

8 TRANSPORT IN PLANTS

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[VIEW EXAM QUESTIONS](#)

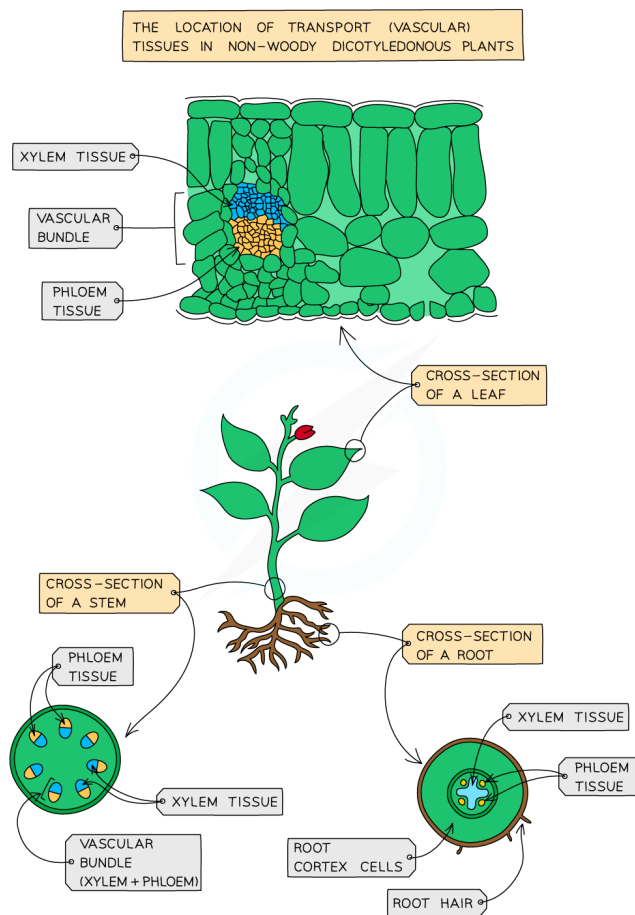
YOUR NOTES



8.1 VASCULAR TISSUE

Functions

- Plants contain two types of transport vessel:
 - **Xylem vessels** – transport water and minerals (pronounced: zi-lem) from the roots to the stem and leaves
 - **Phloem vessels** – transport food materials (mainly sucrose and amino acids) made by the plant from photosynthesising leaves to non-photosynthesising regions in the roots and stem (pronounced: flow-em)
- These vessels are arranged throughout the root, stem and leaves in groups called **vascular bundles**.



Vascular tissue in a dicotyledonous plant

8 TRANSPORT IN PLANTS

8.1 VASCULAR TISSUE cont...

YOUR NOTES



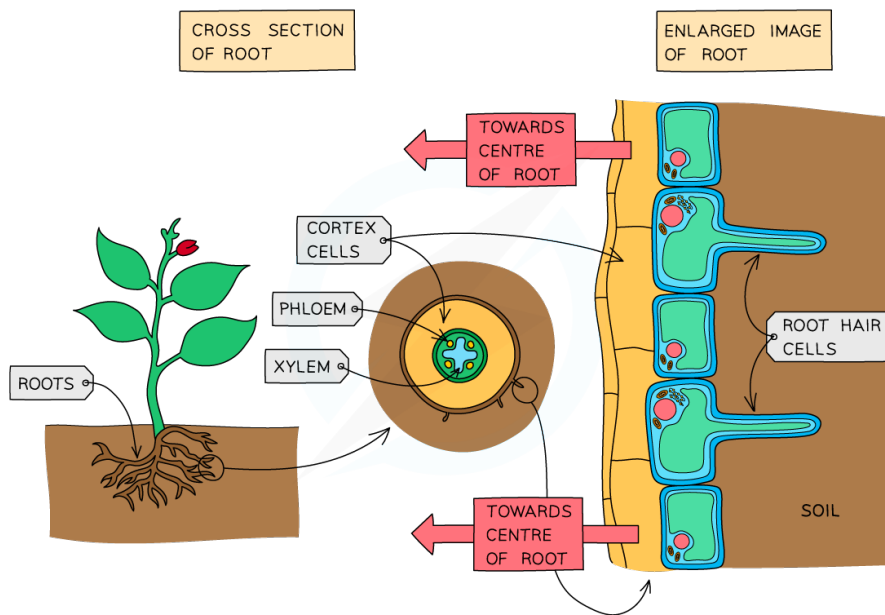
EXAM TIP

If you are asked to identify the xylem or phloem in a diagram showing a cross section of a root, stem or leaf just remember that xylem is always on the inside and phloem is always on the outside.

