HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.2.1 Cell structure

Mark scheme

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TOTAL MARKS	QUESTIONS
70	9

How to use this mark scheme

;	Separates marking points. Each semicolon marks the end of one creditable point, and each point is worth one mark.
;;	Two marks for this answer (used for calculations).
/	Alternative words or phrases that are credited for the same point.
OR	An alternative answer for the same mark.
( )	Words in brackets are not needed to gain the mark.
max	More marking points are listed than marks available. Award up to the number of marks shown.
Accept	An alternative answer that gains credit.
Reject	A wrong answer. It does not gain credit and cancels a correct point it contradicts.
Ignore	Neither credited nor penalised. Mark the rest of the answer.
ECF	Error carried forward: credit correct working that uses an earlier wrong answer.
AO	Assessment objective: AO1 knowledge and understanding; AO2 applying knowledge; AO3 analysing, interpreting and evaluating.

Where an answer is correct but not listed, credit it if it is biologically accurate and answers the question at the depth the marks require. Right + wrong = wrong: a contradiction cancels a correct point.

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Structure of eukaryotic cells 3.2.1.1

Question	Marking guidance	Mark	Comments
01.1	**S**;	**1** (1 × AO2)	S has by far the largest percentage of lysosomes (9%); lysosomes release hydrolytic enzymes that digest the ingested bacteria

Question	Marking guidance	Mark	Comments
01.2	1. R has much more smooth endoplasmic reticulum than P (18% compared with 1%); 2. Smooth endoplasmic reticulum synthesises/makes/processes lipids (so R can make the steroid hormone); 3. P has much more rough endoplasmic reticulum than R (21% compared with 2%); 4. Rough endoplasmic reticulum (has ribosomes that) makes/transports proteins, so P makes a protein, eg the digestive enzyme (and not a lipid);	**3 max** (3 × AO2)	Points 1 and 3 need the comparison; accept the figures from the table as the comparison **Reject** RER, rER, SER or ER as abbreviations: endoplasmic reticulum must be written in full 2. **Accept** smooth endoplasmic reticulum makes steroids 4. **Accept** enzymes are proteins, so P secretes the enzyme **Ignore** references to the Golgi apparatus or mitochondria, which do not distinguish R from P

Question	Marking guidance	Mark	Comments
01.3	Correct answer for 2 marks: 18 OR 18.2;; Accept for 1 mark: 5100 (μm^3) for Q **OR** 280 (μm^3) for R	**2** (2 × AO2)	34% × 15 000 = 5100; 14% × 2 000 = 280; 5100 ÷ 280 = 18.21 **Accept** any correct rounding of 18.214, eg 18.21 **Reject** 2.4 (34 ÷ 14: percentages only) for either mark

Question	Marking guidance	Mark	Comments
01.4	1. A section shows only one plane/slice of the cell, which may not be representative of the whole cell OR organelles may not be evenly spread through the cell; 2. Organelles are cut at different angles/positions, so their size in the section may not show their true size; 3. Preparing the specimen (fixing/dehydrating/staining) may shrink/distort organelles OR may produce artefacts; 4. Some organelles may be hard to identify/tell apart, eg (small) vesicles and smooth endoplasmic reticulum OR lysosomes and vesicles; 5. Only a small number of cells/sections may have been examined;	**2 max** (2 × AO3)	**Ignore** 'human error' unqualified **Ignore** references to magnification **Reject** 'the cells are dead so organelles have changed' unless linked to preparation

Question	Marking guidance	Mark	Comments
01.5	1. (Supports:) Q has the largest percentage of mitochondria (34%) and the largest volume, so the largest total volume of mitochondria (5100 μm^3); 2. (Against:) the volume of mitochondria does not show the rate of (aerobic) respiration/ATP production OR mitochondria in different cells may respire at different rates; 3. (Against:) values are estimates/means OR no measure of variation/statistical test; 4. (Against:) ATP is also produced outside mitochondria/in the cytoplasm OR by anaerobic respiration;	**2 max** (2 × AO3)	**Max 1** if only supporting points or only points against are given 1. **Accept** Q has the most mitochondria for the percentage, but the largest total volume needs the cell volume 2. **Accept** rate of ATP production was not measured **Reject** mitochondria produce energy

