This paper covers the **full Higher Separate** specification. Higher Tier questions are marked ★. Separate-only questions are marked ◆.

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]

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

[3 marks]

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]

★ HIGHER TIER

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

[4 marks]

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]

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]

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 µm.

[3 marks]

★ 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]

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]

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

Q15. ★ A scientist proposes using embryonic stem cells to treat Type 1 diabetes by growing replacement insulin-producing cells. Evaluate this proposal.

[5 marks]

Diffusion (4.1.3.1)

Specification reference: 4.1.3.1

Q16. Define diffusion and state whether energy is required.

[2 marks]

Q17. Describe how THREE factors affect the rate of diffusion.

[3 marks]

★ HIGHER TIER

Q18. ★ Explain how the alveoli in the lungs are adapted to maximise the rate of gas exchange by diffusion.

[4 marks]

Osmosis (4.1.3.2)

Specification reference: 4.1.3.2

Q19. Define osmosis precisely, using the terms water potential and partially permeable membrane.

[2 marks]

Q20. A student places potato cylinders in different concentrations of sucrose solution and records % change in mass. In a 1.0 mol/dm³ 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]

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■ 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 ÷ 0.03 = ×1800 [2] — award 1 for correct substitution, 1 for correct answer
• (b) 0.03 mm = 30 µm [1]

Q8 (4 marks) [★ HT]

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

• Light: max magnification ~×1500; electron: much higher (×500,000+) [1]
• Light: resolution ~200 nm; electron: ~0.1 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]

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]

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■ [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/dm³ 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

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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]