8.2 WATER UPTAKE

Root Hair Cells

- 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
- Water enters the root hair cells by osmosis
- This happens because soil water has a higher water potential than the cytoplasm of the root hair cell



Structure of the root

8 TRANSPORT IN PLANTS

8.2 WATER UPTAKE cont...

YOUR NOTES



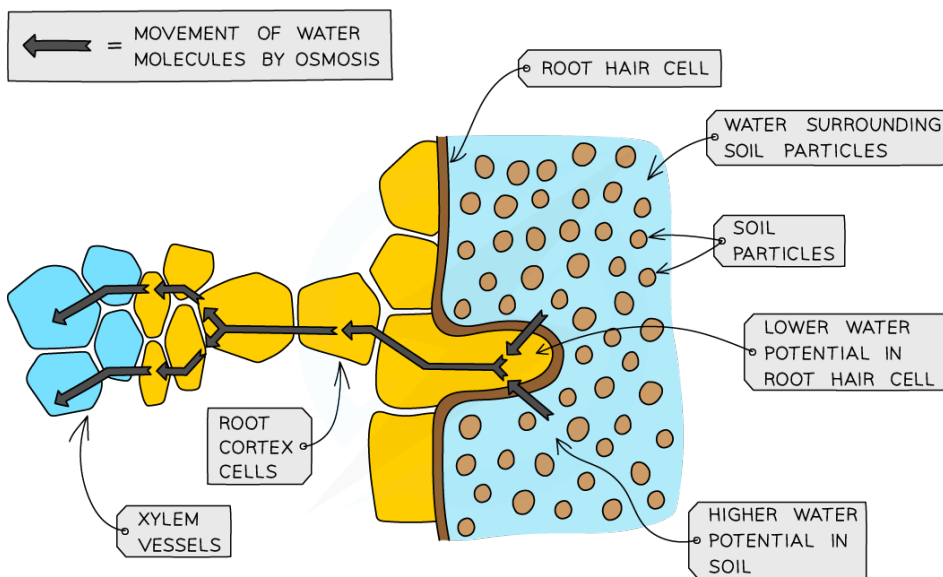
EXTENDED ONLY

How the Large Surface Area of Root Hair Cells is Useful

- The root hair increases the surface area of the cells significantly
- This large surface area is important as it **increases the rate of the absorption of water by osmosis and mineral ions by active transport**

Pathway of Water through Root to Leaf

- Osmosis causes water to pass into the root hair cells, through the root cortex and into the xylem vessels:



Pathway of water into and across a root

- Once the water gets into the xylem, it is carried up to the leaves where it enters mesophyll cells
- So the pathway is:

