Mark scheme - Cell Division and Specialisation

23		i	*idea that* (some) cells contain incorrect number of chromosomes ✓	1 (AO 3.1)	e.g. cells do not contain the diploid number of chromosomes / cells contain different numbers of chromosomes
		ii	G1 (checkpoint) **AND** *idea that* cells (with damaged DNA) should be stopped from entering the S phase ✓ G1(checkpoint) **AND** *idea that* this is the point where DNA damage is checked ✓	1 (AO 3.1)	**DO NOT ALLOW** G2 (as if this was not working both replication and mitosis would occur)
			Total	**2**	
24		i	G_1 **and** S **and** G_2 ✓	1	in any order **IGNORE** G_0, X, Y & Z **DO NOT CREDIT** if M or C are included **Examiner's Comments** Most candidates selected the gap and synthesis stages of the cell cycle as comprising interphase. A few made the error of including either mitosis or cytokinesis as well. A lot of candidates thought that X, Y and Z were phases, rather than the checkpoints they were already identified as in the question.
		ii	*idea that* (checking that) DNA has replicated correctly ✓	1	replicate = duplicate = copy **ACCEPT** (checking that) the chromosomes have duplicated correctly **ACCEPT** (checking that) the duplicated chromatids have no faults **ACCEPT** (checking) for , mutations / damage to DNA / damage to genes / errors in DNA **IGNORE** genetic material / genetic information **IGNORE** ref to organelle replication

					Examiner's Comments This question tested candidates' awareness of what happens at the Sphase of the cell cycle. Correct answers focused on checking that the DNA had replicated correctly without mutation. Some answers also made irrelevant reference to the replication of organelles.
			Total	**2**	
25		i	G_1 first growth (phase) ✓ G_2 / second growth **or** end of / AW, S / synthesis ✓ G_1 / first growth (phase) ✓	3	
		ii	1.3×10^{11} ✓	1	
		iii	(red blood cells) do not contain DNA ✓	1	
			Total	**5**	
26			190 ✓ ✓	max 2	**If the answer is incorrect or incorrectly rounded, award 1 mark for working:** 42÷265 x1200 **OR** 42÷265 x20 x60 **Examiner's Comments** part (c) was well answered by most candidates, calculating the answer correctly at 190 minutes. A very few candidates gained one mark only, for incorrect rounding of the final answer. In general, if the working out was correct, the answer was correct.
			Total	**2**	
27		i	Q ✓	1	**If an additional incorrect answer is given = 0 marks** **Examiner's Comments** Most candidates correctly identified cell Q.
		ii	1 it / P, needs to synthesise / contains / has, more DNA / longer DNA / more genetic material / more	1	1 **CREDIT** ref to P being polyploid **CREDIT** ref to P being diploid and Q being haploid **ACCEPT** *idea of* has more DNA to repair after G_1

			chromosomes ✓ 2 AVP ✓		checkpoint 2 e.g. ref to P being from an organism at a lower temperature P has a lower metabolic rate **ora** **IGNORE** replicating organelles **Examiner's Comments** Some excellent answers were seen to this question. Candidates were expected to refer to DNA and so references to P being a complex cell without further qualification were not credited.
		iii	*two from* 1 it spends all of its time in / does not leave, G_1 **or** it spends all of its time in / does not leave, G_0 ✓ 2 (so) it is not, dividing / replicating / undergoing mitosis ✓ 3 specialised / differentiated ✓ 4 AVP ✓	2	1 **DO NOT CREDIT** *most of the time* in, G_1 / G_0 **ACCEPT** 'has been sent into G_0' **IGNORE** 'is in G_1' as this restates what is in the table **IGNORE** ref to interphase 3 **ACCEPT** ref to having reached the end of its development 4 e.g. of differentiated cell – erythrocyte / neurone / B memory cell etc damage has been detected in G_1 (so cannot progress) is dormant nutrients / size, not right to enter growth phase **IGNORE** is a stem cell / cancer / dead / apoptosis **Examiner's Comments** Some candidates incorrectly thought the cell would be dead but there were plenty of good answers to this question with ideas of differentiation and specialisation and suggestions of examples of cells that cell R could be. There were a number of alternatives on the mark scheme to reflect the wide range of potential correct answers.
			Total	**4**	
28			B	1(AO1.1)	

<table>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>29</td><td></td><td>i</td><td>224 ✓</td><td>1
AO2
.2</td><td>haploid number = 28
x 2 for diploid number = 56
x 2 after DNA replication = 112
x 2 strands per molecule = 224</td></tr>
<tr><td></td><td></td><td>ii</td><td>a cross drawn anywhere between sporophyte and spores ✓</td><td>1
AO2
.5</td><td></td></tr>
<tr><td></td><td></td><td>iii</td><td><u>many</u> mitochondria ✓
to supply , energy / ATP , for movement ✓

OR

enzymes / acrosome ✓
(enzymes) to , penetrate / AW , egg ✓</td><td>2
AO2
.1</td><td>Mark the first suggestion given but ignore partially achieved marking points

DO NOT CREDIT make energy

ALLOW to digest outer layer / break through membrane
DO NOT CREDIT break down egg cell wall</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
<tr><td>30</td><td></td><td>i</td><td>
<table>
<tr><th></th><th>laser scanning confocal microscope</th><th>scanning electron microscope</th><th>transmission electron microscope</th><th></th></tr>
<tr><td>maximum resolution</td><td></td><td></td><td></td><td></td></tr>
<tr><td>image appearance</td><td></td><td>3D</td><td>2D</td><td>✓</td></tr>
<tr><td>image colour</td><td>named colour / coloured</td><td>black and white</td><td></td><td>✓</td></tr>
</table>
</td><td></td><td>Mark each row</td></tr>
<tr><td></td><td></td><td>ii</td><td>larger number of (named) organelles ✓

more DNA / larger nucleus ✓

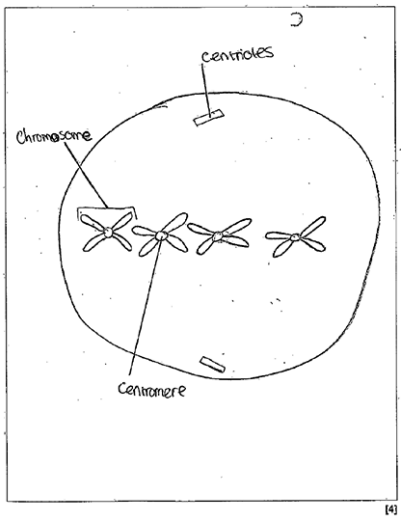
no visible chromosomes ✓

nuclear membrane present ✓</td><td>2
max</td><td>ALLOW twice as much DNA</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
</table>

