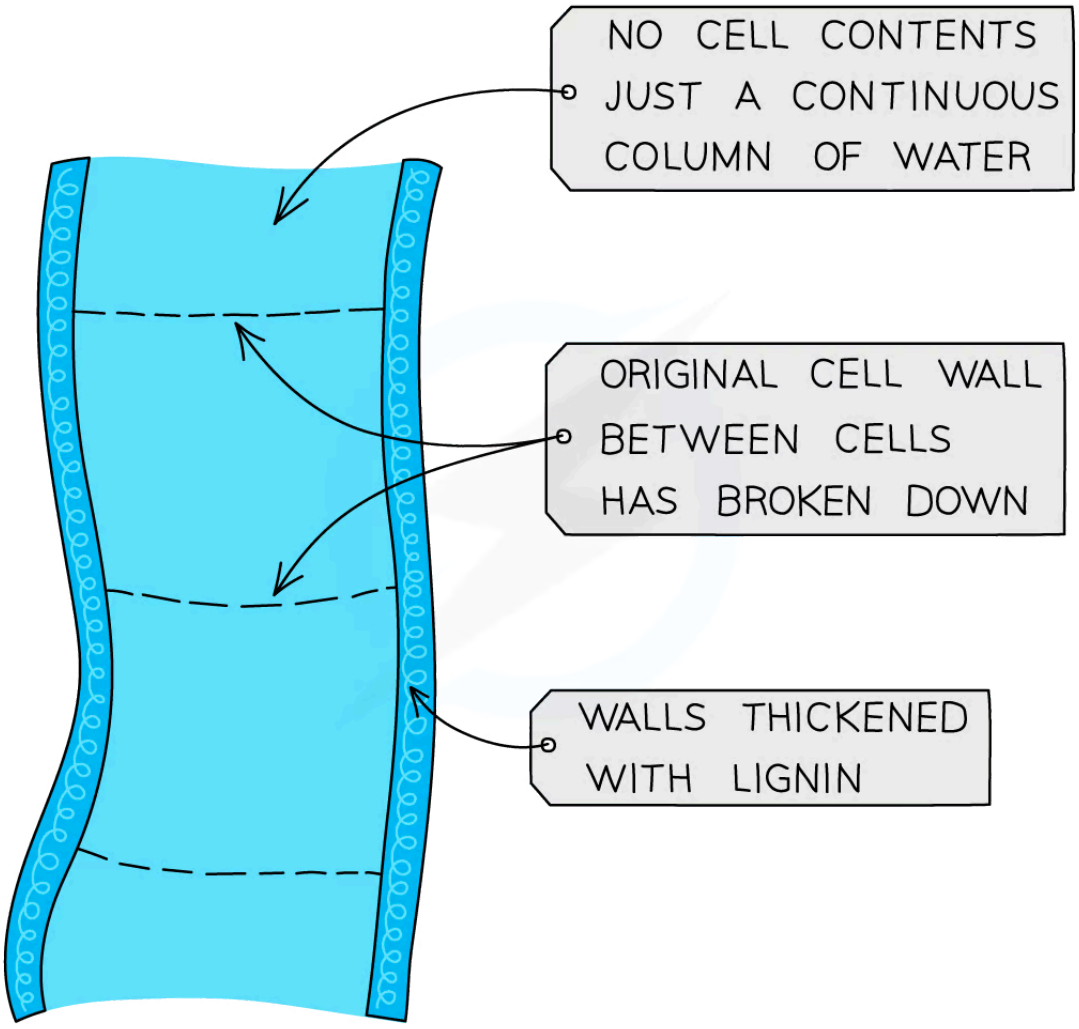
Xylem & Phloem

A xylem vessel

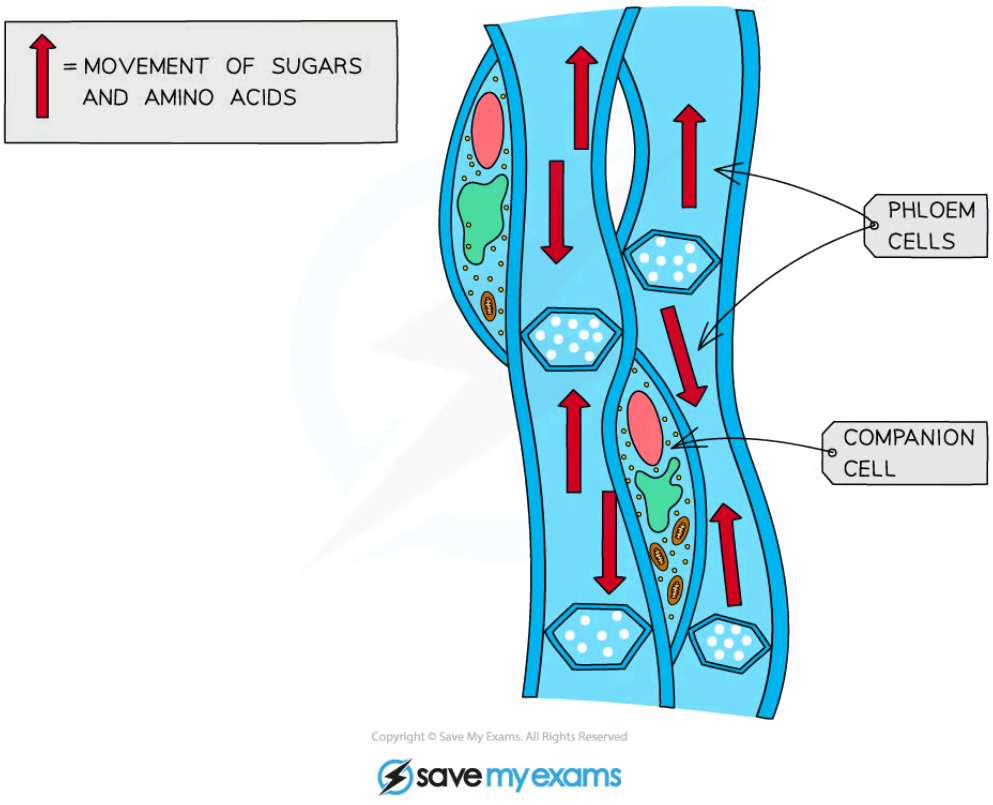


Xylem cells lose their top and bottom walls to form a continuous tube through which water moves through from the roots to the leaves

Your notes

- Function: transport tissue for water and dissolved mineral ions
- Adaptations:
  - **No top and bottom walls** between cells to form continuous hollow tubes through which water is drawn upwards towards the leaves by transpiration
  - Cells are essentially **dead,** without organelles or cytoplasm, to allow **free passage of water**
  - Outer walls are **thickened** with a substance called **lignin,** strengthening the tubes, which helps **support** the plant

Phloem cells



Phloem cells form tubes similar to xylem vessels, except the cells still retain some subcellular structures and are therefore living

- Function: transport of dissolved sugars (e.g. sucrose) and amino acids
- Adaptations:

- Made of **living cells** (as opposed to xylem vessels, which are made of dead cells) that are supported by companion cells
- Cells are **joined** end-to-end and contain holes in the end cell walls (sieve plates) forming tubes which allow sugars and amino acids to **flow easily** through (by translocation)
- Cells also have very **few subcellular** structures to aid the flow of materials

Examiner Tips and Tricks

You may be given some information (including an image) about an unfamiliar cell in an exam, and asked to describe how it's able to carry out its function. This shouldn't faze you – just look at the shape of the cell and its subcellular structures.Does the cell have a shape which increases its surface area? Are there lots of ribosomes to make proteins (such as enzymes or hormones), or lots of mitochondria (to transfer lots of energy via respiration)?

Your notes

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Structure of the Leaf

- Plant leaves have complex structures with layers of different tissues containing specially adapted cells
- The table below describes the different structures in a leaf and their functions

