Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		nucleus ✓ cytokinesis ✓ synthesis / S ✓ DNA , damage / breaks ✓ second growth / G_2 ✓ resting phase / G_0 (phase) ✓(	6 max (AO 1.2)	**ALLOW** cell division **IGNORE** correct DNA / mutation / errors **ALLOW** second gap **ALLOW** apoptosis **Examiner's Comments** This question differentiated well between candidates, with most candidates gaining 2-3 marks. Many found the first gap difficult by not recognising that mitosis is nuclear division and not cell division. More recognised that cytokinesis is the step that follows mitosis. A good number of candidates also named the S, or synthesis, phase as the step where the replication of DNA takes place. Very few candidates were able to correctly identify an event that occurred in both G_1 and G_2 phases in addition to checking for cell size. DNA replication is checked for mutations (a common incorrect suggestion) after the S phase, so this does not occur in G_1. DNA is checked for damage or breaks in both G_1 and G_2. Many candidates knew that the second checkpoint was at the end of G_2. Even more knew that the phase a cell enters when the checkpoint is failed is G_0 or the resting phase (or state). A common incorrect response for the final gap was 'death phase'.
	b	i	telophase ✓	1 (AO 2.7)	**Examiner's Comments** The image shows two clear darkened areas at each pole where the chromosomes have begun to cluster, which happens just before the nuclear envelope is reformed, and individual chromosomes are no longer clearly identifiable. These are clearly signs

					that the cell is in telophase, but 'anaphase' was a much more common candidate response. If the cell were in anaphase, it would show the sister chromatids being separated or the chromosomes migrating towards each pole. The chromosomes would be clearly distinguishable in a 'V' shape.
		ii	single area of dark (staining material) ✓ (individual) chromosomes not visible ✓ (nuclear material) not <u>as</u> dark ✓	2 max (AO 2.7)	**IGNORE** nuclear envelope visible **ALLOW** one / a / the , nucleus visible **IGNORE** present **ALLOW** chromatids not visible **IGNORE** thinner / in nucleus / not in two groups **<u>Examiner's Comments</u>** Many candidates missed the thrust of this question which was about how the image would look different. Around a quarter of responses achieved a mark, usually for noting that the chromosomes would no longer be visible. Simply stating that the chromosomes would not be condensed does not describe how they look. Some candidates stated that the chromosomes would be in the nucleus, but few went on to describe its appearance - that a single nucleus would be visible or that there would be a single central area of dark staining. It was rare to see a description of the nuclear material not being as dark.
		iii	many dividing <u>cells</u> / <u>cells</u> undergo frequent mitosis ✓	1 (AO 3.3)	**IGNORE** meristem tissue **<u>Examiner's Comments</u>** Most responses had the right idea that the correct answer was about high levels of mitotic activity but many of those candidates were let down by a lack of precision in their answers. Many wrote 'it' is undergoing frequent mitosis and in this context 'it' would be the tissue and not the cells. It was essential that candidates presented mitosis only as a process occurring in a cell.

	c	i	chromosomes / chromatin (fibres) , coil / condense ✓ spindle fibres form ✓ nucleolus disappears ✓	2 max (AO 2.5)	**ALLOW** chromosomes thicken **IGNORE** DNA condenses **IGNORE** ref to chromatids **ALLOW** centrioles move to , poles / end of cell **Examiner's Comments** Most candidates gained some credit in this question, which differentiated well between candidates of differing abilities. The most common correct answers addressed either or both of the first two marking points.
		ii	*In meiosis…* only one chromosome from each homologous pair is present ✓ **ora** sister chromatids not genetically identical / recombinants present (due to crossing over) ✓ **ora**	1 (AO 2.5)	**ALLOW** chromosomes already condensed in meiosis **IGNORE** bivalents / chromatids **IGNORE** refs to haploid / diploid **Examiner's Comments** Although many had the right idea here only those candidates who could phrase their answers unambiguously using precise technical terms achieved the mark, and fewer than 1 in 10 did. Many responses stated, or implied, that crossing overtakes place in prophase 2 of meiosis and were not given.
	d		**FIRST CHECK ON ANSWER LINE** **If answer = 116 (min) award 2 marks** *calculate proportion of cells undergoing mitosis* (16/124 =) 0.129 ✓ *calculate time represented by that proportion of cells, convert to minutes* ***and*** *answer to 3 significant figures* (0.129 x 900 =) 116 min ✓	2 max (AO 2.5)	**ALLOW** 1 mark for 1.93 h or 1 h 56 min **ALLOW** 1 mark for 0.129 or 12.9% **Examiner's Comments** Around half of candidates scored here. Although many struggled with principle of converting a proportion of cells to a proportion of time, the vast majority of candidates coped with the change of units. *Calculation:* 16/124 = 0.129 15 hours = 900 minutes 0.129 x 900 minutes = 116 min