Question	Marking guidance	Mark	Comments
02.1	Cell wall: Yes Chloroplast: No Nucleus: Yes;	**1** (1 × AO1)	Fungi have cell walls and a nucleus but no chloroplasts

Question	Marking guidance	Mark	Comments
02.2	Tissue: Epithelium Organ: Small intestine;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
02.3	1. Mitochondria carry out (aerobic) respiration, producing/releasing ATP; 2. ATP (hydrolysis) provides energy for active transport (of chloride ions); 3. Folds give a large surface area (of cell-surface membrane); 4. For more carrier proteins (in the membrane), so more/faster transport of chloride ions; 5. Ribosomes (on the rough endoplasmic reticulum) synthesise/make (carrier) proteins (for the cell-surface membrane);	**4 max** (4 × AO2)	1. **Reject** mitochondria produce/make energy 2. **Accept** 'ATP releases energy' for active transport 3. **Accept** microvilli OR brush border for folds 4. **Accept** channel proteins OR transport proteins for carrier proteins **Reject** RER, rER, SER or ER as abbreviations: endoplasmic reticulum must be written in full **Ignore** thin walls/short diffusion distance/good blood supply (not features of the cell)

Question	Marking guidance	Mark	Comments
02.4	1. Nuclear envelope OR double membrane (around the nucleus); 2. (Nuclear) pores (in the envelope/membrane); 3. Chromosomes/chromatin OR (linear) DNA associated with/bound to proteins/histones; 4. Nucleolus/nucleoli;	**3 max** (3 × AO1)	2. **Ignore** porous 3. Chromosomes or chromatin alone gains the point; DNA alone needs proteins/histones 3. **Accept** nucleoplasm 3. **Reject** DNA is circular **Reject** the nucleolus contains (all) the DNA **Ignore** functions, eg 'controls the cell'

Question	Marking guidance	Mark	Comments
03.1	So that only the protein made in the first 3 minutes is radioactive OR so that no more radioactive amino acids are used/incorporated, allowing one batch of protein to be followed (through the cell);	**1** (1 × AO3)	**Accept** radioactive amino acids are diluted so (almost) none are used in new proteins **Ignore** 'as a control' OR 'fair test' unqualified

Question	Marking guidance	Mark	Comments
03.2	Correct answer for 2 marks: 0.8 (% min^{-1});; Accept for 1 mark: 40 (%) OR 40 ÷ 50	**2** (2 × AO2)	Plotted values: 14% at 40 minutes and 54% at 90 minutes **Accept** readings of 13–15 and 53–55, giving answers of 0.76–0.84, for 2 marks **Accept** a correct gradient from any two points on the line between 40 and 90 minutes

Question	Marking guidance	Mark	Comments
03.3	1. DNA/a gene in the nucleus codes for the protein OR mRNA (is transcribed and) leaves the nucleus through pores; 2. (Radioactive) amino acids are joined to form the protein on ribosomes on the rough endoplasmic reticulum, so most radioactive protein is in the rough endoplasmic reticulum at the start (96% at 0 minutes); 3. The rough endoplasmic reticulum folds/transports the protein OR the protein moves (in vesicles) from the rough endoplasmic reticulum to the Golgi apparatus; 4. Golgi apparatus modifies (eg adds carbohydrate to) OR packages the protein, so radioactivity in the Golgi apparatus rises as it falls in the rough endoplasmic reticulum (peak of 50% at 20 minutes); 5. Golgi apparatus forms (secretory) vesicles containing the protein, so radioactivity in vesicles rises as it falls in the Golgi apparatus (peak of 50% at 60 minutes); 6. Vesicles move to and fuse with the cell-surface membrane, releasing the protein (by exocytosis), so radioactive protein outside the cells increases (to 78% at 120 minutes); 7. Mitochondria (carry out aerobic respiration and) provide ATP for protein synthesis/movement of vesicles/exocytosis; 8. The peaks occur one after another (rough endoplasmic reticulum → Golgi apparatus → vesicles → outside), showing the order in which the protein moves through the cell;	**6 max** (2 × AO1) (2 × AO2) (2 × AO3)	**Max 4** if Figure 1 is not used **Max 4** if only the data are described, with no roles of organelles **Reject** RER, rER, SER or ER as abbreviations: endoplasmic reticulum must be written in full 4. **Accept** Golgi apparatus makes glycoprotein. Accept Golgi body/complex 5. **Accept** peak at 40–60 minutes 6. **Reject** vesicles move 'to where they are needed' or 'out of the cell' without fusion with the cell-surface membrane 7. **Reject** mitochondria produce energy **Accept** values within one small square (2%) of the plotted values

