Cell specialisation

4.1.1.3 · Biology · revision notes

How the structure of a specialised cell is adapted to its job: sperm, nerve and muscle cells in animals, and root hair, xylem and phloem cells in plants. The most common question is 'Explain how this cell is adapted to its function', often with a diagram and sometimes about a cell you have not met before.

Key facts

- Specialised cell: structure adapted to carry out a particular function
- Nerve cell: long, with branched endings; carries electrical impulses
- Root hair cell: large surface area; many mitochondria; no chloroplasts
- Phloem: living cells, pores in end walls; carries dissolved sugars up and down
- Sperm: tail, many mitochondria, enzymes in the head, half the number of chromosomes
- Muscle cell: protein fibres that slide to contract; many mitochondria
- Xylem: dead cells, hollow tubes, lignin; carries water and mineral ions upwards

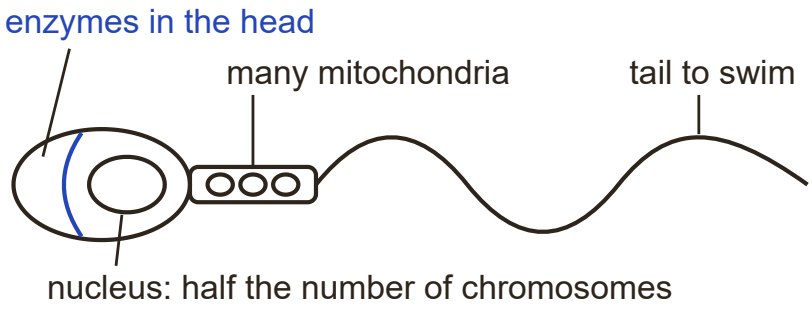
Notes

What a specialised cell is

- A **specialised cell** has a structure adapted to carry out a particular function.
- Its shape and its sub-cellular structures suit its job. Specialised cells work together in tissues, organs and organ systems.

Specialised animal cells

- **Sperm cell** (reaches and fertilises an egg): a tail to swim; many mitochondria to release energy for swimming; enzymes in the head to digest a way into the egg; a nucleus with half the normal number of chromosomes.

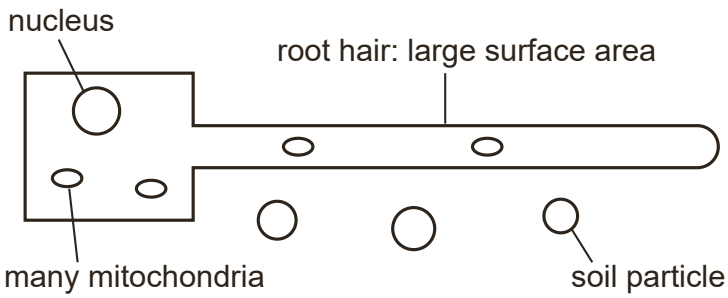


Sperm cell

- **Nerve cell** (carries electrical impulses around the body): long, to carry impulses over long distances; branched endings to connect with many other cells.
- **Muscle cell** (contracts to cause movement): protein fibres that slide over each other to shorten the cell; many mitochondria to release energy for contraction; can store glycogen, which is broken down to glucose for respiration.

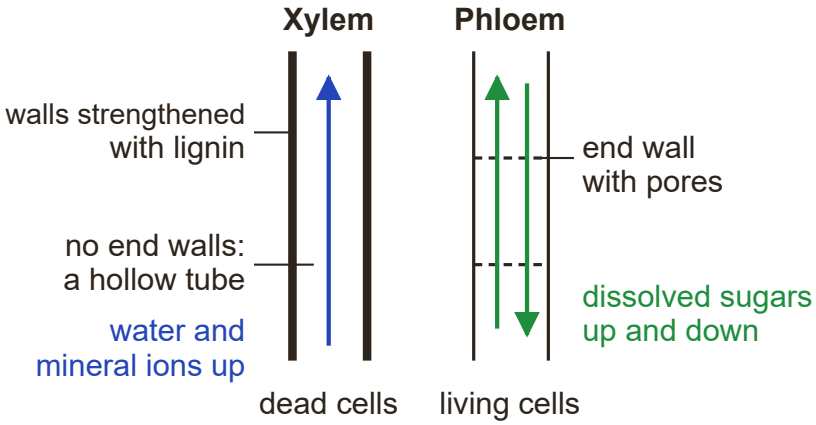
Specialised plant cells

- **Root hair cell** (absorbs water and mineral ions from the soil): a long hair-like projection gives a large surface area; many mitochondria release energy for the active transport of mineral ions; no chloroplasts, as there is no light underground.