			Total	**15**	
2		i	(they can) differentiate into, specialised / specific, cells / AW✓	1	**IGNORE** 'they are, undifferentiated / unspecialised unqualified **ALLOW** develop / change / divide / form, for differentiate **ALLOW** pluripotent / multipotent **IGNORE** totipotent e.g. 'they can specialise into, many / any, different types of cell' e.g. 'they can differentiate into, pancreatic / β, cells' **IGNORE** 'grow into / turn into, specialised cells' **Examiner's Comments** Nearly all candidates recognised that stem cells are undifferentiated, with most continuing to say that they could differentiate to form many types of cells, to gain credit.
		ii	*idea that* type 1 diabetes is an autoimmune disease (so response against (any) β-cells would still occur) ✓	1	e.g. mistake **their own** new β-cells as foreign and attack them' **IGNORE** 'to stop the immune system attacking the cells' alone **Examiner's Comments** This proved to be a demanding question. Very few candidates seemed to notice that the new cells were from the patient, and more candidates referred to autoimmune disease in Question 5 (a) than in this question. Candidates were required to recognise that although the new cells came from the patient, the autoimmune response would need to be suppressed, as their own beta cells were regarded as foreign and therefore were being attacked.
			Total	**2**	
3			phloem ✓ differentiate ✓	2	**DO NOT ALLOW** 'phloem sieve tubes' **ALLOW** 'specialise' **Examiner's Comments** The vast majority of candidates achieved both marks for this question.

					Most identified phloem as the tissue. A very small number of candidates specified a specialised cell within phloem tissue and were not awarded the mark, because they had not acknowledged the word 'tissue' within their answer. The use of 'differentiate' and 'specialise' was equally observed. Typically, those that did not achieve both marks used the terms 'reproduce' or 'replicate' or 'grow' in place of the correct response.
			Total	**2**	
4			tissues are made of (a group/collection) cells **AND** organs are made of (two or more / a group /collection) tissues ✓	1	Must be clear that tissues are made of more than one cell and organs are made of more than one tissue **Examiner's Comments** Generally, candidates were able to define both terms well so many were given the mark.
			Total	**1**	
5	a	i	unzips, (DNA) double helix / strands / molecule ✓ breaks hydrogen bonds between the , two strands /(nitrogenous/complementary/named) bases / base pairs ✓	2	**ALLOW** unwinds **ALLOW** described for MP1 e.g. 'creates 2 separate strands of DNA' **Examiner's Comments** Some candidates were given 2 marks and some were given 1, suggesting the action of helicase is well known. Unzipping/unwinding was nearly always seen, but the most common mistake was not making it clear that there were two strands being separated and/or linking this to the DNA double helix. Many candidates missed out the breaking of Hydrogen bonds for the second mark.
		ii	mutation / described ✓ change in DNA (base) sequence / order of bases changed ✓ description of types of mutation (e.g. substitution / addition / deletion / frameshift / idea of wrong complimentary base pairs being matched up (during DNA replication)	2 max	e.g. spontaneous / random change **ALLOW** wrong nucleotide / base inserted e.g A pairs with G not T **DO NOT ALLOW** direct ref to transcription / RNA bases / A pairing with U e.g. radiation, (named) carcinogens, (toxic) chemicals, sunlight, UV

			etc.) ✓ e.g. exposure to (named) mutagen ✓		**Examiner's Comments** Most candidates were given 1 mark for correctly identifying mutations as a key term. Many candidates focused on incorrect complimentary base pairing but did not link this to the resulting DNA base sequence being different (i.e. suggesting that the base pairing was wrong but then not explaining that this leads to a different sequence of bases). A few candidates lost a mark by referring to transcription and RNA, possible due to not recognising the need to refer to DNA replication stated in the stem of the question.
	b		Checkpoint Z / M checkpoint / mitosis checkpoint ✓ because... chromosomes cannot have been, aligned correctly at the equator / attached correctly to the spindle **OR** not all chromatids have been, separated / pulled apart **OR** some chromatids have not been separated **OR** (daughter) cell did not receive correct number of, chromosomes/chromatids **OR** (daughter) cell received more than one copy of each chromosome/chromatid ✓	2	If wrong checkpoint given = 0 marks **ALLOW** non-disjunction **ALLOW** none / did not receive any **ALLOW** too many **Examiner's Comments** Only a few candidates were able to correctly identify checkpoint Z, and even less could be given an extra mark for explaining why. Many identified Yor X incorrectly, believing that the DNA had over replicated so too many chromosomes entered mitosis, which is not possible as if this was the case theother checkpoints would have stopped the cell cycle moving forward. More successful responses were able to make links to chromatids not being separated/chromosomes not attaching correctly to spindle fibres.
			Total	**6**	
6			D ✓	1	**Examiner's Comments** Most candidates correctly answered D and were able to make links between the features of the different stages of mitosis and the photomicrograph, and/or were familiar with images of the different stages of mitosis.