ROOT HAIR CELL → ROOT CORTEX CELLS → XYLEM → LEAF MESOPHYLL CELLS



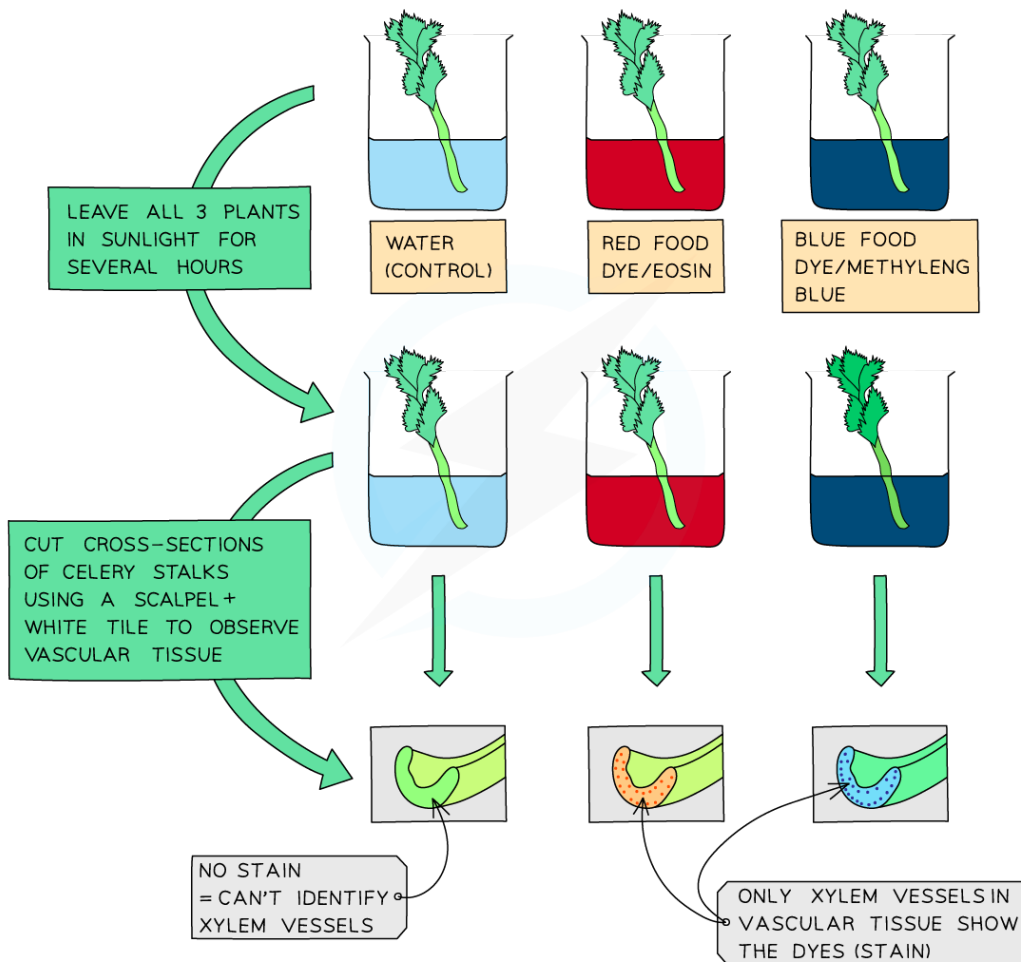
8 TRANSPORT IN PLANTS

8.2 WATER UPTAKE cont...

YOUR NOTES



- The pathway can be investigated by placing a plant (like celery) into a beaker of water that has had a stain added to it (food colouring will work well)
- After a few hours, you can see the leaves of the celery turning the same colour as the dyed water, proving that water is being taken up by the celery
- If a cross section of the celery is cut, only certain areas of the stalk is stained with the dye, showing that the water is being carried in specific vessels through the stem – these are the xylem vessels



Investigating water movement in plants using a stain



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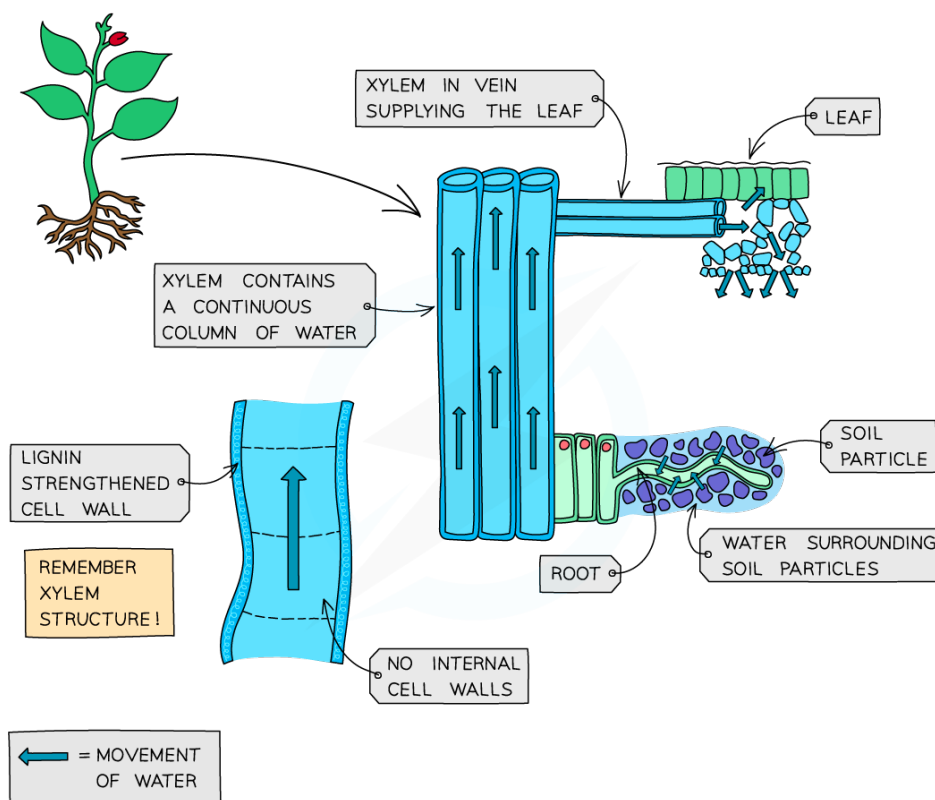
8.3 TRANSPIRATION

