

This is the **Higher Combined Science** version. Higher Tier questions (★) are included. Some Separate-only content has been omitted.

## Cell Structure (4.1.1)

*Specification reference: 4.1.1.1–4*

**Q1. State ONE difference between a eukaryotic cell and a prokaryotic cell.**

[1 mark]

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**Q2. Describe the function of THREE organelles found in plant cells only.**

[3 marks]

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**Q3. A student observes a cell with a nucleus, mitochondria and a large permanent vacuole, but no chloroplasts. State the type of cell and explain your reasoning using THREE features.**

[4 marks]

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### ★ HIGHER TIER

**Q4. ★ Compare the structure of a bacterial cell and a eukaryotic animal cell. State FOUR differences.**

[4 marks]

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**Q5. Explain how cells become specialised. Give ONE named example of a specialised cell and describe how its structure is adapted for its function.**

[3 marks]

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### Microscopy (4.1.1.5)

*Specification reference: 4.1.1.5*

**Q6. Write the formula used to calculate the magnification of a microscope image.**

[1 mark]

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**Q7. A student draws a cell with a length of 54 mm. The actual cell is 0.03 mm long. (a) Calculate the magnification. Show your working. (b) Convert the actual cell size to  $\mu\text{m}$ .**

[3 marks]

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### ★ HIGHER TIER

**Q8. ★ Compare the use of light microscopes and electron microscopes for studying cells. Your answer should refer to magnification, resolution and sample requirements.**

[4 marks]

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### Cell Division — Mitosis (4.1.2.1–2)

*Specification reference: 4.1.2*

**Q9. State TWO uses of mitosis in the human body.**

[2 marks]

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**Q10. Describe the sequence of events that occurs during mitosis, starting with DNA replication.**

[4 marks]

Q11. Explain how cancer results from changes in the cell cycle.

[3 marks]

★ HIGHER TIER

Q12. ★ Describe the differences between a benign and a malignant tumour. Explain why malignant tumours are more dangerous.

[4 marks]

### Stem Cells (4.1.2.3)

*Specification reference: 4.1.2.3*

Q13. Define the term stem cell and explain why stem cells are medically important.

[2 marks]

Q14. Compare embryonic stem cells and adult stem cells in terms of their properties and source.

[4 marks]

★ HIGHER TIER



Q20. A student places potato cylinders in different concentrations of sucrose solution and records % change in mass. In a 1.0 mol/dm<sup>3</sup> solution the potato lost 15% of its mass. Explain this result.

[3 marks]

Q21. Explain the difference between a turgid and a plasmolysed plant cell. State why turgidity is important for plants.

[3 marks]

★ HIGHER TIER

Q22. ★ State the water potential of pure water.

[1 mark]

### Active Transport (4.1.3.3)

*Specification reference: 4.1.3.3*

Q23. State ONE difference between active transport and diffusion.

[1 mark]

Q24. Explain why root hair cells use active transport to absorb mineral ions from soil water.

[3 marks]

Q25. Glucose is absorbed from the small intestine into the blood by active transport. Explain why diffusion alone would not be sufficient.

[3 marks]

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**Total: 72 marks**

## Cell Structure (4.1.1)

### Q1 (1 mark)

State ONE difference between a eukaryotic cell and a prokaryotic cell.

- Eukaryotic cells have a membrane-bound nucleus; prokaryotic cells do not [1] — accept any other correct difference e.g. prokaryotic have circular DNA / no membrane-bound organelles

### Q2 (3 marks)

Describe the function of THREE organelles found in plant cells only.

- Cell wall (cellulose): provides rigid structural support, prevents cell from bursting [1]
- Chloroplasts: contain chlorophyll, site of photosynthesis [1]
- Permanent vacuole: filled with cell sap, maintains turgidity/turgor pressure [1]

### Q3 (4 marks)

A student observes a cell with a nucleus, mitochondria and a large permanent vac...

