HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.2.2 All cells arise from other cells

Mark scheme

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TOTAL MARKS	QUESTIONS
53	8

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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The cell cycle and mitosis 3.2.2

Question	Marking guidance	Mark	Comments
01.1	R → P → S → Q;	**1** (1 × AO2)	R prophase, P metaphase, S anaphase, Q telophase/cytokinesis.

Question	Marking guidance	Mark	Comments
01.2	1. Centromeres have divided/split; 2. (Sister) chromatids are being pulled/moved to opposite poles/ends of the cell; 3. By spindle fibres (attached to the centromeres) shortening/contracting; 4. Chromatids are V-shaped because they are pulled by the centromere (with the arms trailing behind);	**2 max** (1 × AO1) (1 × AO2)	2. **Accept** chromosomes for chromatids 2. **Reject** homologous chromosomes (separating) **Reject** anaphase I or any reference to meiosis **Ignore** naming the stage (anaphase) without explanation

Question	Marking guidance	Mark	Comments
01.3	1. Mitotic index increased (from 0.05 to 0.19), so cells are entering mitosis but not leaving it/cells accumulate in mitosis; 2. Cells like R have condensed/visible chromosomes, so these cells have started (prophase of) mitosis; 3. No spindle fibres to attach to centromeres, so chromosomes cannot line up at the equator (so no cells like P); 4. Chromatids cannot be separated/pulled to opposite poles, so no anaphase/telophase/cytokinesis (so no cells like S or Q);	**3 max** (1 × AO2) (2 × AO3)	**Max 2** unless point 1 or point 2 is given 1. **Accept** a higher proportion of cells in mitosis 3. **Accept** chromosomes not attached to spindle 4. **Reject** homologous chromosomes **Ignore** substance K kills the cells

Question	Marking guidance	Mark	Comments
02.1	DNA replication;	**1** (1 × AO2)	**Accept** (semi-conservative) replication of DNA / DNA is copied **Accept** chromosomes replicate **Reject** mitosis/cell division **Ignore** interphase unqualified

Question	Marking guidance	Mark	Comments
02.2	Correct answer of 35 (%) for 2 marks;; Accept for 1 mark, 7 (hours) for DNA replication **OR** cell cycle of 20 hours identified **OR** 7 ÷ 20	**2** (2 × AO2)	Plotted values: replication from 8 to 15 hours; cells divide at 20 and 40 hours, so the cycle lasts 20 hours **Reject** 0.35 for 2 marks (not a percentage); award 1 mark

Question	Marking guidance	Mark	Comments
02.3	1. The cells divide/cytokinesis occurs, so each cell forms two (daughter) cells; 2. Chromatids of each chromosome are separated (in mitosis), so each (daughter) cell receives one chromatid/copy of each chromosome;	**2** (1 × AO1) (1 × AO2)	1. **Accept** division of the cytoplasm 2. **Accept** each daughter cell receives an identical copy of the DNA made during replication 2. **Reject** homologous chromosomes are separated **Reject** any reference to meiosis

Question	Marking guidance	Mark	Comments
02.4	Stays constant/at 6 (arbitrary units) OR does not increase/double;	**1** (1 × AO2)	**Accept** a description of a horizontal line at 6 **Reject** stays constant at 12 **Ignore** reasons

Question	Marking guidance	Mark	Comments
03	1. (Prophase) chromosomes condense/shorten and thicken/become visible; 2. Each chromosome is made of two (identical/sister) chromatids joined at a centromere; 3. Spindle fibres attach to the centromeres; 4. (Metaphase) chromosomes line up at the equator/centre of the cell/spindle; 5. (Anaphase) centromeres divide/split; 6. (Sister) chromatids are pulled to opposite poles by the spindle fibres shortening/contracting; 7. (Telophase) chromosomes (at each pole) uncoil/become less visible OR two nuclei form; 8. Division of the cytoplasm/cytokinesis produces two cells; 9. Each new cell receives one chromatid/copy of every chromosome, made by (DNA) replication in interphase; 10. Nuclear envelope/membrane breaks down (in prophase) OR re-forms (in telophase);	**6 max** (6 × AO1)	**Max 5** unless point 9 is given 1. **Accept** coil/supercoil for condense 3. **Accept** attachment in prophase or metaphase 4. **Accept** middle of the cell for equator 6. **Accept** chromosomes for chromatids 8. **Accept** pinching in of the cell-surface membrane **Reject** homologous chromosomes pair or separate, crossing over, or any other reference to meiosis, but credit correct points elsewhere Stage names are not required; credit correct events described in the correct order