YOUR NOTES



What is Transpiration?

- **Water** travels up **xylem** from the roots into the leaves of the plant to replace the water that has been lost due to **transpiration**
- Transpiration is defined as the **loss of water vapour from plant leaves by evaporation of water at the surfaces of the mesophyll cells followed by diffusion of water vapour through the stomata**
- Xylem is adapted in many ways:
 - A substance called **lignin** is deposited in the cell walls which causes the xylem cells to die
 - These cells then become **hollow** (as they lose all their organelles and cytoplasm) and join end-to-end to form a **continuous tube** for water and mineral ions to travel through from the roots
 - Lignin strengthens the plant to help it withstand the pressure of the water movement
- Movement in xylem **only takes place in one direction** – from **roots to leaves** (unlike phloem where movement takes place in different directions)



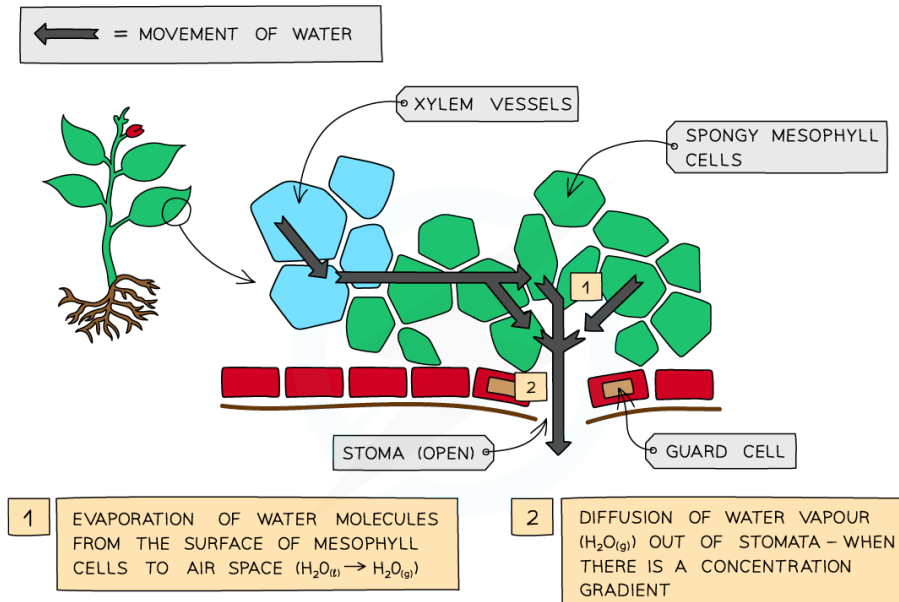
Water uptake, transport and transpiration



8 TRANSPORT IN PLANTS

8.3 TRANSPIRATION cont...

YOUR NOTES



Transpiration in plants

- Transpiration has several functions in plants:

- transporting **mineral ions**
- providing **water to keep cells turgid** in order to support the structure of the plant
- providing **water** to leaf cells for **photosynthesis**
- keeping the **leaves cool** – the conversion of water (liquid) into water vapour (gas), as it leaves the cells and enters the airspace, requires heat energy. The using up of heat to convert water into water vapour helps to cool the plant down



EXTENDED ONLY

How does Transpiration Occur?