3 1			D ✓	1 (AO 1.1)	**Examiner's Comments** Most candidates were able to answer this correctly.
			Total	**1**	
3 2			D ✓	**1**	**Examiner's Comments** There were many correct responses to this question with candidates recognising the use of chromosome number to indicate the doubling and halving of DNA proportion in mitosis and meiosis.
			Total	**1**	
3 3		i	*If cell B is measured and formula applied…* 1.7 (± 0.4) **or** *If working back from information given about cell A…* 2.2 (± 0.4) ✓✓ _____ _____ (number less than 10) ×10^4 (μm^3) ✓	3 (AO 2.8)	*Max 1 if given to 1 only or more than 3 sig. fig.* *Max 1 if no attempt at standard form* **ALLOW** any number that has 17 (± 4) as the first 2 significant figures **ALLOW** any number has 22 (± 4) as the first 2 significant figures If answer is incorrect, **ALLOW** 1 mark for evidence of r = 16 (± 1) mm _____ **Examiner's Comments** Around half of candidates could apply the scaling formula correctly and most did answer in standard form. However, many candidates appeared to struggle with converting units, or measuring using the correct units, and answered with incorrect and implausible orders of magnitude. Many candidates did not appear to realise that their answer should be quite close to the size of cell A, which was given.
		i i	*light (microscope) because* magnification , (only) 1000 / < 2000 / within LM range ✓ colour visible ✓ (other) subcellular structures / (named) organelles , not visible ✓ wide field of view ✓	2 (AO 3.1)	*Electron microscope = 0 marks* **ALLOW** not black & white **IGNORE** stain / dye **ALLOW** whole cell visible **IGNORE** refs to resolution unqualified **Examiner's Comments**

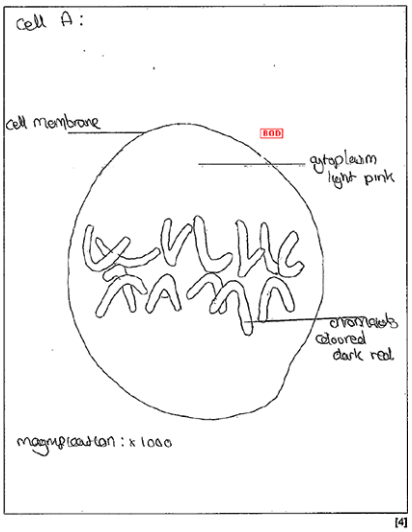
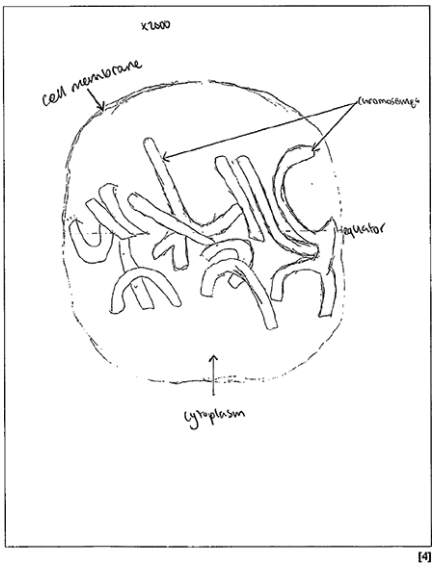
					Most candidates were aware that it was a light microscope and then achieved 1 or 2 marks, usually for reference to magnification or colour. A number of uncredited responses mentioned the cells being alive, which was not obvious from the image, or the 2D nature of the image, which is not an exclusive feature of light microscopes. A number of candidates incorrectly identified the electron microscope as the source of images and a small minority suggested laser scanning confocal microscopes.
		iii	*any **two** from* **1** asexual / vegetative , reproduction **2** (development of) body plan **3** proliferation of white blood cells **4** producing gametes from haploid cells **5** production of <u>new</u> stem cells ✓	1 (AO 1.2)	**1 ALLOW** cloning **2 IGNORE** embryonic development **3 CREDIT** e.g. clonal expansion **4 IGNORE** gamete production unqualified **<u>Examiner's Comments</u>** This question required candidates to bring together their learning from different areas of the specification. Many candidates were able to give asexual reproduction as a response but most struggled to find a second example. Body plan and clonal expansion were the most common additional creditworthy responses.
			Total	**6**	
34		i	prophase then metaphase then anaphase then telophase ✓✓	2 AO1.2	**MAX 1** if interphase or cytokinesis mentioned **ALLOW** 1 mark if phases named correctly but not in correct order
		ii	genetically identical offspring ✓ offspring produced , rapidly / in large numbers ✓ (all) offspring will , find conditions favourable / have same adaptations ✓	2 max AO2.1	**IGNORE** clones **ALLOW** produces more offspring **ALLOW** finding mate requires , time / energy **ALLOW** population can increase rapidly **IGNORE** 'quicker' without some qualification
			Total	**4**	
35		i	<u>metaphase</u> ✓	1 (AO 1.2)	**IGNORE** 1 / 2 **<u>Examiner's Comments</u>**

					Almost all candidates got this right. A few wrote prophase or anaphase.
		i i	**1** **2** **3** **4** **5**	single cell **and** ≥ 60 mm horizontal diameter **and** some attempt to draw chromosomes as in Fig. 16 ✓ **and** broadly circular clear continuous lines (on chromosomes and membrane) ✓ ruled label lines (touching correct feature) ✓ chromosome(s) **and** cytoplasm labelled ✓ colour of any of above mentioned (as annotation) ✓	4 max/ (AO 1.1) (AO 2.3)	**1** *Set measuring tool to 60 mm* **1 DO NOT CREDIT** if all chromosomes represented as a single line or shaded **2 IGNORE** minor errors if it is clear candidate has attempted to draw continuous lines **3 DO NOT CREDIT** arrows **4 ALLOW** chromatids **4 IGNORE** membrane / centromere / equator / pole / metaphase plate **4 DO NOT CREDIT** if any other structures are drawn or labelled **4 DO NOT CREDIT** if labels written on part of diagram **5 ALLOW** e.g. chromosomes are dark **Examiner's Comments** The quality of diagrams was very variable. Less than 1 in 5 candidates achieved full marks. Although most diagrams were large enough, many candidates drew a generic textbook-style image of metaphase with no attempt to draw the chromosomes visible on the insert. Chromosomes were too often drawn as single lines and candidates often added in structures that they could not see but assumed to be there, e.g. spindle fibres and centrioles. Structures were usually labelled correctly but many candidates did not use a ruler or used label lines with an arrowhead. Many candidates omitted to label the cytoplasm. Very few responses mentioned colour in the annotations and those that did had often achieved the other 4 marks anyway. Exemplar 1



The candidate has drawn textbook-style chromosomes at metaphase rather than attempting to copy the image provided so marking point 1 has not been credited. A careless error in the membrane near the top of the diagram has meant that the second marking point has also not been given. The 1 mark credited was for drawing ruled label lines.

