

The need for transport and transport in plants

Revision notes · Why large organisms need transport systems, and how xylem carries water and mineral ions and phloem carries sucrose and amino acids.

For Edexcel International GCSE Science (Double Award) 4SD0.

The need for transport and transport in plants Spec 2.51-2.58B

Why multicellular organisms need transport systems Spec 2.51, 2.52

Every cell needs a supply of oxygen and dissolved food molecules, and must get rid of waste such as carbon dioxide. In a unicellular (single-celled) organism these substances move in and out by **diffusion** across the cell surface.

This works because a single cell has a **large surface area compared with its volume**. No part of the cell is far from the surface, so the diffusion distance is short and diffusion is fast enough to meet the cell's needs.

Multicellular organisms

A multicellular organism is much bigger. Its surface area : volume ratio is **small**, and most of its cells are deep inside the body, far from the outside world. Diffusion over such long distances is far too slow to supply every cell with enough oxygen and food, or to remove waste quickly enough.

Multicellular organisms therefore need a **transport system**. In humans this is the blood in the circulatory system. In flowering plants it is the xylem and phloem.

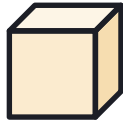
surface area : volume ratio = surface area ÷ volume

Surface area : volume ratio of a cube

A cube-shaped block of tissue has sides of 3 cm. Calculate its surface area : volume ratio.

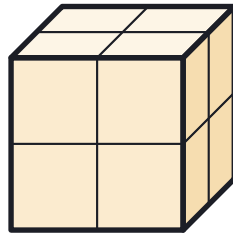
1. A cube has 6 faces. Area of one face = $3 \times 3 = 9 \text{ cm}^2$.
2. Surface area = $6 \times 9 = 54 \text{ cm}^2$.
3. Volume = $3 \times 3 \times 3 = 27 \text{ cm}^3$.
4. Ratio = 54 : 27. Divide both sides by 27.

Answer: 2 : 1



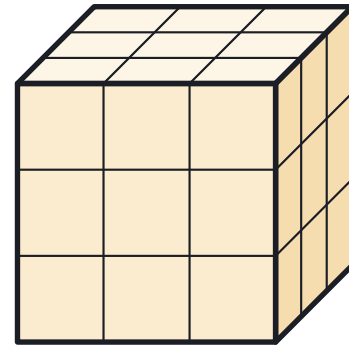
1 cm

surface area = 6 cm^2
 volume = 1 cm^3
 surface area : volume
 = 6 : 1



2 cm

surface area = 24 cm^2
 volume = 8 cm^3
 surface area : volume
 = 3 : 1



3 cm

surface area = 54 cm^2
 volume = 27 cm^3
 surface area : volume
 = 2 : 1

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As the cube gets bigger, its surface area : volume ratio gets smaller.

Substances that a transport system carries

Substance	Direction	Reason
Oxygen	Into cells	Used in aerobic respiration to release energy
Carbon dioxide	Out of cells	Waste product of respiration
Digested food (glucose, amino acids)	Into cells	Source of energy and materials for growth and repair
Urea	Out of cells	Waste product made in the body, removed in urine

Exam tip: Do not just say that large organisms 'need more oxygen'. Link the idea: small surface area : volume ratio, so a long diffusion distance, so diffusion alone is too slow.

Xylem and phloem Spec 2.53, 2.54

Xylem and phloem are the two transport tissues in a flowering plant. They run together through the roots, stem and leaves.

Xylem

The **xylem** carries **water and mineral ions** from the roots to the other parts of the plant, such as the stem and leaves. It is made of dead cells joined end to end.

- The cells are dead with no cytoplasm, and the end walls between them have broken down. This makes a continuous hollow tube that water can flow through easily.
- The walls are strengthened with **lignin**. This is strong and waterproof, so it stops the tubes collapsing and helps to support the plant.

