Cell differentiation

4.1.1.4 · Cell biology · revision notes

How cells become specialised as an organism develops, how this differs between animals and plants, and why it matters. Questions are usually short recall or 'explain' questions, often linked to specialised cells and stem cells.

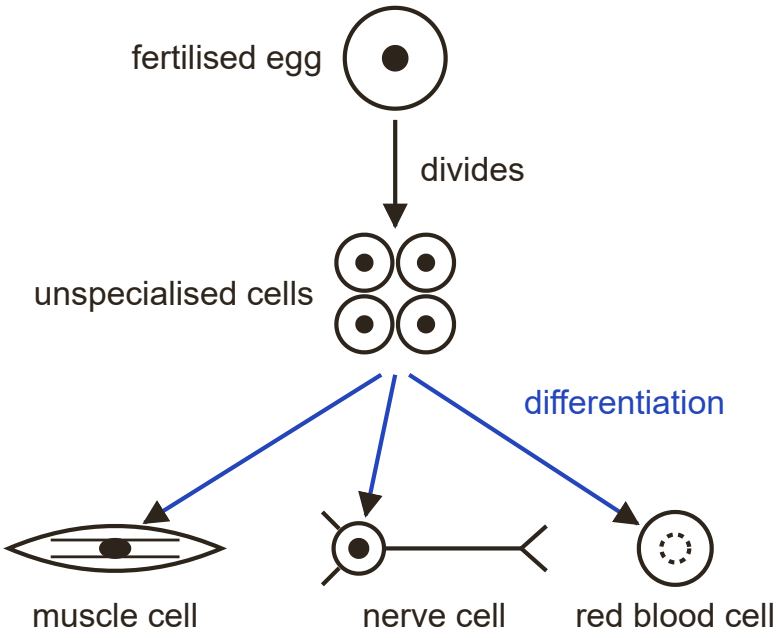
Key facts

- Differentiation: the process by which a cell becomes specialised for a particular function
- Most animal cells differentiate at an early stage of development
- Cell division in mature animals: mainly repair and replacement
- A differentiating cell gains the sub-cellular structures its function needs
- Many plant cells can differentiate throughout the plant's life
- Specialised cells → tissues → organs → organ systems

Notes

What differentiation is

- **Differentiation** is the process by which a cell becomes **specialised** to carry out a particular function.
- As a cell differentiates, it gains the sub-cellular structures it needs for its job, and it may change shape. For example, a developing muscle cell gains many mitochondria and protein fibres.
- When it has done this, it has become a specialised cell.
- An organism starts as one cell, a fertilised egg. Cell division makes more cells, and differentiation turns them into all the different types of cell.



Cell division makes more cells; differentiation turns them into specialised cells.

Animals and plants

- Most types of animal cell differentiate at an early stage of development.
- In mature animals, cell division is mainly restricted to **repair and replacement**, e.g. healing a cut or replacing blood cells.
- Many types of plant cell keep the ability to differentiate throughout the plant's life.
- This is why a cutting taken from a plant can grow new roots, but a human cannot regrow a lost arm.

Why differentiation matters

- A multicellular organism needs many different types of cell to carry out different functions.
- Differentiation produces these specialised cells, which group together to form tissues, organs and organ systems.
- Each specialised cell is adapted to do its own job efficiently.

How to answer each type of question

Define cell differentiation

1 mark | Grade 3

1. Use the key word 'specialised'.
2. Add 'for a particular function' to make the definition complete.

Example. What is meant by cell differentiation?

Model answer. The process by which a cell becomes specialised (for a particular function) (1).

Compare differentiation in animals and plants

2 marks | Grade 5

1. Give the animal side: most cells differentiate at an early stage.
2. Give the plant side: many cells can differentiate throughout life.
3. Join the two with 'but' or 'whereas'.

Example. Describe how cell differentiation in plants is different from cell differentiation in animals.

Model answer. Most animal cells differentiate at an early stage (of development) (1), whereas many plant cells keep the ability to differentiate throughout life (1).

Explain why differentiation is important

2 to 3 marks | Grade 6

1. Say that differentiation produces specialised cells.
2. Say that different cells are needed for different functions.
3. Link to cells forming tissues and organs.

Example. Explain why cell differentiation is important in a multicellular organism.

Model answer. Differentiation produces specialised cells (1). A multicellular organism needs different types of cell to carry out different functions (1). Specialised cells form tissues and organs (1).

Suggest how a cell changes as it differentiates

2 to 4 marks | Grade 7

1. Think about what the finished cell has to do.
2. Name a sub-cellular structure it would need more of.
3. Give the reason, linked to the cell's function.

Example. A cell in an embryo differentiates into a muscle cell.
Suggest **two** changes to the cell as it differentiates. Give a reason for each change.

Model answer. It gains more mitochondria (1) to release more energy (by respiration) for contraction (1). It develops protein fibres (1) that can slide over each other to make the cell contract (1).

Don't lose marks

- Confusing differentiation with cell division. Division makes more cells; differentiation makes cells specialised.
- Saying cells in adult animals never divide. They divide for repair and replacement.
- Saying plant cells stop differentiating when the plant is mature. Many can differentiate throughout life.
- Leaving the key word 'specialised' out of a definition.

More tips

Memory tricks

- Differentiate = become different: an unspecialised cell becomes a specialised one.
- Divide = more cells. Differentiate = different cells.
- Animals decide early; plants keep their options open for life.

Exam technique

- Use the word 'specialised' in any definition of differentiation.
- For 'why is differentiation important' questions, mention different functions and forming tissues and organs.
- Watch for links to stem cells: a stem cell is an undifferentiated cell that can still differentiate.

What each grade needs

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

Grade 3 — **State what cell differentiation is**
Differentiation is the process by which a cell becomes specialised for a particular function.

Grade 4 — **Say when animal and plant cells differentiate**
Most animal cells differentiate at an early stage; many plant cells can differentiate throughout life.

Grade 5 — **State what cell division does in adults**
In mature animals, cell division is mainly for repair and replacement.

Grade 6 — **Explain the importance of cell differentiation**
It produces the different specialised cells a multicellular organism needs to carry out different functions.

Grade 7

Suggest how a cell changes as it differentiates

It gains the sub-cellular structures its function needs, e.g. more mitochondria or ribosomes, and may change shape.

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