Exemplar 2

					 [4] response achieves 5 marking points and full marks. Exemplar 3  [4] This response achieves marking points 1 and 4. Marking point 2 has not been credited because the lines are not clear and continuous and marking point 3 has not been credited because the label lines have arrowheads.
			Total	**5**	
3 6	a	i	***W** / it, has* (many) more cells in prophase **and** (far) fewer cells in telophase ✓	1	**CREDIT** correct ref to the relative numbers of cells in both phases **CREDIT** stated correctly calculated differences e.g. 'W has 20 more cells in prophase and 23 less in telophase' 'W has 20 more cells in prophase and V has 23 more

					cells intelophase' 'a difference of 20 in prophase and 23 in telophase' **ACCEPT** answers referring to speed rather than no. of cells (i.e. W spends longer in prophase but less time in telophase etc) **DO NOT CREDIT** if Metaphase and/or Anaphase are suggested **Examiner's Comments** This question tested candidates' ability to scan a set of data and select the significant differences. The mark was not awarded if only one of prophase or telophase was discussed. The difference neededto be qualified as more in prophase and less in telophase for cell W, or calculated figure differences for both stages needed to be given.
		i i	t-test compares two (or more) means **or** *idea that this* data does not include mean(s) **or** cannot calculate mean from this data **or** cannot calculate SD from this data ✓	1	**CREDIT** ref to not being a normal distribution / is not continuous data / is discrete data **ACCEPT** the idea that there are more than 2 categories **IGNORE** ref to 'average' instead of 'mean' **Examiner's Comments** There was wide variation in candidates' familiarity with the Student's t-test. Most correct answers referred to the need for comparing or calculating means for this test. Some stated that the test could only be used for calculations relating to biodiversity, as this had presumably been the context in which it had been taught.
	b	i	*calculation* $\mathbf{X}^2$ = 13.835 **or** 13.833 **or** 13.834 ✓ ✓ ✓	3	**Correct value of x^2 = 3 marks** **Answer should be to 3 dp to be consistent with the rest of the table. If answer unrounded or over-rounded but otherwise correct, max 2**

Cells	O	E	(O – E)	$(O-E)^2$	$\frac{(O-E)^2}{E}$
In prophase	85	65	20	400	6.154
In metaphase	59	55	4	16	0.291
In anaphase	6	7	-1	1	0.143
In telophase	50	73	- 23	529	7.247
Total	200	200			13.835

Award 1 mark per correct row (whether rounded or not)
plus 1 mark for x^2

Only penalise the same type of error once.ALLOW ecf for x^2 from incorrect row value(s)

Examiner's Comments

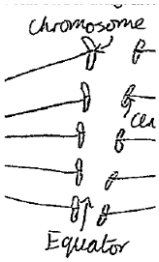
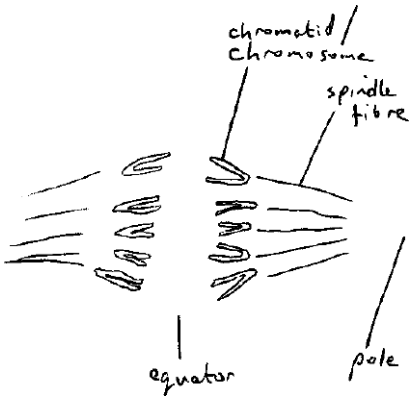
The chi-squared test was well done by a great many candidates, who were clearly well-prepared for the calculation aspect of the test. It was clear, however, that some candidates had not encountered chi-squared before [ref. the mathematical requirements in the AS Specification]. The scaffolding provided in the question, however, assisted them in completing the calculation. In this question as sample figures in the last column were given to three decimal places, answers should also have been given to three decimal places. The common errors were in rounding figures incorrectly or thinking that the square of -23 is also a negative number.

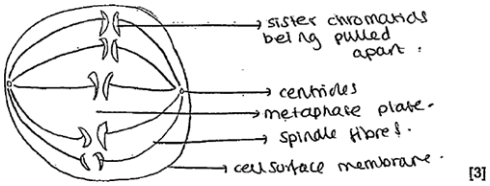
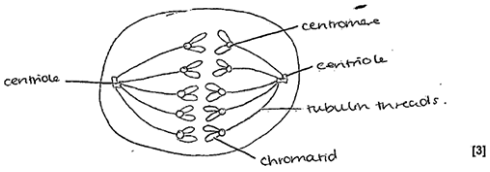
		ii	3 (degrees of freedom) ✓	1	**Examiner's Comments** Most candidates followed the instructions given and correctly identified the degrees of freedom as 3.

		iii	**Any statement(s) made must be correct for the candidate's responses to (i)and (ii).** *two from*1 calculated value is, > / greater than, 7.82 / the critical value at p = 0.05 / the value for (p =) 0.05 **or** 7.82 / the critical value at p = 0.05 / the value for (p =) 0.05, is, less than / <, 13.835 ✓	2	**ALLOW** ecf from candidate's calculated x^2value in **(i)** using the number of degrees of freedom theystated in **(ii)**.

Degrees of freedom	Probability (p)				
	0.99	0.95	0.05	0.01	0.001
1	0.00	0.00	3.84	6.64	10.83
2	0.02	0.10	5.99	9.21	13.82
3	0.11	0.35	7.82	11.35	16.27
4	0.30	0.71	9.49	13.28	18.47
5	0.55	1.15	11.07	15.09	20.52
6	0.84	1.64	12.59	16.81	22.46
7	1.24	2.17	14.07	18.48	24.32