Leaf Structures Table

STRUCTURE	DESCRIPTION
WAX CUTICLE	PROTECTIVE LAYER ON TOP OF THE LEAF, PREVENTS WATER FROM EVAPORATING
UPPER EPIDERMIS	THIN AND TRANSPARENT TO ALLOW LIGHT TO ENTER PALISADE MESOPHYLL LAYER UNDERNEATH IT
PALISADE MESOPHYLL	COLUMN SHAPED CELLS TIGHTLY PACKED WITH CHLOROPLASTS TO ABSORB MORE LIGHT, MAXIMISING PHOTOSYNTHESIS
SPONGY MESOPHYLL	CONTAINS INTERNAL AIR SPACES THAT INCREASES THE SURFACE AREA TO VOLUME RATIO FOR THE DIFFUSION OF GASES (MAINLY CARBON DIOXIDE)
LOWER EPIDERMIS	CONTAINS GUARD CELLS AND STOMATA
GUARD CELL	ABSORBS AND LOSES WATER TO OPEN AND CLOSE THE STOMATA TO ALLOW CARBON DIOXIDE TO DIFFUSE IN, OXYGEN TO DIFFUSE OUT
STOMATA	WHERE GAS EXCHANGE TAKES PLACE; OPENS DURING THE DAY, CLOSES DURING THE NIGHT. EVAPORATION OF WATER ALSO TAKES PLACE FROM HERE. IN MOST PLANTS, FOUND IN MUCH GREATER CONCENTRATION ON THE UNDERSIDE OF THE LEAF TO REDUCE WATER LOSS
VASCULAR BUNDLE	CONTAINS XYLEM AND PHLOEM TO TRANSPORT SUBSTANCES TO AND FROM THE LEAF
XYLEM	TRANSPORTS WATER INTO THE LEAF FOR MESOPHYLL CELLS TO USE IN PHOTOSYNTHESIS AND FOR TRANSPIRATION FROM STOMATA
PHLOEM	TRANSPORTS SUCROSE AND AMINO ACIDS AROUND THE

Your notes

	PLANT

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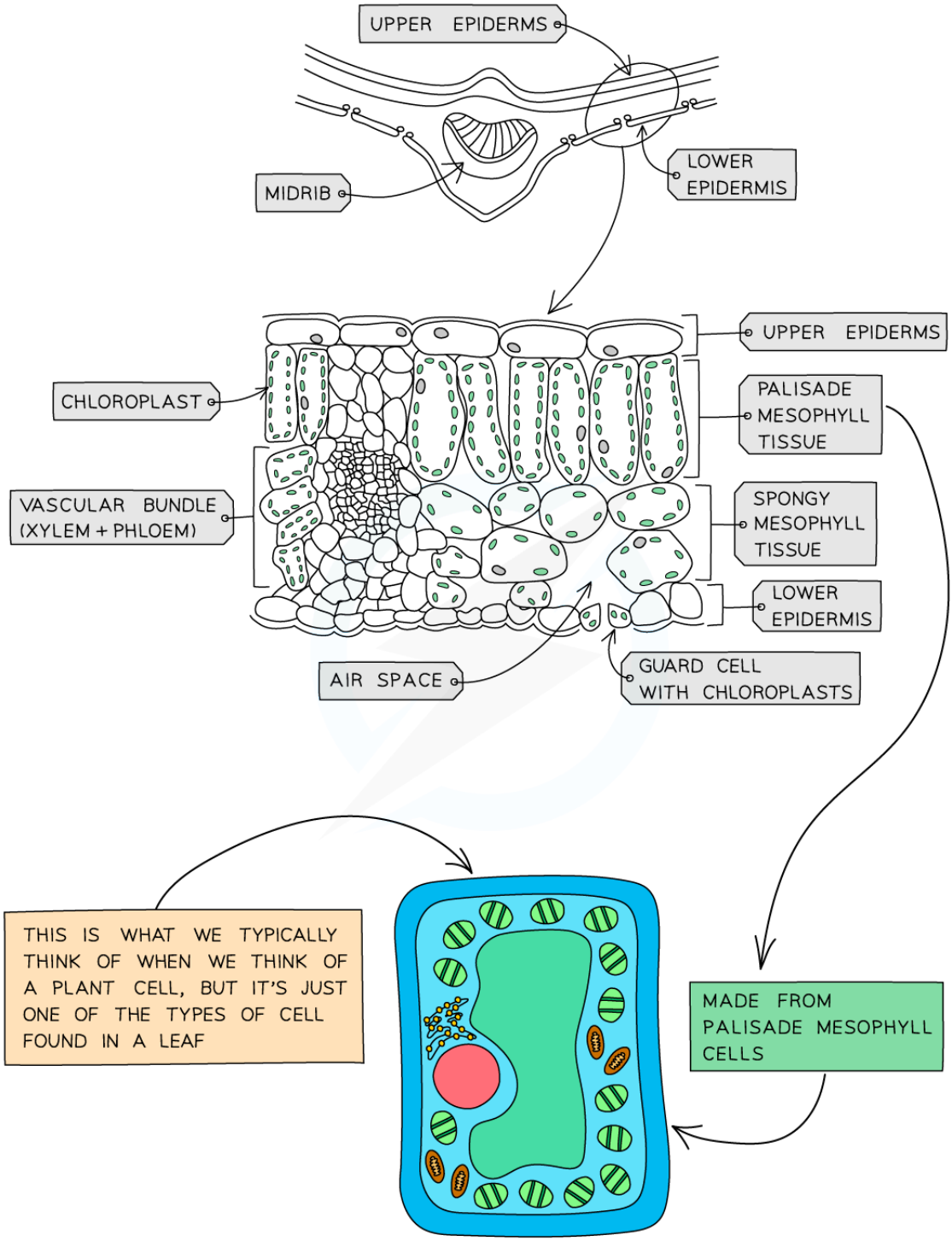