- **Evaporation** takes place from the surfaces of spongy mesophyll cells
- The **many interconnecting air spaces** between these cells and the stomata creates a **large surface area**
- This means evaporation can happen rapidly **when stomata are open**



8 TRANSPORT IN PLANTS

8.3 TRANSPIRATION cont...

YOUR NOTES



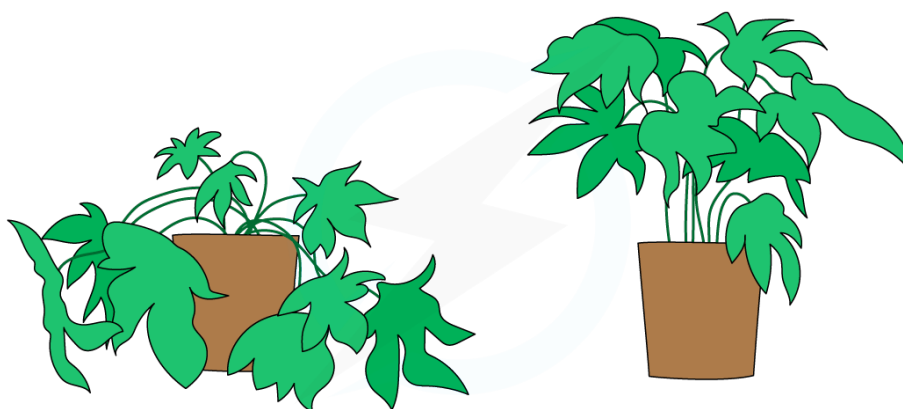
EXTENDED ONLY cont...

How is the Transpiration Stream Created?

- Water molecules are attracted to each other by **cohesion** – creating a continuous column of water up the plant
- Water moves through the xylem vessels in a continuous **transpiration stream** from roots to leaves via the stem
- Transpiration produces a **tension** or 'pull' on the water in the xylem vessels by the leaves
- As water molecules are held together by **cohesive forces** (each individual molecule 'pulls' on the one below it), so water is pulled up through the plant
- If the rate of transpiration from the leaves **increases**, water molecules are pulled up the xylem vessels **quicker**

Wilting

- If more water evaporates from the leaves of a plant than is available in the soil to move into the root by osmosis, then **wilting** will occur
- This is when all the cells of the plant are not full of water, so the strength of the cell walls cannot support the plant and it starts to collapse



A wilted plant cannot support itself and starts to collapse



8 TRANSPORT IN PLANTS

8.3 TRANSPIRATION cont...

YOUR NOTES



Investigating Factors Affecting Transpiration

FACTOR	EFFECT ON RATE OF TRANSPIRATION
TEMPERATURE	INCREASES WITH INCREASING TEMPERATURE
HUMIDITY	DECREASES WITH INCREASING HUMIDITY

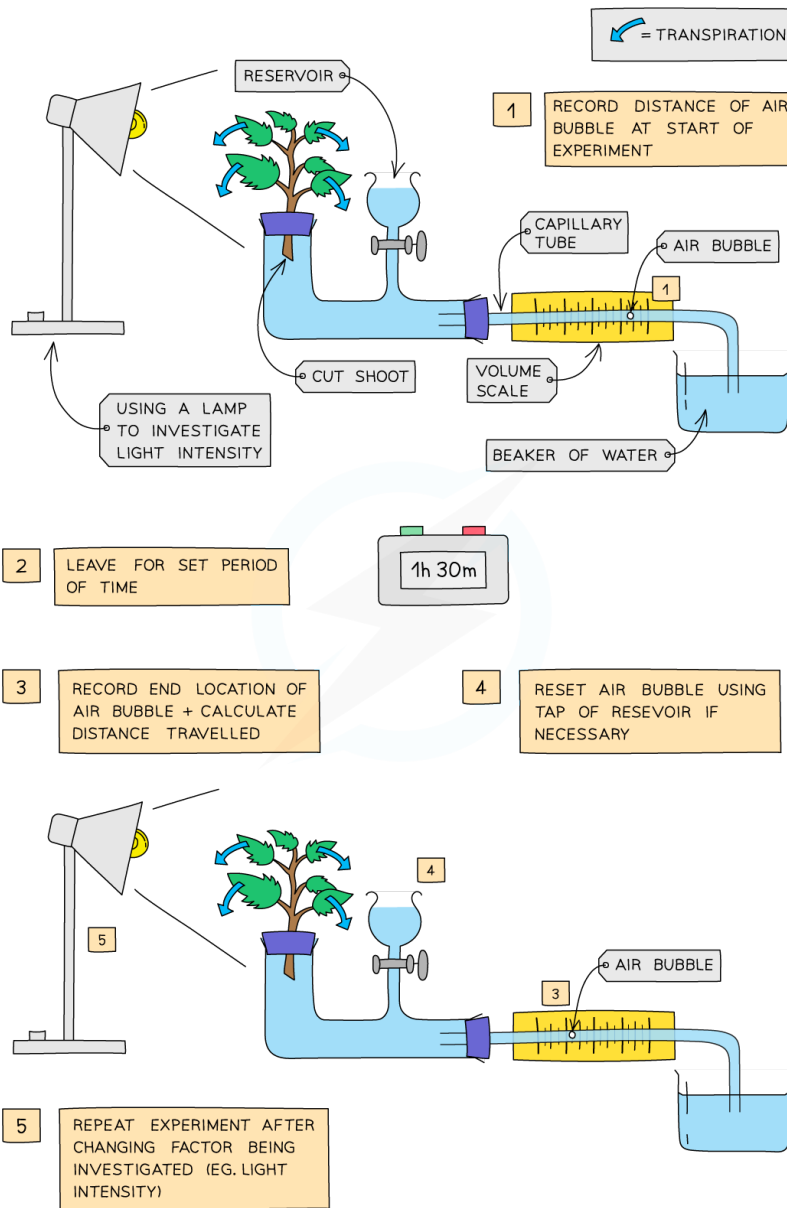
Investigating the role of environmental factors in determining the rate of transpiration from a leafy shoot