			2 (difference / deviation) is, significant / not due to chance ✓ 3 95% certain that the results are not due to chance **or** difference would only occur by chance 5% of the time ✓ 4 (difference / deviation) also significant at p = 0.01 value **or** 99% certain that the results are not due to chance **or** difference would only occur by chance 1% of the time **or** value is, > / greater than, p = 0.01 / 11.35 **or** probability is, < / less than, 0.01 **or** probability is between 0.01 and 0.001 **or** probability is not significant at p = 0.001 ✓ 5 the null hypothesis can be rejected✓		For incorrect x^2 and degrees of freedom values, apply mark points 1 to 5 to correspond to their results. **Examiner's Comments** As might be expected, this part of the question proved to be the most challenging. Comparing the calculated value of chi-squared with a statistical table to draw a conclusion was the weakest step in the mental processing. There are many ways of expressing the conclusion that can be drawn from a chi-squared procedure and the mark scheme gives an exhaustive list of examples for use in teaching. Candidates who got parts (e)(i) and / or (e)(ii) wrong were not disadvantaged at this stage, as conclusions were marked based on their figures. The crucial piece of understanding that was missing from wrong answers is that the probability in the column headings is the probability of this amount of deviation (difference) occurring by chance. The use of p = 0.05 as the critical value is central to the interpretation. It may also help to explain to students that the smaller the chi-squared value, the better the fit of the two sets of data.
			Total	**8**	
37	a	i	R, Q, S, P ✓	1	**Examiner's Comments** Most candidates answered this very well using the letters provided. The most common incorrect answer was putting Q first, followed by S, P, R - an understandable error if you thought that R was one of the two daughter cells.
		ii	chromosomes / centromeres, aligning on, equator / mitotic plate / metaphase plate (of cell) ✓ chromatids either side of, equator / mitotic plate / metaphase plate ✓ spindle fibres attaching to, chromosome / centromere / pole / centriole ✓	max 2	**ALLOW** centre / middle, of cell in mp 1 & 2 **ALLOW** microtubules for spindle fibres **Examiner's Comments** part(a) (ii) was generally well answered, candidates

					often gained both marks where they correctly identified the phase as metaphase. However, a frequent error was to identify the stage as prophase and give a description of chromosomes condensing and the nuclear membrane breaking down.
	b		diagram showing at least 5 chromosomes pulled to each side with spindle fibres shown ✓ all labelling lines drawn with ruler **and** no arrows **and** end at structures ✓ **two** correct labels from chromatid, chromosome, equator, spindle (fibres), microtubules, pole, (position of) centriole, cytoplasm ✓	max 3	**DO NOT ALLOW** if chromosomes vertically aligned e.g.  Example of correct diagram:  **Examiner's Comments** part(b) was generally tackled well and many candidates gained 2 or 3 marks. There was a wide variety in both style and standard of diagram. The most common mistake was not drawing at least 5 chromosomes, but many that did this did go on to gain full credit. Other errors included not using a ruler for drawing the label lines and the label line not touching the structure. A few candidates drew vertical chromosomes that bore no resemblance to the photograph, or drew chromosomes being pulled apart at right angles to those in the photograph. Some drew the chromosomes at metaphase rather than anaphase. **OCR support** OCR provides guidance in the 'Biological drawing

					booklet' available at: https:/www.ocr.org.uk/Images/251799-biology-drawing-skills-handbook.pdf Centres should take guidance from the PAG activity 1.1 in which an example of how to draw a cell during mitosis is provided: https:/interchange.ocr.org.uk/Modules/ControlledMaterials/ControlledMaterialsGCEFrom2015.aspx **Exemplar 3**  This was a well-drawn diagram. The candidate recognised that there were at least five pairs of chromosomes; these were not drawn in a suitable V-shape. The label lines were drawn with a ruler and touched the appropriate part of the diagram; they shouldn't have arrow heads on the label lines. **Exemplar 4**  This was a well-drawn diagram. The chromosomes are clear, the label lines are drawn with a ruler and the labels are correct. The only criticism would be that the candidate has drawn centromeres which were not visible in the image provided.
			Total	**6**	
38			***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)*	6 (AO 2.5) (AO 2.7)	**Indicative scientific points (including details in bold) may include (but are not limited to):** *Cell C:* • Prophase • Chromosomes condense • Chromosomes have become visible (but are unordered)

			Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall quality of the answer. Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* ○ *award the higher mark where the Communication Statement has been met.* ○ *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.*** **Level 3 (5-6 marks)** Describes in detail, with no major errors, the stages of mitosis in all three cells. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3-4 marks)** Describes, with few errors or omissions, the stages of mitosis in all three cells. **OR** Describes in detail, with no major errors, at least two cells. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1-2 marks)**		• Nuclear envelope and nucleolus have disappeared *Cell D:* • (Early) anaphase • Spindle fibres are shortening • Chromatids are separating and are being pulled to opposite sides of the cell *Cell E:* • (Late) telophase • Chromatids have been pulled to opposite sides of the cell • A new cell membrane is visible down the centre of the cell • Cytokinesis / the cell is beginning to divide **Examiner's Comments** Limited understanding of the cell cycle and the checkpoints in the cell cycle resulted in few candidates scoring full marks in (b)(i) and (b)(ii). The wording in (b)(ii) 'cells with chromosomes that had been replicated despite containing damaged DNA' indicates that the relevant checkpoint is G1 rather than G2. This is because the DNA damage was present before replication in the S phase, but this was not discovered. Few candidates scored full marks in (d)(i) as many candidates were uncertain about the difference between using evidence to evaluate a statement, rather than just describing what the graph showed. Although there was often some attempt to discuss the evidence for and against the statement, many only quoted evidence for their own conclusion either agreeing with the statement or providing evidence against it. Many candidates did not realise the growth curve had a logarithmic scale for the number of cells in the culture, and so did not realise that the growth curve did have an exponential growth phase present (between day 1 and 2). Many candidates could then not convert the log10 number of cells from the graph to estimate the number of bacterial cells present on day 1 for (d)(ii). Candidates could often not describe a procedure to estimate bacterial population in (d)(iii), with few candidates suggesting the use of serial dilutions or the idea of scaling up the count from a serial dilution. Many candidates correctly suggested growing bacteria on

			Describes the stages of mitosis, with some errors, in at least one cell. **OR** Describes stages of mitosis with no link to cells in question *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.		agar plates, but then mistakenly believed that you were counting individual bacteria from these plates, rather than counting the colonies of bacteria.  **AfL** Candidates should be encouraged to set out their working clearly, rather than just writing down final answer in calculations involving multiple steps. This would help candidates to gain 1or 2 marks for correct steps in the calculation even if the final answer is incorrect. Practice at reading logarithmic scales from growth curves and using readings to estimate the number of bacteria grown over a certain length of time would also be useful, as would practice at converting between numbers in standard and ordinary form. See Maths for Biology and Maths skills handbook.
			Total	**6**	
39			(mitosis) for growth (of zygote / embryo) ✓ (which needs) genetically identical cells ✓ (not meiosis as) gametes / haploid cells not produced ✓	2 max (AO 1.2)	**ALLOW** identical genetic information **ALLOW ORA** **ALLOW** diploid cells produced **ALLOW** there is no halving of chromosome number in mitosis **ALLOW** meiosis produces haploid cells / gametes / cells with 23 chromosomes
			Total	**2**	
40			B	1	**Examiner's Comments** This should have been fairly straightforward for candidates who had seen images of mitosis or who could interpret the image using knowledge from diagrams of the process. A few suggested M, which was not a valid option.
			Total	**1**	
41		i	prophase (1) ✓	**1**	**DO NOT ACCEPT** prophase II