Diagram showing the cross-section of a leaf

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- The specialised cells in leaves have adaptive features which allow them to carry out a particular function in the plant

Adaptations of Plant Leaves for Photosynthesis Table

FEATURE	ADAPTATION
LARGE SURFACE AREA (LEAF)	INCREASES SURFACE AREA FOR THE DIFFUSION OF CARBON DIOXIDE AND ABSORPTION OF LIGHT FOR PHOTOSYNTHESIS
THIN	ALLOWS CARBON DIOXIDE TO DIFFUSE TO PALISADE MESOPHYLL CELLS QUICKLY
CHLOROPHYLL	ABSORBS LIGHT ENERGY SO THAT PHOTOSYNTHESIS CAN TAKE PLACE
NETWORK OF VEINS	ALLOWS THE TRANSPORT OF WATER TO THE CELLS OF THE LEAF AND CARBOHYDRATES FROM THE LEAF FOR PHOTOSYNTHESIS (WATER FOR PHOTOSYNTHESIS, CARBOHYDRATES AS A PRODUCT OF PHOTOSYNTHESIS)
STOMATA	ALLOWS CARBON DIOXIDE TO DIFFUSE INTO THE LEAF AND OXYGEN TO DIFFUSE OUT
EPIDERMIS IS THIN AND TRANSPARENT	ALLOWS MORE LIGHT TO REACH THE PALISADE CELLS
THIN CUTICLE MADE OF WAX	TO PROTECT THE LEAF WITHOUT BLOCKING SUNLIGHT
PALISADE CELL LAYER AT TOP OF LEAF	MAXIMISES THE ABSORPTION OF LIGHT AS IT WILL HIT CHLOROPLASTS IN THE CELLS DIRECTLY
SPONGY LAYER	AIR SPACES ALLOW CARBON DIOXIDE TO DIFFUSE THROUGH THE LEAF, INCREASING THE SURFACE AREA
VASCULAR BUNDLES	THICK CELL WALLS OF THE TISSUE IN THE BUNDLES HELP TO SUPPORT THE STEM AND LEAF

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Living in Extreme Conditions

- Some organisms live in **environments** that are very **extreme**, such as at very high or low temperatures, pressures, or high salt concentrations
- An example of habitats where extremophiles are found are **deep-sea volcanic vents**, where the conditions are extremely **hot**, under high **pressure** and there is no sunlight
- Plants are adapted to survive in extreme environments including through adaptations to their **leaf size and shape, their cuticle and stomata**

Xerophytic plants

- Plants that live in conditions with a plentiful supply of freshwater have **leaves with a short diffusion distance** through the **stomata** and a **large surface area** provided by the **air spaces** in the **spongy mesophyll**
- These factors make them vulnerable to water loss
- Plants that live in conditions where freshwater is limited have evolved very effective **adaptations to conserve water**, including:
  - Very few stomata
  - Sunken stomata
  - Hairs surrounding stomata
  - Needle-shaped or small leaves
  - Waxy cuticle
- Plants with these adaptations are described as **xerophytic**