- Plant cell [1]
- Has a permanent vacuole — characteristic of plant cells [1]
- Has a nucleus — eukaryotic cell [1]
- Absence of chloroplasts suggests it is not a leaf palisade cell but is still a plant cell (e.g. root cell) [1] — accept any three valid structural reasons

### Q4 (4 marks) [★ HT]

★ Compare the structure of a bacterial cell and a eukaryotic animal cell. State ...

- Bacterial cell has no membrane-bound nucleus; animal cell has a nucleus [1]
- Bacterial cell has circular DNA/plasmids; animal cell has linear chromosomes in nucleus [1]
- Bacterial cell has no membrane-bound organelles (e.g. no mitochondria); animal cell has mitochondria [1]
- Bacterial cell may have flagellum/plasmids; animal cell does not [1]

### Q5 (3 marks)

Explain how cells become specialised. Give ONE named example of a specialised ce...

- Cells differentiate — genes are switched on or off [1]
- Named example: e.g. red blood cell — biconcave shape increases surface area for O<sub>2</sub> diffusion, no nucleus gives more space for haemoglobin [1+1] — accept any valid specialised cell with two linked adaptations

## Microscopy (4.1.1.5)

### Q6 (1 mark)

Write the formula used to calculate the magnification of a microscope image.

- Magnification = Image size ÷ Actual size [1]

### Q7 (3 marks)

A student draws a cell with a length of 54 mm. The actual cell is 0.03 mm long. ...

- (a) Magnification =  $54 \div 0.03 = \times 1800$  [2] — award 1 for correct substitution, 1 for correct answer
- (b)  $0.03 \text{ mm} = 30 \mu\text{m}$  [1]

### Q8 (4 marks) [★ HT]

★ Compare the use of light microscopes and electron microscopes for studying cel...

- Light: max magnification  $\sim \times 1500$ ; electron: much higher ( $\times 500,000+$ ) [1]
- Light: resolution  $\sim 200 \text{ nm}$ ; electron:  $\sim 0.1 \text{ nm}$  — can resolve much finer detail [1]
- Light: can view living cells; electron: sample must be dead and in a vacuum [1]
- Electron microscope reveals sub-cellular detail (e.g. mitochondria cristae, ribosomes) not visible with light [1]

## Cell Division — Mitosis (4.1.2.1–2)

**Q9 (2 marks)**

State TWO uses of mitosis in the human body.

- Growth — increasing the number of cells [1]
- Repair — replacing damaged or worn-out cells [1]

**Q10 (4 marks)**

Describe the sequence of events that occurs during mitosis, starting with DNA re...

- DNA replicates so each chromosome is copied [1]
- Chromosomes condense and become visible [1]
- Chromosomes line up at the equator of the cell [1]
- Spindle fibres pull chromosomes to opposite poles; cell divides → two genetically identical daughter cells each with the same chromosome number as parent [1]

**Q11 (3 marks)**

Explain how cancer results from changes in the cell cycle.

- Mutations occur in genes that normally control cell division [1]
- Normal cell cycle checkpoints fail — cells no longer respond to signals to stop dividing [1]
- Cells divide continuously and uncontrollably → tumour forms [1]

**Q12 (4 marks) [★ HT]**

★ Describe the differences between a benign and a malignant tumour. Explain why ...

- Benign: tumour remains localised / does not invade surrounding tissue [1]
- Malignant: invades surrounding tissue [1]
- Malignant: cells can break off and travel in blood or lymph to other parts of body (metastasis) [1]
- Secondary tumours form in other organs — difficult to treat and potentially fatal [1]

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**Stem Cells (4.1.2.3)****Q13 (2 marks)**

Define the term stem cell and explain why stem cells are medically important.

- An undifferentiated cell that can divide and differentiate into specialised cell types [1]
- Can potentially be used to replace damaged or diseased tissue (e.g. treating leukaemia with bone marrow transplant, or future treatments for Parkinson's, diabetes) [1]

**Q14 (4 marks)**

Compare embryonic stem cells and adult stem cells in terms of their properties a...