					(as question states meiosis I) **Examiner's Comments** Most students could correctly identify that the cell was in prophase. Anaphase was the most common incorrect answer. A few mistakenly referred to prophase 2, which did not gain the mark.
		i i	1. chromosomes / chromatids, visible / condensed ✓ 2. chromosomes not, organised / yet aligned / arranged **OR** chromosomes not at, ends / equator ✓ 3. nuclear envelope (around chromosomes) / nuclear membrane is present / chromosomes separated from cytoplasm ✓ 4. no (visible) nucleolus ✓	**2 max**	**Mark the first 2 answers** 1. Needs to be a clear statement 2. **ACCEPT** chromosomes, &nbs p; in different positions / scattered / &nb sp; spread out 3. **ACCEPT** nuclear membrane starting to disappear **DO NOT ACCEPT** nuclear membrane has disappeared **Examiner's Comments** Many candidates observed that the chromosomes were condensed or visible, and were not yet organised or at the equator of the cell. The presence of the nuclear membrane was also noted but a number of candidates failed to gain this mark by thinking that it had disappeared. Many candidates answered in terms of crossing over. The absence of the nucleolus was rarely offered by candidates.
		i i i	1. independent / random, <u>assort</u>ment ✓ 2. (homologous chromosomes) line up, across the centre of the cell / on the equator / on the metaphase plate ✓ 3. maternal or paternal chromosomes / either one of the homologous pair, can end up, facing either pole / in either (daughter) cell ✓	**3 max**	**4 ACCEPT** if described in terms of chromatids being genetically different

			4. each chromosome of the homologous pair, is genetically different / contains different alleles / contains different gene variant ✓		**Examiner's Comments** The responses to this question were variable, the best candidates were able to confidently describe how the process of independent assortment led to variation, while other candidates struggled to describe how the random alignment of the homologous pairs of chromosomes gives new combinations of the original maternal and paternal chromosomes in the gamete mother cell. In many cases there was no clear idea of which chromosomes were facing either side or pole of the cell – better use of the terms maternal and paternal would have helped. Few supported their description with a simple diagram, which would have clarified an otherwise vague answer. Many did not seem clear that pairs of chromosomes were lining up at the equator, often referring to chromosomes randomly lining up. Explaining the genetic variation was generally done poorly, with reference to crossing over but vague descriptions of the actual outcome.
			Total	**6**	
4 2			**B ✓** **C ✓** **B ✓**	**3**	*If two or more letters given, 0 mark* **Examiner's Comments** The majority of candidates were able to gain at least one mark in **Q19(a)** and the gap fill in **Q19(b)** enabled the majority of candidates to show their knowledge about DNA structure gaining at least three out of the four marks available.
			Total	**3**	
4 3		i	***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1, Level 2*** *or* ***Level 3****, best describes the overall quality of the answer. Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown*	6 AO1 .1 AO1 .2 AO2 .5	**Indicative points include** *AO1.1 Demonstrate knowledge and understanding of scientific ideas* • genetic variation is the variety of alleles • offspring have alleles from more than one parent • random fertilisation • meiosis produces genetically unique gametes *AO1.2 Demonstrate knowledge and understanding of scientific processes* • crossing over in prophase 1 • alleles swapped between non-sister chromatids • base sequence of chromosomes altered • independent assortment / random segregation

			in italics): ○ *award the higher mark where the Communication Statement has been met.* ○ *award the lower mark where aspects of the Communication Statement have been missed.* • **The science content determines the level.** • **The Communication Statement determines the mark within a level.** **Level 3 (5–6 marks)** Explains in detail how sexual reproduction leads to genetic variation with reference to more than one stage of meiosis and with reference to Hydra. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Explains in some detail how sexual reproduction leads to genetic variation with reference to more than one stage of meiosis OR with reference to Hydra and one stage of meiosis. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Mentions more than one reason why sexual reproduction leads to genetic variation. *The information is basic and communicated in an unstructured*		• in metaphase 1 • also relevant in metaphase 2 if crossing over has occurred *AO2.5 Apply knowledge and understanding of scientific processes in a theoretical context when handling qualitative data* • the sperm from one *Hydra* can fertilise an egg from any other individual Hydra • the two *Hydra* can have different alleles • sperm carried in water • might travel large distances • to unrelated *Hydra*

			way. The information is supported by limited evidence and the relationship to the evidence may not be clear. **0 marks** *No response or no response worthy of credit.*		
		i i	(some offspring) might survive unfavourable conditions ✓ (some) offspring have useful alleles ✓ (named) unfavourable conditions mean (all) offspring might die (if asexual) ✓	1 max AO2 .1	**IGNORE** eggs can lie dormant as stated in question **IGNORE** less susceptible to unfavourable conditions
			Total	**7**	
4 4			<table><tr><th></th><th>mitosis</th><th>meiosis</th></tr><tr><td>A</td><td></td><td>✓</td></tr><tr><td>B</td><td>✓</td><td></td></tr><tr><td>C</td><td>✓</td><td></td></tr></table> <table><tr><th></th><th>mitosis</th><th>meiosis</th></tr><tr><td>D</td><td>✓</td><td></td></tr><tr><td>E</td><td></td><td>✓</td></tr></table>	3	**Only credit 1 tick on each row.** **IGNORE crosses** **A ALLOW** a tick for mitosis instead of meiosis **Mark A, B & C together to max 2** 3 correct answers = 2 marks 2 correct answers = 1 mark 1 or 0 correct answers = 0 marks 1 ✗ = max 12 ✗ = 0 marks **Mark D & E together to max 1** 2 correct answers = 1 mark 1 or 0 correct answers = 0 marks 1 ✗ = 0 marks **Examiner's Comments** Most candidates struggled to apply their knowledge of mitosis and meiosis in the unfamiliar context of two life cycle diagrams. The most frequent mark to be awarded was for recognising that stage C represented mitosis and that A could be either meiosis or mitosis. Candidates almost universally made the mistake of naming meiosis as producing the gametes in the sporophyte plant life cycle. They made the same mistake at step D for the stage between a haploid organism and its gametes. The association of meiosis with gametes in candidates' thinking clearly over-rides any understanding of the reduction or maintenance of chromosome numbers. The instruction was clear that 'a'