Uncontrolled cell division and cancer treatment 3.2.2

Question	Marking guidance	Mark	Comments
04.1	A mass of cells produced by uncontrolled mitosis;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
04.2	1. Drug D stops chromatids being pulled/moved to (opposite) poles, so cells cannot complete mitosis/divide (and die); 2. Tumour/intestine lining/hair follicles have a high(er) mitotic index, so a high(er) proportion of cells are dividing/in mitosis (so more cells are killed); 3. Liver/heart muscle cells rarely/never divide OR have (almost) lost the ability to divide, so few/no cells are affected;	**3 max** (3 × AO2)	1. **Accept** centromeres/chromosomes not separated OR anaphase cannot happen 2. **Accept** faster rate of cell division for high mitotic index **Ignore** a description of the pattern in the data without an explanation **Reject** meiosis

Question	Marking guidance	Mark	Comments
04.3	1. (For) greatest decrease is in tumour cells (62%); 2. (Against) also large decrease in cells of the intestine lining (45%)/hair follicles (31%), so harmful side effects; 3. Tested in mice, which may not respond in the same way as humans; 4. Only one dose/only 5 days, and 38% of tumour cells remain, so the tumour may not be removed/may regrow; 5. Number of mice/repeats not given OR no measure of variation/statistical test;	**3 max** (3 × AO3)	**Max 2** if only points for or only points against are given 2. **Accept** named side effects, eg hair loss, damage to the gut **Reject** 'it only kills cancer cells' (Table 1 shows healthy tissues also lose cells)

Binary fission and the replication of viruses 3.2.2

Question	Marking guidance	Mark	Comments
05.1	Replication of plasmids;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
05.2	1. Not supported, because for 4 of the 5 parent cells the daughter cells had different numbers of plasmids, eg 12 and 18 OR only parent cell 2 gave equal numbers (9 and 9); 2. The numbers in the two daughter cells always add up to the number in the parent cell, so all plasmids are passed on/on average each daughter cell receives about half; 3. Only five parent cells/only one type of plasmid/only one species studied;	**2 max** (2 × AO3)	1. **Accept** any correct pair of unequal values from the table **Ignore** 'no repeats' unqualified

Question	Marking guidance	Mark	Comments
05.3	1. Circular DNA is replicated once (before division) and one copy goes to each daughter cell; 2. Plasmids are (many and) shared out randomly/unevenly when the cytoplasm divides;	**2** (2 × AO2)	2. **Accept** plasmids are not separated into equal groups 2. **Accept** plasmids replicate a variable number of times/independently of the circular DNA, only if linked to different cells having different numbers of plasmids. Do not accept it as the reason the two daughter cells of one parent differ **Reject** chromosome for circular DNA **Reject** mitosis **Ignore** genetically identical

Question	Marking guidance	Mark	Comments
06.1	1. Attachment proteins (on the virus) bind to (complementary) receptors on the bacterium; 2. (Viral) nucleic acid is injected/enters the bacterium; 3. (Viral) nucleic acid is replicated (by the host cell/host enzymes); 4. Viral proteins/capsids are made (by host ribosomes); 5. New virus particles are assembled; 6. Virus particles are released when the bacterium bursts/lyses;	**4 max** (4 × AO1)	2. **Accept** DNA/RNA/genetic material for nucleic acid 2. **Reject** mRNA is injected 3. **Accept** DNA/RNA/genetic material for nucleic acid 3. **Reject** 'the virus replicates' for point 3 **Ignore** genetic information for nucleic acid **Ignore** viral nucleic acid incorporated into the host chromosome/genome **Ignore** 'receptor protein' on the virus **Reject** the virus divides by binary fission/mitosis