			Total	**1**	
7	a		growth (of organisms / tissues) **AND** repair (of organisms / tissues) ✓	1 (AO1.1)	Both answers required for 1 mark If more than two responses are given, **DO NOT AWARD** the mark if any of the responses is incorrect. **ALLOW** controlling body plan **ALLOW** clonal expansion / replacement of cells **IGNORE** stem cells **Examiner's Comments** This was expected to be a high-scoring question but only around half of candidates achieved the mark. Candidates who kept their answers simple and straightforward gained the mark but those who added unnecessary detail often included something that was incorrect and so the mark was not given. Many answers referred to the growth or repair of *cells* and so were not credited. Other commonly seen non creditworthy responses included 'cloning' (which was excluded by the word 'other' in the question) and 'differentiation'.
	b	i	produces genetically identical , cells / organisms ✓ maintains , chromosome / diploid , number (between generations) ✓	2 (AO1.2)	**ALLOW** ora for meiosis **ALLOW** offspring with identical genes **IGNORE** clones **IGNORE** produces diploid cells **Examiner's Comments** Around half of candidates gained the first marking point but many omitted the key word 'genetically'. Far fewer achieved the 2nd marking point and those that did often missed out on the first. Many answers spent time (and space) discussing the benefits of asexual reproduction in general, which this question did not ask for.

					Misconception A large minority of candidates thought that plants were unable to produce gametes or carry out sexual reproduction. **OCR support** Our delivery guide on 'Cell division, cell diversity, cellular organisation' offers and overview of the key concepts and suggested a range of classroom activities to support with the topic.
		ii	mitosis is nuclear division ✓ bacteria have no nucleus ✓ AVP ✓	2 Max (AO2.1)	**ALLOW** e.g., mitosis involves disintegration of nuclear membrane **IGNORE** chromosomes / plasmids **CREDIT** further detail, e.g. ref to absence of spindle fibres **Examiner's Comments** Around half of candidates scored 1 mark, usually for marking point 2. Other alternative valid points were regularly awarded but the first marking point was rarer. Only a few candidates were aware of the distinction between the main loop of DNA and plasmids in prokaryotes. Some candidates thought bacteria did not contain DNA.
			Total	**5**	
8			D ✓	1	
			Total	**1**	
9			C ✓	1 (AO1.1)	**Examiner's Comments** A lot of candidates selected the correct answer **C**. There was a significant minority of candidates who incorrectly chose option A, perhaps not noticing the important plural distinction of the word 'functions'.
			Total	**1**	

10			C ✓	1 (AO1.2)	**Examiner's Comments** Two thirds of candidates gave the correct response, **C**. The most common incorrect responses were options **A** and **B.**
			Total	**1**	
11			C ✓	1 (AO2.5)	**Examiner's Comments** Two thirds of candidates selected the correct response, **C**.
			Total	**1**	
12			D is, pyrimidine (base) / thymine, and, pentose sugar / deoxyribose ✓ (*B_9 deficiency causes*) fewer, nucleotides / pyrimidines / bases (available) ✓ DNA synthesis / DNA replication / S phase , slows / stops / incomplete ✓ (due to) less complementary base pairing with, purines / adenine (on template strand) ✓ does not pass G2 checkpoint / AW ✓	2 max (AO2.5)	**ALLOW** D is thymidine **IGNORE** cytosine **ALLOW** 'less D available' **DO NOT ALLOW** 'no D available' **IGNORE** guanine e.g. 'due to G2 checkpoint identifying the error' **Examiner's Comments** A relatively large proportion of candidates mentioned in their answers that DNA replication would be incomplete, scoring 1 mark. A small number of candidates did not attempt this question, some candidates scored no marks as they only gave a general description of what interphase is without including details of how the lack of B_9 would alter it. Many candidates suggested that 'no molecule D' could be produced, overlooking the wording in the stem ('deficiency'), which would suggest some D could be synthesised. Quite a few answers that described checkpoints did not specify the G2 checkpoint and therefore did not gain credit.
			Total	**2**	