Root hair cell. There are no chloroplasts, because no light reaches the roots.

- **Xylem cells** (carry water and mineral ions up from the roots): dead cells that form long hollow tubes with no end walls, so water flows through easily; walls strengthened with **lignin**.
- **Phloem cells** (carry dissolved sugars up and down the plant): living, elongated cells joined end to end, with pores in the end walls so the cell sap can flow from one cell to the next.



Xylem and phloem

How to answer each type of question

Identify a specialised cell from its function

1 mark | Grade 3

1. Read the function carefully: what is carried, absorbed or done?
2. Match it to one cell: water and mineral ions in the soil (root hair), water up the stem (xylem), sugars (phloem).
3. Tick only the number of boxes asked for.

Example. Which type of cell carries dissolved sugars around a plant?
Tick (✓) **one** box.
☐ Palisade cell
☐ Phloem cell
☐ Root hair cell
☐ Xylem cell

Model answer. Phloem cell (1)

Explain how a cell is adapted to its function

2 to 4 marks | Grade 4

1. Name a feature, from the diagram or from memory.
2. Say what it does for the cell, using 'so that' or 'to'.
3. Usually 1 mark is for the feature and 1 for its explanation, so give one linked pair for every 2 marks.

Example. Explain how a sperm cell is adapted to its function. [4 marks]

Model answer.

Any two linked pairs:

it has a tail (1) so it can swim to the egg	(1)
it has many mitochondria (1) to release energy (by respiration) for swimming	(1)
it has enzymes in its head (1) to digest a way into the egg	(1)

Compare xylem and phloem

2 to 3 marks **Grade 6**

1. Compare what each carries.
2. Compare whether the cells are living or dead, and their structure.
3. Compare the direction of flow, and write each point as a comparison ('xylem…, but phloem…').

Example. Give **three** differences between xylem and phloem.

Model answer.

Any three from:

xylem carries water and mineral ions, but phloem carries dissolved sugars	(1)
xylem cells are dead, but phloem cells are living	(1)
xylem carries substances upwards only, but phloem carries sugars up and down the plant	(1)
xylem walls are strengthened with lignin	(1)
xylem tubes have no end walls, but phloem cells have end walls with pores	(1)

Suggest how an unfamiliar cell is adapted

2 to 3 marks **Grade 7**

1. Use the information given: every feature in the question is there for a reason.
2. Think about surface area (absorption), mitochondria (energy) and shape.
3. Link each feature to the job the question describes.

Example. The cells lining the small intestine absorb digested food molecules. The cell membrane facing the gut has many tiny folds called microvilli. The cells also contain many mitochondria. Suggest how these features help the cells to absorb digested food.

Model answer. The microvilli increase the surface area (1), so more food molecules can be absorbed at the same time / faster (1). The many mitochondria release more energy (by respiration) for active transport (1).

Don’t lose marks

- Listing features without saying what each one is for. Most marks need the feature **and** its purpose.
- Saying mitochondria 'make energy'. Say they release energy by respiration.
- Swapping xylem and phloem: xylem carries water and mineral ions; phloem carries dissolved sugars.
- Saying xylem cells are living or that phloem cells are dead.
- Saying a root hair cell has chloroplasts. It is underground, so it has none.

More tips

Memory tricks

- Most adaptations are one of four ideas: a large surface area, many mitochondria (energy), a shape that suits the job, or structures that are missing because they would get in the way.
- **Ph**loem carries food (sugars): 'ph' and 'food' both start with an 'f' sound. Xylem carries water.
- Wood is mostly xylem: dead, hollow and stiffened with lignin.

Exam technique

- Use 'so that' after every feature: 'many mitochondria, so that more energy is released for swimming'.
- If a diagram is given, use features you can see on it and name them precisely.
- For an unfamiliar cell, ask: does it absorb (surface area), use a lot of energy (mitochondria) or carry something (shape)?

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Name specialised animal and plant cells**
Sperm, nerve and muscle cells in animals; root hair, xylem and phloem cells in plants.

Grade 4 — **State the function of each specialised cell**
e.g. a nerve cell carries electrical impulses; phloem carries dissolved sugars.

Grade 4 — **Explain how each adaptation helps the cell**
Give the feature and what it does, e.g. the root hair gives a large surface area for absorbing water.

Grade 5 — **Describe the adaptations of each specialised cell**
e.g. a sperm cell has a tail, many mitochondria and enzymes in its head.

Grade 7 — **Suggest adaptations of unfamiliar specialised cells**
Use the same ideas (surface area, mitochondria, shape, missing structures) for a cell you have not studied.

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