Structure of prokaryotic cells and of viruses 3.2.1.2

Question	Marking guidance	Mark	Comments
04.1	1. J: capsule; 2. K: cell wall; 3. L: plasmid;	**2** (2 × AO1)	3 correct = 2 marks; 2 correct = 1 mark J: reject capsid OR slime K: accept murein (cell) wall; reject cell-surface membrane L: accept plasmid only; reject (circular) DNA OR ribosome

Question	Marking guidance	Mark	Comments
04.2	1. Bacterium is (much) smaller; 2. No nucleus, so DNA is free in the cytoplasm, but the palisade cell has DNA in a nucleus; 3. Bacterium has circular DNA, but the palisade cell has linear DNA (in its nucleus); 4. DNA in the bacterium is not associated with proteins/histones, but DNA in the palisade cell (nucleus) is associated with proteins/histones; 5. No mitochondria/chloroplasts in the bacterium, but mitochondria/chloroplasts in the palisade cell; 6. No Golgi apparatus/endoplasmic reticulum/vacuole in the bacterium, but present in the palisade cell; 7. Cell wall of murein in the bacterium, but of cellulose in the palisade cell; 8. Smaller ribosomes in the bacterium (than in the palisade cell); 9. Capsule/plasmids/flagellum in the bacterium, but not in the palisade cell;	**5 max** (5 × AO1)	Each point must be a direct comparison; 'bacterium has no …' implies the palisade cell has it **Accept** prokaryote for bacterium and eukaryote/plant cell for palisade cell 3, 4, 8. **Credit** whether or not the nucleus/cytoplasm is mentioned: the palisade cell has linear, histone-bound DNA and larger ribosomes, and the bacterium does not 3, 4, 8. **Reject** the palisade cell has no circular DNA OR all of its DNA is linear/associated with histones OR it has no small(er) ribosomes (chloroplasts and mitochondria contain circular DNA and smaller ribosomes) **Accept** 'no membrane-bound organelles in the bacterium, but membrane-bound organelles in the palisade cell' for point 5 or 6 5, 6. Each point is credited once, whichever organelles are named 7. **Accept** glycoprotein OR peptidoglycan for murein. Reject murein in the palisade cell 8. **Accept** 70S v. 80S 9. **Credit** once only. Accept mesosome in the bacterium but not in the palisade cell as an alternative for point 9 **Reject** DNA only in plasmids in the bacterium. Reject single-stranded DNA **Reject** bacterium has no DNA OR no ribosomes OR no cell-surface membrane **Reject** endoplasmic reticulum abbreviations (RER, rER, ER)

Question	Marking guidance	Mark	Comments
05.1	1. Ribosomes in bacteria/prokaryotes are smaller (than ribosomes in the cytoplasm of human/eukaryotic cells); 2. T binds only to the smaller/bacterial ribosomes, so translation/protein synthesis stops in bacteria but not in the cytoplasm of human cells;	**2** (2 × AO2)	1. **Accept** 70S v. 80S 1. **Accept** ribosomes in bacteria have a different shape/structure 2. **Accept** T is complementary to/fits bacterial ribosomes only **Ignore** references to mitochondria **Reject** T kills human cells

Question	Marking guidance	Mark	Comments
05.2	1. (At high concentrations,) T (binds to ribosomes in mitochondria and) reduces protein synthesis in mitochondria; 2. Fewer proteins/enzymes for (aerobic) respiration, so less ATP is produced (for muscle contraction);	**2** (2 × AO2)	1. **Accept** figures, eg protein synthesis in mitochondria falls to 26% at 16 μg cm^{-3} 2. **Reject** less energy produced 2. **Accept** less energy released