13			Any two from **1** stem cells, differentiate/ specialise, into nerve cells ✓ **2** (these) can be added to replace (dopamine producing) nerve cells in the, substantia nigra/ brain ✓ **3** (so) dopamine levels will increase ✓ **4** would, stop it progressing / allow normal body movements ✓	Max 2 (AO1.1)	**2 ALLOW** they can be implanted into the, brain/substantia nigra **3 ALLOW** dopamine levels, go back to normal/ are restored **3 IGNORE** dopamine will become more active **4 IGNORE** regulate/improve, body movements **4 IGNORE** functions for 'movement' **4 ALLOW** regain control of body movements/ reverses the effects of Parkinsons **Examiner's Comments** The majority of candidates could define a stem cell as an undifferentiated cell and stated that it could specialise into a nerve cell. Few candidates went further with how these differentiated nerve cells could be used, jumping their answer from specialising into a nerve cell to treating Parkinson's disease. A few candidates stated that the stem cell could differentiate to dopamine, not appreciating that dopamine is a chemical not a cell. Some answers simply referred to stem cells turning into nerve cells.
			Total	**2**	
14	a	i	Mitosis/it **1** produces many cells (for growth of fragment) ✓ **2** (daughter) cells are genetically identical (to parent starfish)✓	2 (AO2.2)	**1 ALLOW** cell number increases/ continually produces cells **1 IGNORE** cells multiply / cells reproduce/ cells divide unqualified. **2 ALLOW** (mitosis) produces clones that are genetically identical **Examiner's Comments** Most candidates did state that daughter cells would be identical but did not say 'genetically' so did not use precise enough scientific terminology. Few candidates indicated that mitosis would give lots of cells that would be required for a starfish to form, limiting

					their answer to mitosis producing two cells.
		ii	Any one from growth ✓ repair / replacing lost arms ✓	Max1 (AO1.2)	**ALLOW** control of body plan **IGNORE** repair cells/ healing **ALLOW** replace, dead/damaged, cells **Examiner's Comments** This question was well answered. Some candidates referred to repair of cells. Candidates should appreciate that individual cells cannot be repaired by mitosis, they can only be replaced.
		iii	Any three from **1** crossing over **2** (crossing over in) prophase 1 ✓ **3** independent assortment of (homologous) chromosomes in metaphase 1 ✓ **4** independent assortment of (chromatids) in metaphase 2 ✓ **5** DNA/ gene / chromosome, mutation ✓	Max 3 (AO2.2 × 1) (AO2.5 × 2)	**ALLOW** mp1-3 for any correct description of prophase 1 or metaphase1/2 **3 ALLOW** random for 'independent' **4 ALLOW** random for 'independent' **Examiner's Comments** Most candidates stated crossing over although some could not recall the stage of meiosis when it occurs. Few candidates could describe independent assortment and did not appreciate the difference between chromosomes and chromatids in metaphase 1 and 2, respectively. No candidates stated that DNA could mutate to give variation.
	b		**FIRST CHECK ON ANSWER LINE** **If answer = 86 award 2 marks** 31 / 0.36 (= 86.11) ✓ 86 ✓	2 (AO2.6)	**ALLOW** for 1 mark Correct answer (if no workings shown) to more than 2 significant figures. **Examiner's Comments** This question was well answered although a few candidates did not attempt the question at all. Some candidates multiplied 31 by 0.36 and some candidates did not answer to two significant figures. Most candidates should clear steps in their workings.

					OCR support Correctly rounding values is discussed in maths skills handbook as well as the 'Maths for Biology' resources (Module 0).
			Total	**8**	
15	a		Any two from **F** tail / flagellum **AND** **R** (for) movement / swimming ✓ **F** (many) mitochondria **AND** **R** release / provide, energy/ATP, for, movement / swimming ✓ **F** acrosome **AND** **R** contains, hydrolytic/ digestive enzymes **OR** **R** (enzymes) allow sperm to penetrate ovum / to breakdown outer part of ovum ✓	Max 2 (AO2.5)	**Feature must match the role** e.g. *sperm cell has flagellum and mitochondria that provide energy for the cell to move = 2 marks* **IGNORE** break the egg membrane **ALLOW** sperm to fuse with the egg for 'sperm to penetrate ovum' **Examiner's Comments** This question was well answered with most candidates achieving both marks. A few answers referred to the acrosome as an enzyme rather than a structure that contains enzymes. The outer layers of the egg were sometimes referred to as a membrane or cell wall.
	b		Any two from **F** (many) chloroplasts **AND** **R** for, photosynthesis/ light absorption ✓ **F** cylindrical/ rectangular, shape **AND** **R** can be closely packed to form continuous layer ✓ **F** thin cell wall **AND** **R** (increase) diffusion of carbon dioxide / (greater) light penetration ✓ **F** Large vacuole **AND** **R** to maintain turgor pressure / push chloroplasts to edge **OR** **R** to store the, cell sap/ sugars made in photosynthesis ✓	Max 2 (AO2.5)	**Feature must match the role** **ALLOW R** shorter distance for, gas exchange / carbon dioxide **IGNORE** to keep cell rigid for 'maintain turgor pressure' **Examiner's Comments** Most candidates achieved 1 mark, usually for the role of chloroplasts in photosynthesis. Many answers did refer to all the components in the picture and attempted to give roles for all of them. Candidates should be reminded that the mark total is an indicator of the level of detail required.
			Total	**4**	