- Cut a shoot underwater to **prevent air entering the xylem** and place in tube
- Set up the apparatus as shown in the diagram below and make sure it is airtight, using vaseline to seal any gaps
- Dry the leaves of the shoot (wet leaves will affect the results)
- Remove the capillary tube from the beaker of water to allow a single **air bubble** to form and place the tube back into the water
- Set up the environmental factor you are investigating
- Allow the plant to adapt to the new environment for 5 minutes
- Record the **starting location** of the air bubble
- Leave for a set period of time
- Record the **end location** of air bubble
- Change the light intensity or wind speed or level of humidity or temperature (only one – whichever factor is being investigated)
- Reset the bubble by opening the tap below the reservoir
- Repeat the experiment
- The **further the bubble travels in the same time period, the faster transpiration is occurring** and vice versa

8 TRANSPORT IN PLANTS

8.3 TRANSPIRATION cont...

YOUR NOTES



Investigating transpiration rates using a potometer

Environmental factors can be investigated in the following ways:

- **Temperature** : Temperature of room (cold room and warm room)
- **Humidity** : Spray water in plastic bag and wrap around plant



EXAM TIP

Remember when designing an investigation to ensure a fair test: You must keep all factors the same other than the one you are investigating.



8 TRANSPORT IN PLANTS

8.3 TRANSPIRATION cont...

YOUR NOTES



EXTENDED ONLY

Temperature & Humidity on Transpiration Rate

FACTOR	EFFECT	EXPLANATION
TEMPERATURE	INCREASED	<ul style="list-style-type: none"> – IF TEMPERATURE INCREASES THE WATER MOLECULES WILL HAVE MORE KINETIC ENERGY, CAUSING THEM TO MOVE FASTER WHICH MEANS THEY WILL EVAPORATE MORE EASILY
HUMIDITY	DECREASED	<ul style="list-style-type: none"> – IN A HUMID ENVIRONMENT, AIR IS ALMOST SATURATED WITH WATER VAPOUR – THIS MEANS THERE IS HARDLY ANY CONCENTRATION GRADIENT BETWEEN THE AIRSPACES INSIDE THE LEAF AND THE AIR OUTSIDE THE LEAF, THEREFORE THE RATE OF EVAPORATION IS SLOW

8.4 TRANSLOCATION



EXTENDED ONLY

Transport of Food

- The soluble products of photosynthesis are **sugars (mainly sucrose) and amino acids**
- These are transported around the plant in the **phloem tubes** which are made of living cells (as opposed to xylem vessels which are made of dead cells)
- The cells are joined end to end and contain holes in the end cell walls (called **sieve plates**) which allow **easy flow of substances** from one cell to the next
- The transport of sucrose and amino acids in phloem, from regions of production to regions of storage or use, is called **translocation**