Question	Marking guidance	Mark	Comments
05.3	1. (Supports:) protein synthesis in bacteria is reduced to 18% OR by 82%; 2. (Supports:) protein synthesis in the cytoplasm of human cells is not affected (98–100%); 3. (Against:) protein synthesis in mitochondria is reduced (to 86% OR by 14%), so the patient may be harmed; 4. (Against:) 18% of bacterial protein synthesis continues, so some bacteria may survive OR a higher concentration inhibits bacteria more (9% at 8 μg cm^{-3}) but inhibits mitochondria more too (74%); 5. (Against:) results are from isolated cells/mitochondria (in the laboratory), not from a patient OR only one species of bacterium tested OR no data on repeats/variation;	**3 max** (3 × AO3)	**Max 2** if only supporting points or only points against are given **Accept** readings within one small square (2%) of the plotted values: bacteria 18%, mitochondria 86% at 6 μg cm^{-3} **Ignore** 'fair test' unqualified

Question	Marking guidance	Mark	Comments
06.1	Made of cells: No Contains genetic material: Yes Has a cell-surface membrane: No;	**1** (1 × AO1)	Viruses are acellular: they are not made of cells and have no cell-surface membrane or cytoplasm, but all virus particles contain genetic material

Question	Marking guidance	Mark	Comments
06.2	1. Capsid; 2. Protects/encloses the genetic material/nucleic acid/DNA/RNA;	**2** (2 × AO1)	1. **Accept** capsomeres. Ignore protein coat. Reject capsule OR cell wall 2. **Ignore** genetic information 2. Mark independently

Question	Marking guidance	Mark	Comments
06.3	1. Attachment protein/X has a specific shape that is complementary to/binds to a receptor (protein) on the cell-surface membrane of nose/throat cells; 2. Liver cells do not have this receptor, so the virus cannot bind to/attach to/enter them;	**2** (2 × AO2)	1. **Accept** X for attachment protein. Accept glycoprotein for attachment protein 1. **Ignore** receptor on the virus **Reject** antibody OR antigen–antibody complex

Question	Marking guidance	Mark	Comments
06.4	Virus (particle) has no ribosomes (for T to bind to) OR viral proteins are made by the host cell's (cytoplasmic) ribosomes, which T does not affect;	**1** (1 × AO2)	**Accept** viruses have no metabolism/do not carry out protein synthesis themselves **Ignore** viruses are inside cells **Ignore** 70S/80S **Reject** antibody for antibiotic

Microscopes and measuring cells 3.2.1.3 (AT d)

Question	Marking guidance	Mark	Comments
07.1	Electrons have a shorter wavelength than light;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
07.2	1. Specimens for a transmission electron microscope must be in a vacuum/dead/fixed/very thin sections, so living cells/movement cannot be seen; 2. Chloroplasts (5×10^{-6} m) are (25 times) larger than the resolution (2×10^{-7} m), so they can be seen/distinguished with an optical microscope; 3. Optical microscope shows colour, so the (green) chloroplasts can be seen;	**2 max** (2 × AO2)	**Max 1** if the sizes are not compared 2. **Accept** 0.2 μm for 2×10^{-7} m, or 5000 nm and 200 nm 2. **Ignore** magnification for resolution

Question	Marking guidance	Mark	Comments
07.3	1. (Supports:) granules were seen only in cells treated with chemicals/dried, so they may have been produced by the preparation method; 2. (Supports:) rapid freezing keeps structures closer to the living state, so organelles should still be seen with this method; 3. (Against:) the freezing method might not preserve/show the granules OR the granules might be lost/destroyed/not stained by freezing; 4. (Against:) only one tissue/one alternative method used OR needs repeating by other scientists/with other methods;	**2 max** (2 × AO3)	**Max 1** if only supporting points or only points against are given **Accept** artefacts are structures produced by the preparation that are not present in living cells **Ignore** 'human error'