16			*idea that* sponges produce, genetically identical offspring / clones ✓ *idea that shark offspring will not be,* genetically identical / clones ✓ shark offspring have alleles from only, the mother / one parent ✓ (but) crossing over / independent assortment, (in meiosis) creates, new allele combinations / genetic variation ✓	max 3(AO3.2)	e.g. offspring of sponges share same, DNA / genome / genetic material **IGNORE** 'similar DNA' 'only sponges, produce clones of themselves / share same DNA' = 2 marks **ALLOW** 'shark offspring have, DNA / genetic material, only from the mother' **IGNORE** 'changes the DNA' **Examiner's Comments** Strong responses provided an evaluation of the student statement that both animals produce clones of themselves by naming each animal in turn and discussing whether the claim was justified. Candidates with a sound understanding of mitosis and meiosis responded correctly that *A. aerophoba* (the sponge) produces clones but that *S. fasciatum* (the zebra shark) does not. For *S. fasciatum* strong responses explained that new allele combinations form due to crossing over or independent assortment in meiosis. Many candidates realised that production of gametes involved meiosis but did not gain marks by not linking it to crossing over or independent assortment or just saying that it produced variation rather than genetic variation. **Misconception** Less successful responses stated that meiosis generates genetic variation by mutation. Most mutation occurs in DNA replication during S phase of the cell cycle and the mutation rate will be the same preceding mitosis or meiosis. The processes that 'reshuffle' pre-existing alleles to give new genetic combinations in meiosis are a different source of genetic variation to the mutation events that change the DNA sequence to give brand new alleles.
			Total	**3**	

17		i	(X) (T or B) lymphocyte ✓ (Y) neutrophil ✓	2(AO2.3)	**ALLOW** T cell / B cell / T helper cell / T killer cell / T regulator cell **ALLOW** phagocyte **Examiner's Comments** Most candidates only got 1 mark for correctly naming Y as a neutrophil. The most common errors were incorrectly naming X as a macrophage or monocyte, with few candidates correctly identifying it as a lymphocyte.
		ii	flattened / biconcave (shape), to increase surface area (to volume ratio) ✓ no, nucleus / organelles, to give (more) space for haemoglobin ✓ flexible, to increase surface area in contact with capillary wall / to squeeze through capillaries ✓ small, for short diffusion pathway / to fit through capillaries ✓ transport proteins in plasma membrane, to allow chloride shift ✓ high concentrations of carbonic anhydrase (inside cells), to allow transport of carbon dioxide / described ✓	2 max(AO1.1)(AO2.1)	**IGNORE** concave **ALLOW** few organelles so more haemoglobin can be in the cell **IGNORE** to give (more) space for oxygen 'cells are small and flexible to fit through capillaries' = 2 marks **Examiner's Comments** This question was generally answered well by a wide range of candidates. Common errors included omitting 'bi' from 'biconcave' and describing the lack of a nucleus as giving more space for oxygen (rather than haemoglobin). Some candidates lost marks for linking an adaptation to the wrong benefit, especially biconcave with being able to fit through capillaries, rather than increasing surface area.
		iii	**FIRST CHECK ON ANSWER LINE** **If answer = 13 award 2 marks** 10 mm / 800 (= 0.0125mm) ✓ 0.0125mm × 1 000 (= 12.5μm) ✓	2(AO2.8)	**ALLOW** 12.5 for 2 marks **ALLOW** answer to more than 3 s.f. for 1 mark **ALLOW ECF** if incorrect measurement of cell W **with units** used but divided by 800 for 1 mark **or** measurement of cell W **with units** correctly converted to μm for 1 mark **ALLOW** 0.01m / 800 (= 0.0000125m) **and** 0.0000125m x 1 000 000 (= 12.5μm) **ALLOW** 1cm / 800 (= 0.00125cm) **and** 0.00125 × 10 000 = (12.5μm)

					If candidate measures cell W as 9.5 mm **ALLOW 12 /11.9 for 2 marks and 11.88/11.875 for 1 mark** **If candidate measures cell W as 10.5 mm** **ALLOW 13 /13.1 for 2 marks and 13.13 / 13.125 for 1 mark** **Examiner's Comments** About half of candidates gained the full 2 marks for this question. Marks were most often lost for measuring in cm then an incorrect conversion to micrometres – most multiplying by 1000 rather than 10,000. Candidates who showed working, including the measurement of the diameter with units divided by 800, could access 1 mark even if their final answer was incorrect.
			Total	**6**	
18	a	i	**1** (named) protein, synthesis / made ✓ **2** (named) organelle, replication / synthesis ✓ **3** energy stores increase ✓ **4** (replicated / new) DNA checked for errors ✓ **5** DNA repair ✓	1 max (AO1.2)	**1** e.g. tubulin **2** e.g. mitochondria **2 ALLOW** G2 checkpoint to ensure enough organelles **3 ALLOW** G2 checkpoint to ensure enough energy stores **Examiner's Comments** Cell division and growth were explored in the context of the growth in a stag beetle larva. Many candidates identified organelle synthesis and checking DNA for errors as processes that take place during G2 of the cell cycle. The commonest incorrect response was stating that DNA replicates at this point, despite the diagram showing the 'S' phase preceding G2.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3 award 1 mark** 3 ✓	1 (AO2.2)	**ALLOW** answer given on **Fig. 2.1** **ALLOW** an answer anywhere between 2 and 4 **Examiner's Comments** Some candidates calculated the slope