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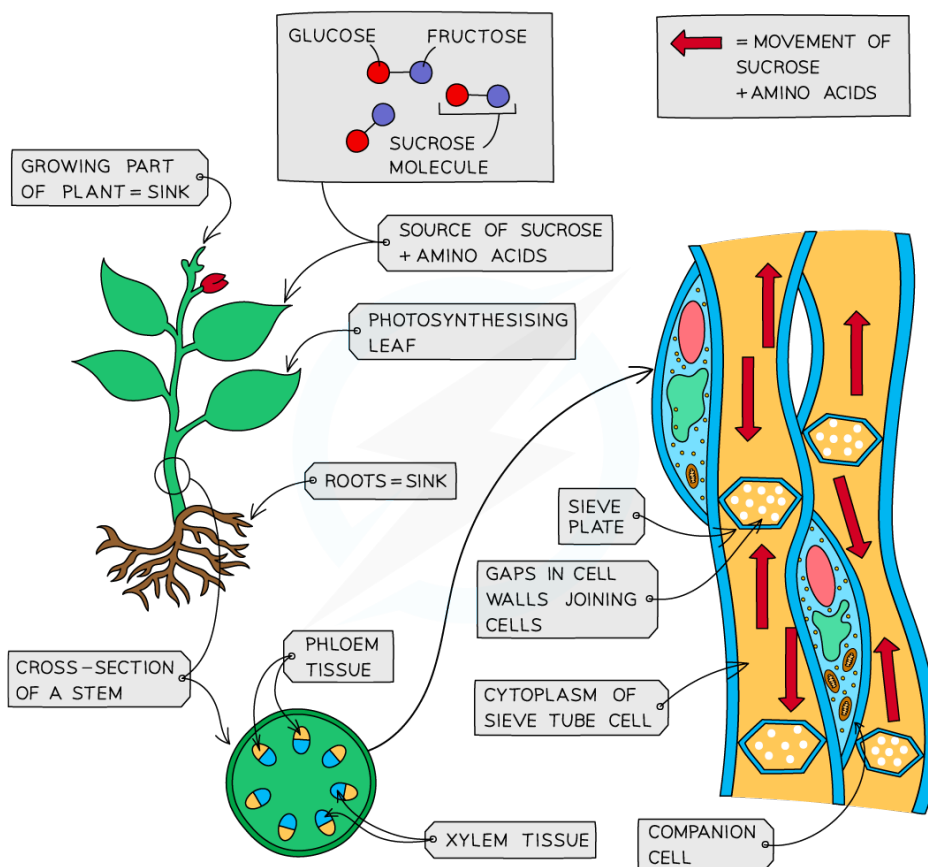
8.4 TRANSLOCATION cont...

YOUR NOTES



EXTENDED ONLY cont...

- Transport in the phloem **goes in many different directions** depending on the stage of development of the plant or the time of year; however dissolved food is always transported from **source** (where it's made) to **sink** (where it's stored or used):
 - During **winter**, when many plants have no leaves, the phloem tubes may transport dissolved sucrose and amino acids from the storage organs to other parts of the plant so that respiration can continue
 - During a **growth period** (eg during the spring), the storage organs (eg roots) would be the source and the many growing areas of the plant would be the sinks
 - After the plant has grown** (usually during the summer), the leaves are photosynthesizing and producing large quantities of sugars; so they become the source and the roots become the sinks – storing sucrose as starch until it is needed again



Translocation through the phloem



8 TRANSPORT IN PLANTS

8.3 TRANSPIRATION cont...

YOUR NOTES



EXTENDED ONLY cont...