Question	Marking guidance	Mark	Comments
08.1	Correct answer for 2 marks: 57.6 (µm);; Accept for 1 mark: 1 eyepiece division = 2.4 µm OR 60 ÷ 25	**2** (2 × AO2)	**Accept** 58 (µm) for 2 marks 1 stage micrometer division = 1 mm ÷ 100 = 10 µm; 6 divisions = 60 µm 5.76 (stage micrometer divisions, not converted to µm) gains 0 marks on its own; award 1 mark only if 2.4 µm OR 60 ÷ 25 is shown in the working

Question	Marking guidance	Mark	Comments
08.2	The graticule divisions stay the same size, but the image of the specimen changes size, so each division represents a different actual length;	**1** (1 × AO2)	**Accept** each division represents a larger actual length at lower magnification **Ignore** 'the magnification has changed' unqualified

Question	Marking guidance	Mark	Comments
08.3	Correct answer for 2 marks: (×) 1200;; Accept for 1 mark: 70 000 ÷ 57.6 OR 1215 (not to 2 significant figures)	**2** (2 × AO2)	70 mm = 70 000 µm; 70 000 ÷ 57.6 = 1215.3 **Accept** 58 µm, which also gives (×) 1200 **ECF**: correct answer to 2 significant figures from an incorrect diameter in 08.1 **Ignore** the unit 'times' OR the × sign

Question	Marking guidance	Mark	Comments
08.4	Measure many cells (at least 10) and calculate a mean;	**1** (1 × AO3)	**Accept** cells chosen at random/from different fields of view, with a mean **Ignore** 'repeat the measurement' of the same cell

Cell fractionation and ultracentrifugation 3.2.1.3

Question	Marking guidance	Mark	Comments
09.1	1. Ice-cold: reduces/slows enzyme activity, so organelles are not digested/damaged (by enzymes); 2. Buffered: prevents a change in pH, so enzymes/proteins (in the organelles) are not denatured; 3. Same water potential: no (net) movement of water by osmosis, so organelles do not burst/shrink;	**3** (3 × AO1)	1. **Reject** cold denatures enzymes 2. **Accept** keeps pH constant 3. **Accept** isotonic. Reject cells for organelles 3. **Reject** WP for water potential

Question	Marking guidance	Mark	Comments
09.2	To remove (large) debris/unbroken cells/pieces of tissue;	**1** (1 × AO1)	**Reject** to remove organelles/nuclei

Question	Marking guidance	Mark	Comments
09.3	1. Most enzyme M/mitochondria (80%) is in pellet 2, but most enzyme L/lysosomes (58%) is in pellet 3; 2. So a greater force/higher speed is needed for lysosomes to form a pellet (than mitochondria); 3. Larger/denser organelles form a pellet/sediment at lower forces/speeds OR smaller/less dense organelles need a greater force;	**3** (1 × AO2) (2 × AO3)	1. Must refer to both enzymes/both organelles 3. **Accept** heavier for denser **Reject** lysosomes are in the supernatant for pellet 3

Question	Marking guidance	Mark	Comments
09.4	1. Contains enzyme M (12%), so mitochondria are present; 2. Contains DNA (2%), which lysosomes do not contain, so other DNA-containing structures/nuclei/nuclear fragments are present;	**2** (2 × AO3)	1. 'Some mitochondria and lysosomes are similar in size/density' explains point 1 but is not a separate mark 2. **Accept** mitochondria as the DNA-containing structures only if point 1 has not already been awarded for mitochondria **Ignore** 'only 58% of lysosomes are in pellet 3' (this is about yield, not purity)

Question	Marking guidance	Mark	Comments
09.5	Some lysosomes burst/were broken (during homogenisation), releasing enzyme L into the solution OR some lysosomes were too small/light to form a pellet at 25 000 × g;	**1** (1 × AO3)	**Accept** lysosome membranes damaged **Reject** enzyme L made in the supernatant

Question	Marking guidance	Mark	Comments
09.6	Ribosomes;	**1** (1 × AO2)	Ribosomes are the smallest of these organelles and need the greatest force; liver cells have no cell walls, and nuclei and mitochondria were removed at lower forces

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