<table>
<tr>
<td></td><td></td><td></td><td></td><td></td>
<td>of the relationship from two data points on the graph and used the equation to find ‘c’, but the easier method was to join the points on the graph and to read off the intercept at time 0 to find the length of the larva at year 0. Many candidates did not recognise that the equation simply means that the relationship is a straight line relationship, allowing one to join the points with a ruler to find the intercept.</td>
</tr>
<tr>
<td></td><td></td><td>iii</td>
<td>FIRST CHECK THE ANSWER ON ANSWER LINE
If answer = 18 (mm year^{-1}) award 2 marks
$\frac{110-21}{6-1}$ OR $\frac{89}{5}$ ✓
18 ✓</td>
<td>2
(AO2.2)</td>
<td>ALLOW data from any pair of years to calculate growth rate (change in y axis ÷ change in x axis). E.g. working & answer OR correct answer alone for 2 marks
<table>
<tr><td>year</td><td>0</td><td>1</td><td>3</td></tr>
<tr><td>1</td><td>$\frac{21-3}{1}$
= 18.0</td><td></td><td></td></tr>
<tr><td>3</td><td>$\frac{56-3}{3}$
= 17.7</td><td>$\frac{56-21}{2}$
= 17.5</td><td></td></tr>
<tr><td>6</td><td>$\frac{110-3}{6}$
= 17.8</td><td>$\frac{110-21}{5}$
= 17.8</td><td>$\frac{110-56}{3}$
=18.0</td></tr>
</table>
ALLOW answer given to 3 significant figures as shown (2 marks)
If answer given to more than 3 sig. fig. max 1 mark
ALLOW ECF from candidate’s 2(a)(ii) figure for year 0
ALLOW calculations from variant y axis readings as shown:
<table>
<tr><td>year</td><td>length (mm)</td></tr>
<tr><td>0</td><td>2 or 4</td></tr>
<tr><td>1</td><td>20.5</td></tr>
<tr><td>3</td><td>56.5</td></tr>
<tr><td>6</td><td>109.5</td></tr>
</table>
e.g. (yrs 6 and 1) 110 − 20.5 = 89.5 and 89.5 ÷ 5 = 17.9 OR
109.5 − 21 = 88.5 and 88.5 ÷ 5 = 17.7
109.5 − 20.5 = 89 and 89 ÷ 5 = 17.8

<u>Examiner’s Comments</u>

To calculate the growth rate of the larva candidates needed to find the gradient of the line using the formula:

$\text{gradient} = \frac{\text{change in } y}{\text{change in } x}$</td>
</tr>
</table>

					The most common error was to forget that the line intercept was not 0, that is, when the larva hatched from the egg its size was not nothing (answers for part (i) between 2 and 4 mm were allowed). Therefore taking a single plotted point and dividing *y* by *x* overestimated the slope of the line. The commonest wrong answer of this type was 110/6 = 18.3. **Assessment for learning** This question could be used in teaching in conjunction with the Biology Mathematical Skills Handbook dealing with M3.5 on page 54.
	b	i	(position / arrangement, of) chromosomes visible ✓	1 (AO2.7)	**ALLOW** chromosomes, different colour to cytoplasm / contrast with rest of cell / show up / stand out, for 'visible' **ALLOW** to, identify / distinguish, chromosomes **ALLOW ORA** 'otherwise we could not see chromosomes' **ALLOW** chromatids / genetic material / DNA / chromatin, for 'chromosomes' **Examiner's Comments** Most candidates realised that staining made the chromosomes visible.
		ii	chromosomes lined up at, equator / metaphase plate ✓	1 (AO3.1)	**ALLOW** middle (of cell) for 'equator' **ALLOW** pairs of sister chromatids for 'chromosomes' **Examiner's Comments** Most candidates described the chromosomes lining up at the equator of the cell as showing metaphase.
		iii	**all** columns with informative headings ✓ stages of mitosis in correct order ✓	2 (AO3.2)	**IGNORE** data in table. **OR**

Stage (of mitosis)	Number of cells (counted)		
	Student 1	Student 2	Student 3
Prophase	3	5	2
Metaphase	1	0	5
Anaphase	3	4	0
Telophase	0	1	3

Student	Number of cells (at stage of mitosis)			
	Prophase	Metaphase	Anaphase	Telophase
1	3	1	3	0
2	5	0	4	1
3	2	5	0	3