					tick was needed in each row, but a number of candidates put two ticks in some rows.
			Total	**3**	
45			(produced) in, meristems / cambium ✓ (by) differentiation (from stem cells) ✓	2 (AO 1.2)	**ALLOW** specialised **IGNORE** mitosis
			Total	**2**	
46		i	(opsonin) binds to antigen on pathogen and, assists binding / binds, to phagocyte	1	
		ii	*any one:* well-developed cytoskeleton (1) many lysosomes (1) many mitochondria (1) lobed nucleus (1)	1	
			Total	**2**	
47	a		synthesise (a lot of) haemoglobin (1) remove / digest, (named) organelles associated with protein synthesis (1)	2	**ACCEPT** nucleus, ribosomes, rough ER
	b		(can be grown into different tissues to) test how effective new medicinal drugs are (1) (can be grown into different tissues to) test for side effects / toxicity of new drugs (1) (can be grown and) studied to see how they develop into different cell types (developmental research) (1) cell function can be studied to find out what can make it fail to work properly in certain (named) diseases (1)	3	e.g. cancer
	c		muscle tissue is a group of cells which contract together (1) a muscle is an organ that consists of muscle tissue and other (named) tissues working together (1)	2	Other named tissues could include: nervous tissue, blood, connective tissue

			Total	**7**	
48			D ✓	1	
			Total	**1**	
49		i	surface area: volume ratio too small ✓ *idea of* diffusion from outer surface not sufficient ✓ (transport system) ensures molecules / nutrients / sugars / water, reach all tissues s ✓ (allows) high metabolic rate ✓	2 max	
		ii	<table><tr><th>Cell</th><th>Location</th><th>Examp a subst transp</th></tr><tr><td>Guard cell</td><td>Leaf</td><td>carb dioxi</td></tr><tr><td>Companion cell</td><td>Vascular tissue / phloem / next to sieve tube</td><td>Sucr</td></tr><tr><td>Root hair cell</td><td>roots</td><td>Nitrate</td></tr></table>	3	
			Total	**5**	
50			*organ is* collection / AW, of <u>tissues</u> ✓ perform / carry out / adapted to, function / role ✓ *leaves have* **two** from: epidermis / spongy mesophyll / palisade mesophyll / vascular / phloem / xylem, (tissues) ✓ (to carry out) photosynthesis / gaseous exchange ✓	**4**	**IGNORE** cells throughout **ALLOW** working together **IGNORE** mesophyll (unqualified) **IGNORE** stomata **Examiner's Comments** **Q18(d)** was generally well-answered with xylem and phloem being the most commonly referred to tissues.
			Total	**4**	
51		i	**1** have already / are, differentiated / specialized (so cannot divide) ✓	**3 max**	

			2 are in, G_0 (phase of cell cycle) / resting phase ✓ **3** *idea that* shape is (too), irregular / asymmetrical (so cannot divide) ✓ **4** cytoskeleton cannot function / spindle (fibres) cannot form✓ **5** (if mitosis occurred) it would alter, number / size, of the, gaps / fenestrations ✓ **6** *idea that it* would alter an aspect of ultrafiltration ✓		**ALLOW** cannot pass G1 checkpoint / cannot go into S phase / remains in G_1 e.g. (podocyte) has projections (so cannot divide) **ALLOW** for aspect of ultrafiltration e.g. different sized molecules can pass through e.g. no / less, ultrafiltration e.g. changes rate of ultrafiltration e.g. changes composition of filtrate **Examiner's Comments** In **Q22(c)(i)** there were some excellent responses where candidates recognised that podocytes must already be differentiated and so in the G_0 stage. A surprisingly high number of candidates incorrectly stated that podocytes do not have a nucleus and that this is the reason why they could not undergo mitosis.
		i i	(adult stem cells) are <u>multipotent</u> ✓ (differentiate to) become any <u>cell</u> type within, kidney / nephron (tissue) ✓	**2**	**DO NOT ALLOW** totipotent / pluripotent **ALLOW** (adult stem cells) can, differentiate / specialise **Examiner's Comments** Many candidates knew that adult stem cells had the ability to differentiate to achieve mark point one in **Q22(c)(ii)**, but some contradicted their response by using the incorrect term, i.e. totipotent or pluripotent.
			Total	**5**	
5 2		i	**U** matrix ✓ **W** crista(e) / <u>inner</u> (mitochondrial) membrane ✓ **Z** <u>inter</u>-membrane space ✓	**3**	**IGNORE** ETC / ATP synthase / cytochromes **ALLOW** <u>inter</u>-membranal space **Examiner's Comments** **Q19(c)(i)** was generally well-answered although some candidates failed to interpret the diagram correctly and gave totally irrelevant structures as their answers. The most common mistake was failing to identify the inter-membrane space or referring to it as the inner-membrane space.

		i i	cyanide, prevents / AW, aerobic respiration **AND** fluoride, prevents / AW, anaerobic respiration (which also prevents aerobic respiration) ✓	**1**	*BOTH statements required for one mark* **IGNORE** 'affects' throughout **ALLOW** link reaction / Krebs cycle / ETC / oxidative phosphorylation instead of aerobic respiration **ALLOW** cyanide allows, glycolysis / anaerobic respiration **ALLOW** prevents, all respiration / both stages of respiration **IGNORE** lactate fermentation **Examiner's CommentsQ19(c)(ii)** saw some strong responses with candidates using data to support their answer even though it was not required. Weaker candidates gave vague answers about how fluoride and cyanide 'affected' respiration or repeated the information in the table without attempting a conclusion.
			Total	**4**	
53			A ✓	1 (AO 1.1)	
			Total	**1**	
54			C	1 (AO 1.2)	
			Total	**1**	
55		i	*embryonic stem cells* (are) undifferentiated / not specialised ✓ (are) a renewing source of cells / AW ✓ (can) differentiate into any cell <u>type</u> (of the developing foetus) ✓	2 max (AO 1.2)	**ALLOW** have ability to divide continually **ALLOW** can form all <u>types</u> of cells
		i i	*not totipotent stem cells* as cannot form whole organism ✓ cannot give rise to extra-embryonic tissues / AW ✓	2 max (AO 2.1)	**ALLOW** are pluripotent **ALLOW** cannot form any, cell / tissue, type Eg have already differentiated a bit (into embryo cells) e.g. umbilicus / placenta / amnion