Your notes

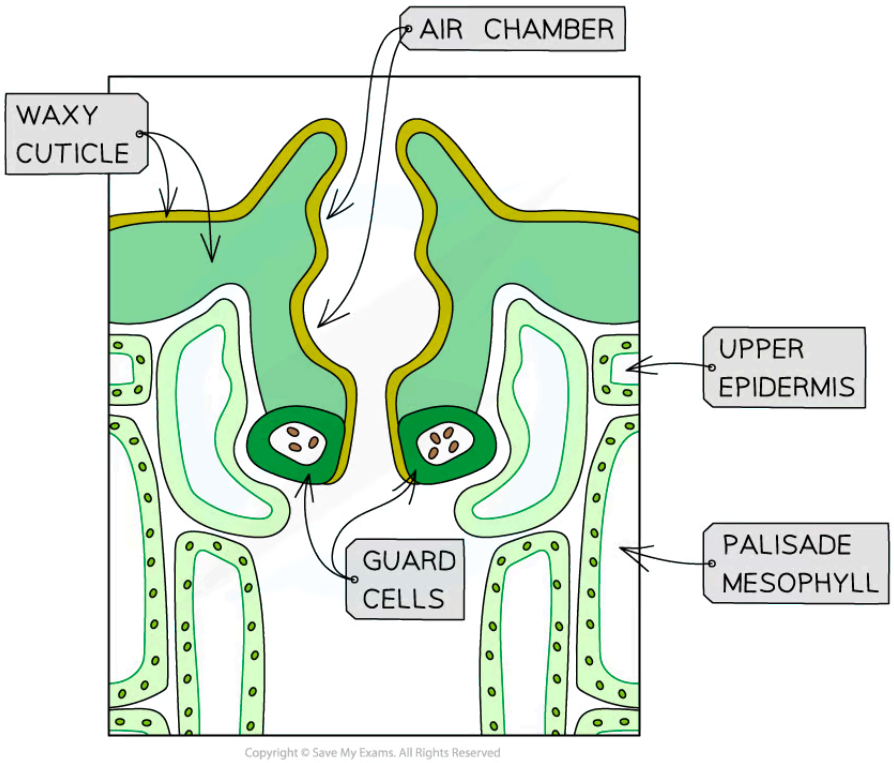

Image showing how sunken stomata protects the escaping water vapour from the external air currents

Cacti

- Cacti are well-studied xerophytes usually found in the deserts of North and South America
- They have several characteristics adaptations
  - Their leaves have become **spines that can no longer photosynthesise**
  - Photosynthesis occurs in the green stem which possesses chloroplasts
  - The stem has a **thick cuticle** and is very **large in diameter** which allows it to **store water**
  - There are **both** shallow and deep penetrating roots which allow it to access all available water

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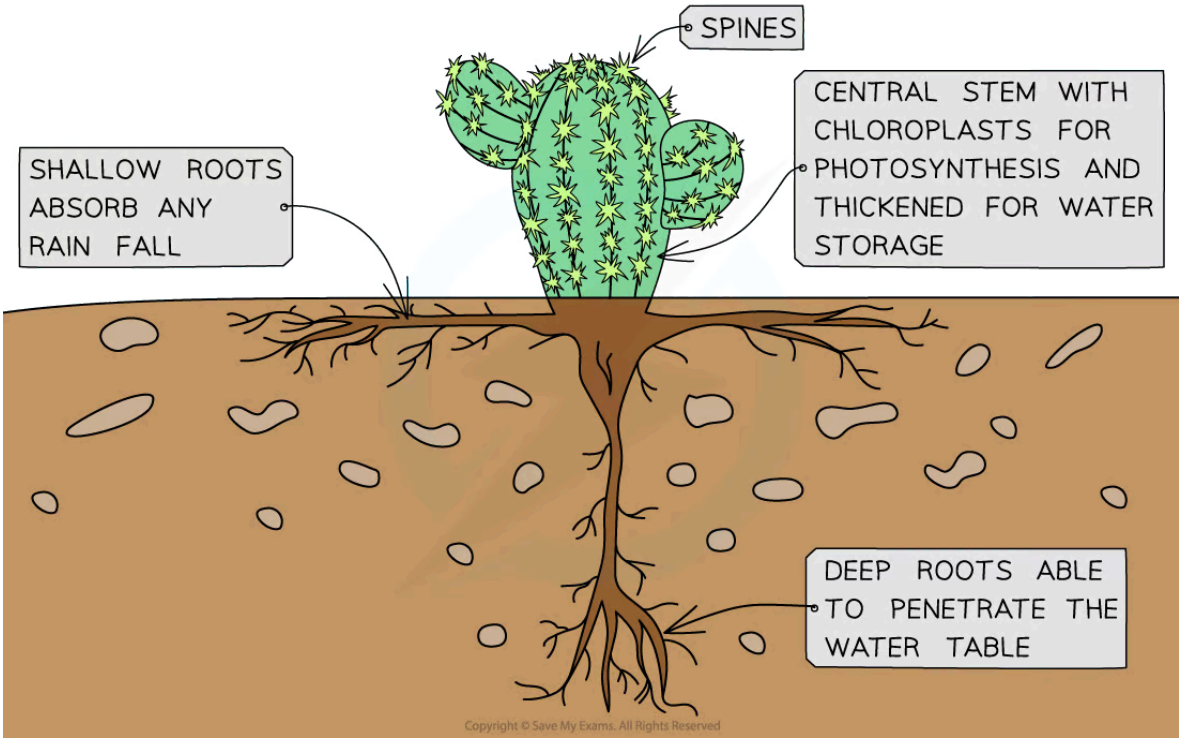