Question	Marking guidance	Mark	Comments
06.2	1. Viral nucleic acid is being replicated and/or viral proteins are being made (inside the bacteria); 2. New virus particles have not yet been assembled/released OR the bacteria have not yet burst;	**2** (2 × AO3)	2. **Accept** particles appear/increase after 20 minutes when the bacteria burst/release the new virus particles **Accept** virus particles are being assembled but not released **Reject** the virus is dividing

Question	Marking guidance	Mark	Comments
06.3	Correct answer of 150 for 2 marks;; Accept for 1 mark, 3.0×10^7 OR 30 million (virus particles per cm^3) read from the graph **OR** $3 \times 10^7 \div 2 \times 10^5$	**2** (2 × AO2)	Plotted plateau: 30 million per cm^3 **Accept** readings of 29–31 million, giving 145–155, for 2 marks

Required practical 2: root tip squashes and mitotic index 3.2.2

Question	Marking guidance	Mark	Comments
07.1	1. Cells near the root tip are (still) dividing (by mitosis) OR cells further from the tip have stopped dividing; 2. So the squash contains (many) cells in mitosis OR a high(er) proportion of cells in mitosis, so the stages of mitosis can be seen;	**2** (2 × AO2)	1. **Accept** the tip is the growing region. Accept meristem (not required) 2. **Accept** so the mitotic index is not underestimated **Ignore** 'the tip is softer/easier to squash' unqualified **Reject** cells further from the tip are dead

Question	Marking guidance	Mark	Comments
07.2	Chromosomes (contain DNA so) are stained and become visible, so the stage of each cell can be identified;	**1** (1 × AO1)	**Accept** so chromosomes can be seen **Ignore** 'to see the cells' unqualified

Question	Marking guidance	Mark	Comments
07.3	0.15;	**1** (1 × AO2)	**Accept** 75 ÷ 500 **Accept** 15% (a percentage is accepted) **Reject** 75 ÷ 425

Question	Marking guidance	Mark	Comments
07.4	Correct answer of 28.8 (minutes) for 2 marks;; Accept for 1 mark, 0.48 (hours) **OR** 15 ÷ 500 × 16 (× 60)	**2** (2 × AO2)	**Accept** 29 (minutes) for 2 marks

Question	Marking guidance	Mark	Comments
07.5	Correct answer of 40 (µm) for 2 marks;; Accept for 1 mark, 24 000 µm (conversion) **OR** 24 ÷ 600 = 0.04 (mm) **OR** correct digits with the wrong power of 10, eg 4 or 400	**2** (2 × AO2)	**Reject** the magnification divided by the image size

Question	Marking guidance	Mark	Comments
07.6	1. Use single, continuous/sharp lines OR no sketching; 2. No shading/colouring; 3. Label the chromosomes/structures, using label lines drawn with a ruler that do not cross; 4. Keep the correct proportions/relative sizes of structures; 5. Add a scale bar; 6. Add a title;	**2 max** (2 × AO1)	**Ignore** 'add the magnification' (a scale bar is needed) **Ignore** 'use a pencil' on its own

Question	Marking guidance	Mark	Comments
08	1. Mean mitotic index increases from 10 °C to 25 °C (supports conclusion up to 25 °C); 2. Mean mitotic index decreases at/above 30 °C, so it does not increase at all temperatures; 3. Standard deviations overlap for 20 °C and 25 °C, so there may be no significant difference/the difference may be (likely) due to chance; 4. No statistical test carried out; 5. Mitotic index is the proportion of cells in mitosis, not the rate of division, eg time spent in mitosis may change with temperature; 6. Only one field of view per root tip, so may not be representative; 7. Large intervals between temperatures, so the temperature giving the highest mitotic index is not known;	**5 max** (5 × AO3)	**Max 4** if no point that supports the conclusion (point 1) is given 1. and 2. Accept that standard deviations do not overlap, so the differences are significant/(probably) not due to chance, as support for these points 3. **Accept** 'no significant difference' or '(likely) due to chance' 3. **Accept** mean ± standard deviation values quoted to show the overlap, eg 0.133 and 0.102 **Ignore** 'only pea was studied' (the conclusion is about pea root tips) 4. **Accept** a named test, eg t-test **Ignore** 'no repeats' (10 root tips were used)

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