- Embryonic: can differentiate into any cell type (totipotent); adult: more limited range of cell types [1]
- Embryonic: from early embryos (blastocyst); adult: from specific tissues e.g. bone marrow [1]
- Embryonic: more versatile for therapy; adult: less ethically controversial [1]
- Both can divide repeatedly by mitosis [1]

**Q15 (5 marks) [★ HT]**

★ A scientist proposes using embryonic stem cells to treat Type 1 diabetes by gr...

- Benefit: embryonic stem cells are totipotent — can differentiate into any cell type including beta cells [1]
- Benefit: could provide a long-term cure rather than daily insulin injections [1]
- Ethical concern: obtaining embryonic stem cells requires destroying a human embryo [1]
- Risk: immune rejection of transplanted cells (unless therapeutic cloning used) [1]
- Risk: possible tumour formation from stem cells / unknown long-term effects [1]

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**Diffusion (4.1.3.1)****Q16 (2 marks)**

Define diffusion and state whether energy is required.

- Net movement of particles from high to low concentration (down a concentration gradient) [1]
- Passive process — no energy (ATP) required [1]

**Q17 (3 marks)**

Describe how THREE factors affect the rate of diffusion.

- Concentration gradient: steeper gradient → faster diffusion [1]
- Temperature: higher temperature → more kinetic energy → faster diffusion [1]
- Surface area: larger surface area → more particles crossing at once → faster diffusion [1] — accept: thickness of membrane

**Q18 (4 marks) [★ HT]**

★ Explain how the alveoli in the lungs are adapted to maximise the rate of gas e...

- Large total surface area (millions of alveoli) — maximises area for diffusion [1]
- Thin walls (one cell thick) — minimises diffusion distance [1]
- Dense capillary network — maintains steep concentration gradient by continuously removing O<sub>2</sub> [1]
- Moist lining — gases dissolve before diffusing through the membrane [1]

## Osmosis (4.1.3.2)

**Q19 (2 marks)**

Define osmosis precisely, using the terms water potential and partially permeabl...

- Net movement of water molecules [1]
- From a region of high water potential to low water potential through a partially permeable membrane [1]

**Q20 (3 marks)**

A student places potato cylinders in different concentrations of sucrose solutio...

- The 1.0 mol/dm<sup>3</sup> solution has a lower water potential than inside the potato cells [1]
- Water moves out of the potato cells by osmosis down the water potential gradient [1]
- Potato cells lose water → mass decreases by 15% [1]

**Q21 (3 marks)**

Explain the difference between a turgid and a plasmolysed plant cell. State why ...

- Turgid: water has entered by osmosis → vacuole presses cytoplasm against cell wall → cell is firm [1]
- Plasmolysed: water has left by osmosis → cell membrane pulls away from cell wall → cell is limp [1]
- Turgidity supports plant structure (without a skeleton) — prevents wilting [1]

**Q22 (1 mark) [★ HT]**

★ State the water potential of pure water.

- Zero (0 kPa) [1] — solutions have lower (more negative) water potential

## Active Transport (4.1.3.3)

**Q23 (1 mark)**

State ONE difference between active transport and diffusion.

- Active transport moves substances against the concentration gradient / requires energy (ATP); diffusion is passive and moves substances down the concentration gradient [1] — accept either difference

**Q24 (3 marks)**

Explain why root hair cells use active transport to absorb mineral ions from soi...

- The concentration of mineral ions in the soil water is often lower than inside the root cells [1]
- The ions need to move against the concentration gradient (from low to high) [1]
- Active transport uses energy (ATP from respiration) and carrier proteins to move ions against the gradient [1]

**Q25 (3 marks)**

Glucose is absorbed from the small intestine into the blood by active transport...

- After a meal, blood glucose concentration rises rapidly [1]
- The concentration of glucose in the blood may be higher than in the intestine — so diffusion would move glucose OUT of the blood, not in [1]
- Active transport allows glucose to be absorbed even against the concentration gradient [1]