Image showing the adaptations of a Cactus that enables it to survive in dry, hot environments

Marram Grass

- Sand dunes are another example of a dry environment where plants have evolved to survive
- Marram grass is commonly found on these sand dunes
- Their leaves are well adapted to minimise water loss:
  - **Leaves can roll up** to reduce the exposure of surfaces to the wind
  - The rolling of the leaf provides deep grooves which protect the stomata
  - The **exposed surface has no stomata** and a **thick cuticle**
  - The inner surface of the leaf possesses a **large number of hairs to trap air**

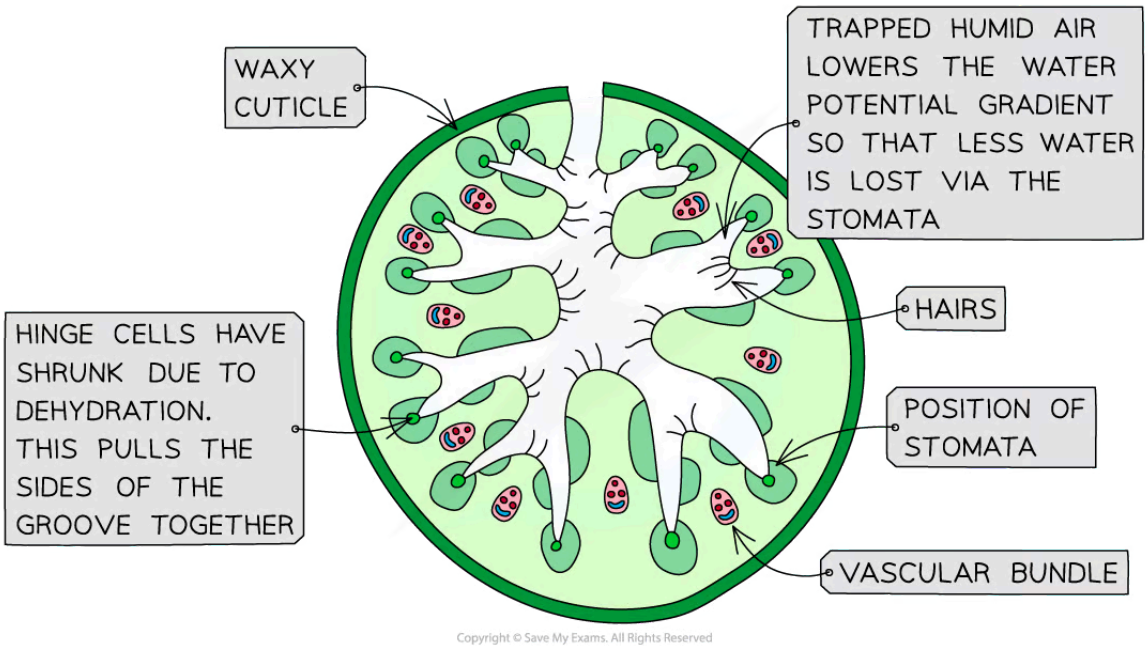

Image showing how the adaptations of the leaf causes water vapour to be trapped and retained near the stomata. This humid air near the stomata means the water potential gradient out of the leaf is reduced, so the rate of evaporation decreases.

Examiner Tips and Tricks

Most plants have a mechanism to balance gas exchange with water loss - if the guard cells that open the stomata lose water and become **flaccid** due to dehydration, then the stomata close and no more water can be lost through them.

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