Comparison between xylem and phloem tissue

TISSUE	WHAT IS MOVED	PROCESS	DIRECTION OF FLOW	CELLS
XYLEM	WATER AND MINERAL IONS	TRANSPIRATION STREAM	ONE WAY FROM ROOTS TO LEAVES	DEAD
PHLOEM	SUCROSE AND AMINO ACIDS	TRANSLOCATION	IN ALL DIRECTIONS	LIVING

> NOW TRY SOME EXAM QUESTIONS



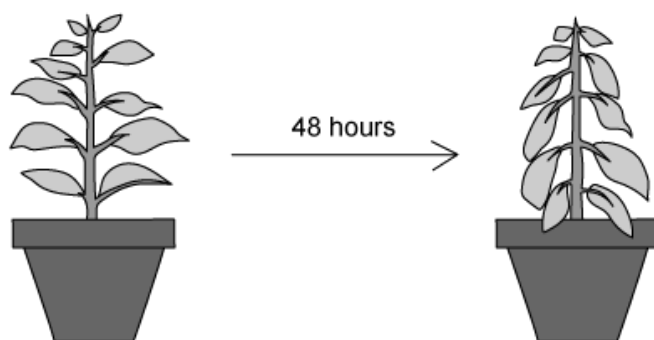
8 TRANSPORT IN PLANTS

EXAM QUESTIONS

YOUR NOTES

**? QUESTION 1**

The diagram below shows a potted plant and the same plant 48 hours later.



What has caused the plant's appearance to change?

Which process causes this change?

- A Water loss by translocation is greater than water uptake
- B Water evaporating from the leaves by translocation
- C Water loss by transpiration is greater than water uptake
- D Water loss from the leaves by osmosis

? QUESTION 2

Which order below is correct in describing the pathway of water as it travels from the roots through a plant?

- A Root hair cell → xylem → mesophyll cells → air space → stomata
- B Root hair cell → xylem → air spaces → mesophyll cells → stomata
- C Root hair cell → mesophyll cells → phloem → stomata
- D Root hair cell → cortex cells → mesophyll cells → xylem → stomata



8 TRANSPORT IN PLANTS

EXAM QUESTIONS cont...

YOUR NOTES

**? QUESTION 3**

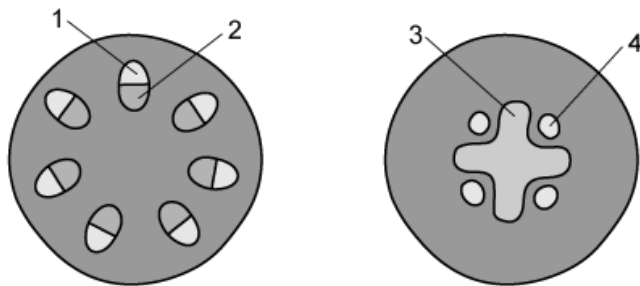
Which of the following is a correct explanation of the process of translocation?

- A The movement of mineral ions through the xylem of a plant
- B The movement of sucrose and amino acids through the phloem from a source to a sink
- C The unidirectional movement of sucrose and amino acids through the phloem.
- D The movement of sucrose and amino acids through the phloem from a sink to a source

? QUESTION 4

A dicot plant is placed into a bowl of water coloured with red dye.
After 1 hour, a cross section of one of the roots is cut.
After 4 hours, a cross section is cut from the stem.

Which labelled regions would be stained red in each case?



- A 1 and 3 B 1 and 4 C 2 and 4 D 2 and 3



8 TRANSPORT IN PLANTS

EXAM QUESTIONS cont...

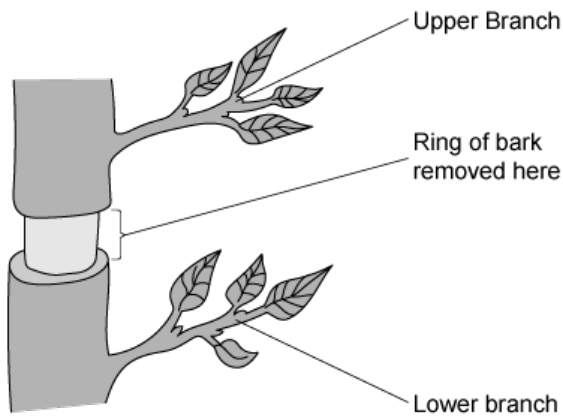
YOUR NOTES



? QUESTION 5

The diagram below shows part of the trunk of a small dicotyledonous tree with a ring of bark removed.

Removing the ring of bark removes one type of transport tissue but leaves the other type intact.



What effect does removing the bark have on the two branches?

	Upper branch		Lower branch	
	Leaves	Growth	Leaves	Growth
A	normal	normal	normal	reduced
B	wilted	normal	wilted	normal
C	wilted	reduced	normal	normal
D	normal	reduced	wilted	reduced

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