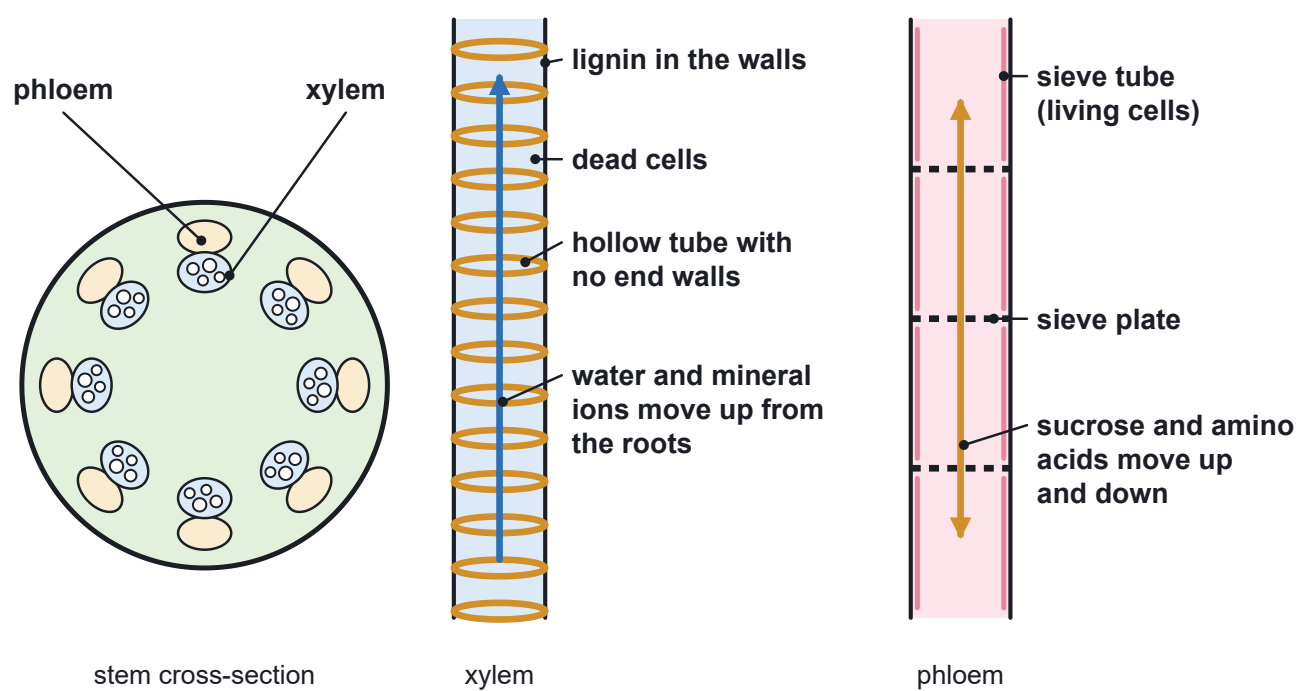
Phloem

The **phloem** carries **sucrose and amino acids** between the leaves and other parts of the plant. Sucrose is made from the glucose produced in photosynthesis. Phloem is made of living cells, and the substances can move up or down the plant, depending on where they are needed.

- Sucrose and amino acids travel from the leaves to growing tips, roots, flowers, fruits and storage organs.