ALLOW Trial / test, for 'Student'
ALLOW Amount for 'Number'
ALLOW Phase for 'Stage'
ALLOW student 1, student 2, student 3 on left in 2nd table

Examiner's Comments

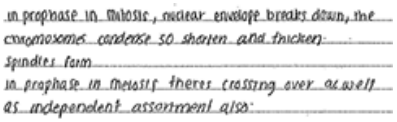
Very few candidates were able to design an appropriate table. Too frequently candidates were not providing informative column headings, not giving all the required information within the table itself, not enclosing the table in a box (or the box provided) and not showing the stages of mitosis in the correct order. Candidates should be encouraged to draw tables for their results from class practical experiments rather than relying on pre-printed worksheets to fill in the data. The table on page 4 of the exam paper could have been taken as a model for the task; in this example the dependent variable column was subdivided to show three trials in the same way that 'number of cells in each stage' results from three students needed to be plotted in Question 2 (b) (iii). The published mark scheme shows two ways of arranging the table, with the top version being a better match to the principle of putting the independent variable in the left-hand column. The principles of drawing a table are shown in the checklist below.

OCR support

This checklist for producing tables can be found in the 'Learner Checklist: Graphs, Tables and Drawings' here: https:/www.ocr.org.uk/qualifications/as-and-a-level/biology-a-h020-h420-from-2015/planning-and-teaching/

1	All raw data in a single table with ruled lines and border.	
2	Independent variable (IV) in the first column; dependent variable (DV) in columns to the right (for quantitative observations) OR descriptive comments in columns to the right (for qualitative observations).	
3	Processed data (e.g. means, rates, standard deviations) in columns to the far right.	
4	No calculations in the table, only calculated values.	
5	Each column headed with informative description (for qualitative data) or physical quantity **and** correct units (for quantitative data); units separated from physical quantity using either brackets or a solidus (slash).	
6	No units in the body of the table, only in the column headings.	
7	Raw data recorded to a number of decimal places appropriate to the resolution of the measuring equipment.	
8	All raw data of the same type recorded to the same number of decimal places.	
9	Processed data recorded to up to one significant figure more than the raw data.	

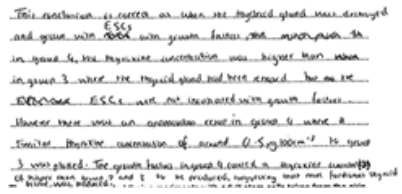
	c		*any three similarities from:* **S1** chromosomes consist of two (sister) chromatids ✓ **S2** chromosomes / chromatids, condense ✓ **S3** nuclear, envelope / membrane, breaks down ✓ **S4** centrioles move to opposite, poles / ends of the cell ✓ **S5** spindle (fibres) form(s) ✓ *any three points unique to meiosis (differences):* **D6** meiosis has, prophase 1 and 2 / two prophases ✓	4 Max (AO2.5)	**S2 ALLOW** nucleolus disappears **S4 ALLOW** centrosomes for 'centrioles' **D8 DO NOT ALLOW** crossing over between sister chromatids **Examiner's Comments** Most candidates were able to recall features of prophase in mitosis and meiosis but not all candidates

			D7 homologous chromosomes pair / bivalents form / synapsis occurs, in prophase (1) ✓ **D8** crossing over occurs / chiasma(ta) form, in prophase (1) ✓ **D9** in prophase 2 chromatids are genetically different ✓		responded to the command word 'compare'. **Making a comparison** The command word 'compare' covers **similarities** and **differences**. Comparing is a skill that involves **selecting** and **organising** factual knowledge. Ideally similarities should be clearly stated in the format '**both** processes show….' Differences should be paired, e.g. 'In meiosis … **does** happen but in mitosis … **does not** happen'. In terms of knowledge, the most well-known facts were that chromosomes condense, the nuclear envelope breaks down and the centrioles move to the poles of the cell in both processes. The differences most often mentioned were the existence of two prophase stages in meiosis and mention of crossing-over in prophase 1 of meiosis. Some candidates missed out on marks by listing what happens in mitosis but not stating that the same also happens in meiosis (see exemplar 2). Some wasted valuable time in the examination by writing out two separate paragraphs with the same content for mitosis and then meiosis. Exemplar 2  in prophase in Mitosis, nuclear envelope breaks down, the chromosomes condense so shorten and thicken. spindles form in prophase in meiosis theres crossing over as well as independent assortment also. This response shows limited examination technique, with recalled facts not earning marks. The candidate did not draw a comparison by saying that the described events in mitosis also happen in meiosis. This response scored one mark but if the candidate had used the word both, or said for the first paragraph that 'the same happens in meiosis', they would have scored all 4 marks.
			Total	**12**	
19		i	phagocyte / neutrophil ✓	1 (AO1.1)	**ALLOW** (non-human) macrophage **IGNORE** leucocyte / white blood cell