			named example of tissue not formed ✓		
			Total	**4**	
56		i	C and F and I and J ✓	1 AO1.2	**ALLOW** the correct terms written instead of letters
		ii	I and J ✓	1 AO1.1	**ALLOW** the correct terms written instead of letters
		iii	A and E and G and H ✓	1 AO1.2	**ALLOW** the correct terms written instead of letters
		iv	F ✓ one / few , types of cell performing a function ✓	2 AO2.1 AO1.1	**ALLOW** mucous membrane **IGNORE** J **ALLOW** examples of cells involved if one or few types is implied **ALLOW** similar cells doing the same job
			Total	**5**	
57			A ✓	1 (AO 1.1)	
			Total	**1**	
58		i	to provide, lots of / much, energy / ATP ✓	1 (AO 2.1)	**DO NOT ALLOW** make / produce energy. **ALLOW** cell, needs / uses, lots of, energy / ATP
		ii	Golgi apparatus ✓ to, modify / process / package, protein ✓ ref. vesicles / secretion (of mucus) / exocytosis ✓	2 max (AO 2.1)	**ALLOW** smooth endoplasmic reticulum / SER **ALLOW** lipid / triglyceride, synthesis (for smooth ER)
			Total	**3**	
59		i	**E1** (erythrocytes / neutrophils, formed in the) spleen **C1** (formed in) bone marrow ✓ **E2** (ciliated epithelial cells in) blood vessels **C2** in, trachea / bronchi / bronchioles / airways / lungs / respiratory system / oviducts / central canal of spinal cord ✓	3 (AO 2.1)	**E1 ALLOW** erythrocytes / neutrophils (formed in the spleen) **C1 ALLOW** lymphocytes (are formed in spleen) **E2 ALLOW** ciliated (epithelial cells in blood vessels) **C2 ALLOW** squamous (epithelial / endothelial, cells in blood vessels) **DO NOT ALLOW** digestive system / ileum **E3 ALLOW** (cell wall thickest) on side furthest from

			E3 cell wall thickest (on side furthest from stoma) **C3** cell wall thin(ner) (on side furthest from stoma) ✓		stoma **C3 ALLOW** (cell wall thick(er)) on, inner side / side nearest stoma
		ii	**FIRST CHECK ANSWER ON ANSWER LINE** *correct answer = 2 marks* 35.7 ✓ ✓ *1 mark for working if final answer wrong:* (normal production = 1.6 x 73 x 24) = 2803.2 / 2803 ✓ or (difference = 3804 – 2803.2) = 1000.8 / 1001 ✓	2 (AO 2.6)	**ALLOW** figure in range 35.4 – 36 with up to 3 dp correct for working shown **ALLOW** (hospital production rate = 3804 ÷ (73 x 24)) = 2.17 or **ALLOW** (difference in rate = 2.17 – 1.6) = 0.57
		iii	For answers marked by levels of response: Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. **The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. **The lower mark** should be awarded	6 max (AO 1.1)	**Indicative scientific points may include the following:** ***erythrocyte / red blood cell*** biconcave / flattened, disc no nucleus contain haemoglobin flexible shape 7.5 µm diameter 2.0 µm thick ref. contain carbonic anhydrase transport oxygen transport carbon dioxide move / squeeze, through, blood vessels / capillaries space for, oxygen / haemoglobin, maximised large surface area to volume ratio short diffusion distance to, centre of cell / all haemoglobin ***neutrophil / white blood cell*** granular cytoplasm many lysosomes hydrolytic / digestive, enzymes can change shape / diapedesis / phagocytosis 10-14 µm diameter immune response innate / non-specific / inflammation destroy / engulf, (named) pathogens / bacteria move to site of infection / wound

			where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. **In summary:** • The science content determines the level. • The communication statement determines the mark within a level. **Level 3 (5–6 marks)** Full and detailed description of how each cell's specialised structure is suited to function: erythrocytes, neutrophils, squamous (epithelial) cells and ciliated (epithelial) cells. Candidate demonstrates a good understanding of the specialised features in **all** of these cells, **and** how these features make the cells suited to their specific function. *There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.* **Level 2 (3–4 marks)** A correct feature for each type of cell stated and linked to function of cell. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1–2 marks)** Some features correctly linked to a cell type. The linking of structure to function in outline only. *The information is communicated*		***squamous (epithelial cells)*** flattened shape very thin / (form layer) one cell thick fit together, tightly / like a pavement for rapid diffusion / short diffusion distance of, oxygen / carbon dioxide / gases, at alveoli / lungs / blood vessels ***ciliated (epithelial cells)*** have cilia / 'hair like' structures which, move / beat in rhythm to move mucus and trapped, pathogens / dust / debris from, lungs / (named) airways to move, ovum / egg from ovary / to uterus / to site of fertilisation to move cerebrospinal fluid / ventricular fluid multilobed nucleus **Examiner's Comments** On this question candidates varied in their knowledge of the features of a good biological drawing, but the main guidelines (title, scale, no shading, do not overlap label lines) are easily taught.  **OCR support** The Biology Drawing skills handbook provides support with this: https:/www.ocr.org.uk/Images/251799-biology-drawing-skills-handbook.pdf

			with only a little structure. Communication is hampered by the inappropriate use of technical terms. **0 marks** No response or no response worthy of credit.		
			Total	**11**	
60	a	i	(similar) cells working together with, common / same / similar, (named) function ✓	1	Need to see both 'working together' **and** 'same function' The named function must be storage of starch or photosynthesis **Examiner's Comments** This question is asking for a definition of a tissue in the context of the parenchyma. Many candidates gave a detailed definition although some candidates did not include the idea that the cells are working together.
		i i	Q is phloem ✓ S is xylem ✓	2	**Examiner's Comments** This question should have been straightforward recall for candidates that were familiar with images or slides showing a cross section of a stem. Most candidates managed to interpret the photomicrograph accurately. Some less able candidates named other tissues and were presumably simply writing any name they could recall.
	b		cambium / meristem(atic)	1	**Examiner's Comments** Again, the majority of candidates were able to name the cambium or stated 'meristem'.
			Total	**4**	
61			***2 max for sources*** embryonic / embryo ✓ fetus / fetal ✓ umbilical cord (blood) ✓ (adult) bone marrow (tissue) ✓ convert somatic cell into pluripotent cell ✓ ***ethical issue – must relate to one of their stated sources***	**2 max** **2**	**ACCEPT** e.g. breast milk / muscle / liver / placenta / etc. **ACCEPT** blastocyst **Note:** list of issues is not exhaustive – credit a well expressed issue