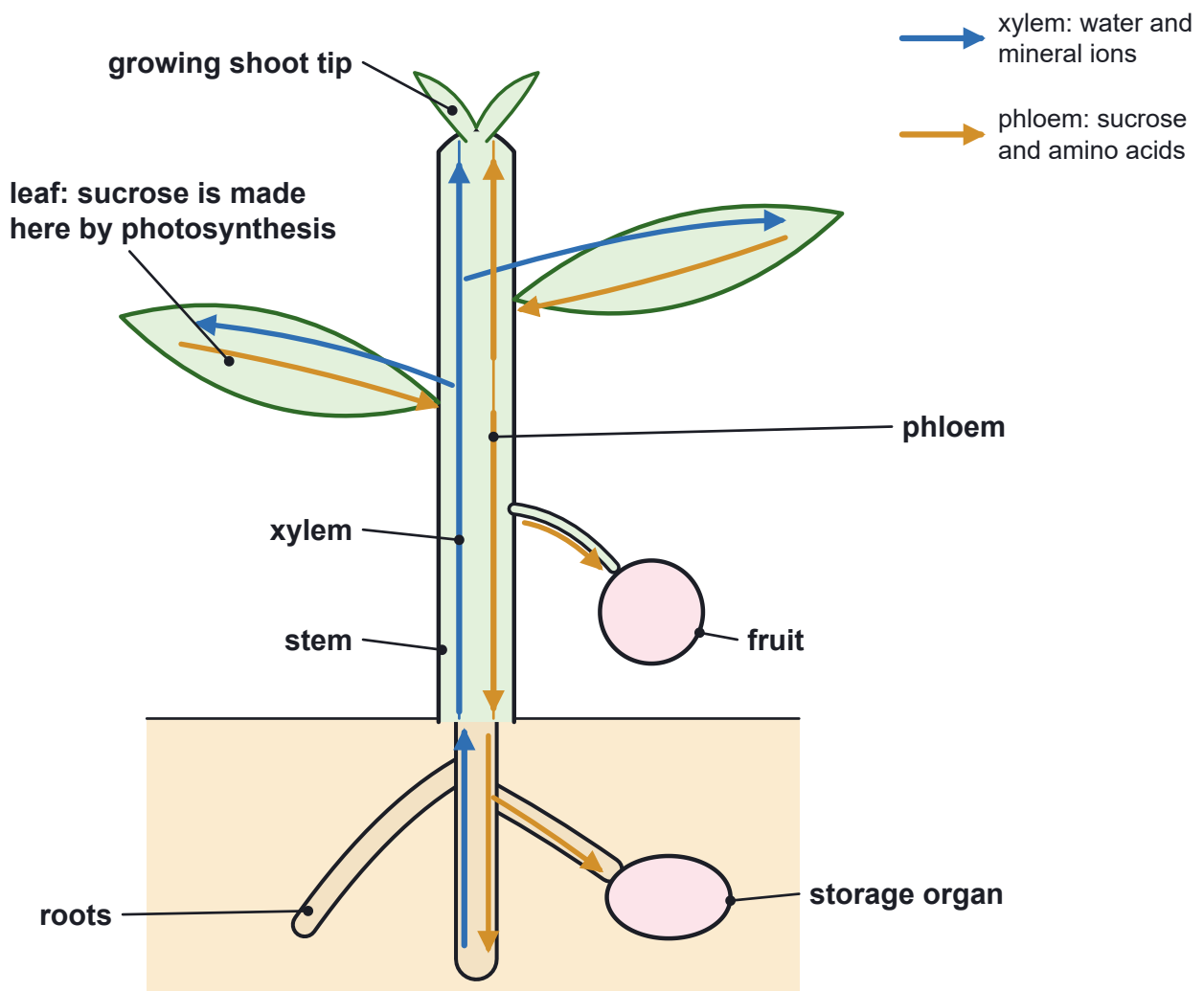
- The phloem tubes (sieve tubes) are made of living cells joined end to end. Their end walls have small holes (sieve plates), so the solution can flow from one cell to the next.

Xylem and phloem compared		
	Xylem	Phloem
Substances carried	Water and mineral ions	Sucrose and amino acids
Direction	Roots to the rest of the plant (upwards)	Between the leaves and other parts, up or down
Cells	Dead, hollow tubes	Living cells
Cell walls	Strengthened with lignin	Sieve plates in end walls



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Xylem: dead, hollow tubes strengthened with lignin. **Phloem:** living sieve tubes with sieve plates.



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Xylem carries water and mineral ions **up** the plant. Phloem carries sucrose and amino acids **up or down** to where they are needed.

Common mistake: Do not mix the two up. Xylem = water and mineral ions, dead cells. Phloem = sucrose and amino acids, living cells.

Quick check

1. Why can a unicellular organism rely on diffusion?
2. Which tissue carries water and mineral ions from the roots?
3. Which substances does phloem transport?

Quick check answers

The need for transport and transport in plants

- 1 . It has a large surface area compared with its volume, so diffusion distances are short.
- 2 . Xylem.
- 3 . Sucrose and amino acids.