			ethical issue identified – such as 1 from the list below ✓ *embryonic* **E1** embryo, destroyed / killed / discarded **E2** use of excess embryos from assisted fertilisation **or** (IVF) **or** **E3** debate about when life begins **or** **E4** embryo cannot give consent **or** **F1** obtained from, miscarried / aborted, fetuses *fetal* **or** *umbilical cord* **U1** detached from infant at birth anyway **or B1** harvesting bone marrow is, painful / risky *bone marrow* **B2** donor babies / **or** babies conceived specifically to provide a bone marrow transplant for a sibling (with a condition requiring the transplant) a statement indicating, judgement / opinion / understanding, of this ethical issue ✓		**F1 IGNORE** ref to obtaining fetal stem cells by killing fetus but can still access the judgement mark Can only be awarded once the issue relating to one of their sources has been identified. **IGNORE** 'playing God' as an opinion **Examiner's Comments** Most students were able to identify two correct sources of stem cells and also discuss an ethical issue associated with their use. Some students did not link the ethical issues they were discussing with the source of the stem cells, e.g. confusing embryo with fetus. There was also frequent inclusion of information which was irrelevant to the question, describing the properties of stem cells and why they were used, rather than focusing on naming the sources and discussing the ethics of their use. Most candidates gave embryo and bone marrow as their two sources and discussed (successfully on the whole) the ethics of embryo use. Some mentioned fetal or umbilical sources but incorrectly suggested that the fetus either needed to be killed or cells removed during invasive surgery without realising that they would only be obtained from miscarried or aborted fetuses.

			Total	**4**	
6 2		i	*advantages* A1 more space for / can contain more / can carry more, haemoglobin / oxygen ✓ A2 can squeeze through capillaries easily ✓ *disadvantages* D1 limited life span / cannot divide / cannot reproduce / cannot undergo mitosis ✓ D2 no, protein synthesis / repair ✓ D3 no respiration, in / by, mitochondria **or** no mitochondria for respiration **or** limited respiration / no aerobic respiration / only anaerobic respiration ✓	max 2	Mark **first answer** only for advantage and disadvantage. A1 **DO NOT CREDIT** in context of larger surface area **ACCEPT** 'Hb' for haemoglobin D1 max time of 120 days / 4 months D3 **DO NOT CREDIT** 'no mitochondria so no respiration' (as some respiration will still take place) **ACCEPT** 'ATP release' or 'energy provided' instead of 'respiration' e.g. no energy being provided from mitochondria ATP is not released by mitochondria **DO NOT CREDIT** ref to producing / creating, energy **Examiner's Comments** Most candidates stated that lack of a nucleus left more space for oxygen/haemoglobin but a significant number referred wrongly to an increase in surface area. The short life span of erythrocyte was commonly stated as a disadvantage but very few candidates realised their inability to carry out protein synthesis. Many candidates simply re-stated that erythrocytes had no membrane-bound organelles or a nucleus without any further qualification. A common misunderstanding was that the erythrocyte would be unable to respire, failing to realise that anaerobic respiration does still take place. A significant number said that erythrocytes would be unable to defend themselves from infection without a nucleus, or could not control cell activities or what entered or left the cell.
		i i	*virus* virus is unable to / cannot, replicate / reproduce, on its own / outside a	2	**IGNORE** ref to the erythrocyte not having membrane-bound organelles without ref to the need of the virus to use them inside the cell Must be a clear statement **ACCEPT** needs / has to use, host cell to, replicate / reproduce

			host cell **or**virus requires host cell, machinery / DNA / RER / ribosomes, for protein synthesis **or** virus does not contain, RER / ribosomes, for protein synthesis ✓ ..... *Plasmodium* *idea that Plasmodium is* using the host cell to hide from the immune system **or** for *Plasmodium* to complete its life cycle **or** for *Plasmodium* to use as a source of food (for, growth / reproduction) ✓		**ACCEPT** 'malarial pathogen' for *Plasmodium* **IGNORE** eukaryotic / protoctist **IGNORE** it has its own, DNA / nucleus / protein synthesis apparatus **IGNORE** ref to just, part / stage, of life cycle **IGNORE** ref to organelles **Examiner's Comments** This was a challenging question for many, and several failed to specify which organism they were talking about. Candidates often understood that viruses couldn't use erythrocytes for reproduction but failed to make the link that viruses must use the host cell to replicate. Candidates restated the question describing that part of the Plasmodium life cycle took place in the red blood cell but failed to realise it did not complete its life cycle. Commonly, candidates said that the Plasmodium used the erythrocyte for transport and as a source of oxygen. Many candidates spoke of Plasmodium using the erythrocyte because it is injected directly into the blood by the mosquito. Only the most able candidates described how Plasmodium could evade the immune response within the red blood cell.
		iii	1 oxygen is bound to haemoglobin (while being transported) ✓ 2 lack mitochondria ✓ 3 (therefore) no aerobic respiration ✓ 4 (moved by mass flow so) doesn't	2	1 **ACCEPT** 'it' for 'oxygen' **ACCEPT** 'Hb' for haemoglobin 3 **ACCEPT** only respires anaerobically **IGNORE** ref to energy 4 **DO NOT CREDIT**' does not need, energy / ATP' unqualified

			need, energy / ATP, to move **or**needs less, energy / ATP (for metabolic processes) ✓		**DO NOT CREDIT** ‘makes / produces, energy’ **Examiner's Comments** Most candidates scored 1 mark for lack of mitochondria although some candidates just referred to no organelles or no organelles for respiration. Very few candidates made the connection with aerobic respiration and the majority of candidates believed that erythrocytes could not respire at all and just had a completely passive role. Many candidates referred to the pointless nature of using the oxygen that they are supposed to be carrying to other tissues, more of a philosophical attitude than biological one.
			Total	**6**	
6 3	a		lamella	1	**ALLOW** lamellae.
	b		*three from* many / AW, lamellae / structure A, provide large surface area (1) (presence of) secondary lamellae on main lamellae provide large surface area (1) short distance between blood and, water / outside (1) idea that blood maintains diffusion gradient (1) *any of above linked to* faster diffusion (of oxygen, carbon dioxide) (1)	4	**ALLOW** only if linked to another marking point. **IGNORE** refs to squamous cells as not visible on Fig. 1.1.
	c		*three from* tissue has, one / few, types of cell **and** performs, one / few, functions (1) *idea that* bone has, one / few, types of cell **or** *idea that* bone performs, one / few, functions (1) organs consist of several tissues (1) gills contain two or more **named** tissues (1)	3	**ALLOW** bone, blood, epithelial, connective.

			Total	**8**	
6 4			*Type of cell* stem (cells) (1) *Description - any three from,* by differentiation (1) (cell) elongation (1) deposition of lignin / lignification (of cell walls) (1) end walls break down (1)	4	
			Total	**4**	