					Examiner's Comments Many candidates named the cell correctly as phagocyte or neutrophil. Macrophage was accepted although in humans, macrophages are larger than this cell (the diameter of which was calculated in part (ii)). The most frequently written incorrect response was the general term 'white blood cell'.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 14 or 15 (μm) award 2 marks** 14mm ÷ 950 = 0.0147mm ✓ 0.0147 × 1000 = 15μm ✓	2 (AO2.8)	**ALLOW** answer given to **3 significant figures for 2 marks** e.g. 13.7 / 14.2 / 14.7μm If answer given to **more than 3** sig. fig. **max 1 mark** **ALLOW** (13 000 ÷ 950) = 13.7μm **for 2 marks** **ALLOW** (13 500 ÷ 950) = 14.2μm **for 2 marks** If final answer incorrect **award 1 mark** for **two clearly shown** correct steps in working (other than 1 plus 4). **IGNORE** crossed-out working. **steps in working**: **1** (diameter with units =) 13 / 13.5 / 14mm **OR** 1.3 / 1.35 / 1.4cm **2** divide by 950 **3** convert **EITHER** original diameter **OR** answer to μm (mm → μm × 1000, cm → μm × 10 000) **4** round to 2 significant figures **Examiner's Comments** Candidates seemed well-prepared in terms of knowing the equation: $\text{magnification} = \frac{\text{image size}}{\text{object size}}$ (although, not all could rearrange it). Many were given 1 mark for measuring the cell correctly and stating the length with units in their working and for dividing by the magnification, 950. Where many ran into problems was in converting their answer to micrometres and giving the answer to an appropriate number of significant figures (the same number as the original measurement or one

					more than that). Many answers were out by a factor of 10 because the candidate measured in centimetres and then multiplied by 1000 instead of 10 000 to convert to micrometres. A simple protocol for performing this calculation is shown below. **Checklist for calculating the diameter of a cell in a photomicrograph** • Measure in **millimetres** • **Multiply by 1000** to convert this measurement to micrometres • **Divide** by the magnification • Round answer to **same** number of significant figures as the original measurement (or **one more**).
		iii	made up of different cells / not made up of different tissues ✓	1 (AO1.1)	**IGNORE** differentiated cells **ALLOW** two or more named blood cells for 'different' **Examiner's Comments** Only a minority of candidates explained that blood is made up of different cells but not different tissues. Although the different cell types were visible in the photomicrograph many candidates wrote that blood consisted of similar cells carrying out a similar function.
			Total	**4**	
20		i	can, differentiate / specialise, into, any / all, (adult) cell type / tissue type ✓ cannot form, whole organisms / extra-embryonic tissues ✓	2 (AO1.2)	**ALLOW** for extra-embryonic e.g. placenta **or** umbilical cord **or** amnion **Examiner's Comments** Many candidates did not know the definition of 'pluripotent' and commonly gave the definition of multipotent stem cells. Several candidates did not refer to 'types' of cell or tissue. Few candidates developed their answer to refer to

					them as not being able to form a whole organism or extra-embryonic tissues. **Assessment for learning** It is evident that despite having knowledge of the terms pluripotent and multipotent many candidates still struggle to distinguish between them in context. Learning definitions for key terms is a good learning strategy.
		ii	**any three from**: ***max 2 marks supporting conclusion from MPs 1 to 5*** **1** group 4 has a higher concentration of thyroxine than group 3 ✓ **2** group 4 can produce thyroxine ✓ **3** group 2 shows destroying thyroid gland lowers, concentration / production of, thyroxine ✓ **4** *idea that* group 4 produces almost as much thyroxine as, group 1 / control ✓ **5** *idea that* if the anomalous result in group 4 had been ignored, errors bars / SDs, between groups 1 and 4 would overlap ✓ ***max 2 marks not supporting conclusion from MPs 6 to 11*** **6** group 4 <u>mean</u> is lower than, that of group 1 / control ✓ **7** error bars / SDs, of groups 1 and 4 don't overlap ✓ **8** there was an, anomaly / outlier, in group 4 ✓ **9** relatively small groups of mice / small sample sizes / larger sample sizes should have been used ✓	3 (AO3.2)	**ALLOW** use of descriptions for groups **MP1 ALLOW** ORA **MP6 ALLOW** ORA **MP7 DO NOT ALLOW** range bars **MP10 ALLOW** groups 1 to 3 have fewer mice than group 4 which could affect results **<u>Examiner's Comments</u>** As with other questions that required 'evaluation', this proved challenging for many candidates. Some candidates scored well by organising their response into 'supporting' statements and 'non-supporting' statements and referred to groups by number rather than by long descriptions. They compared one group directly with another rather than just making general descriptive comments about the results. Few candidates challenged the validity of the data. Those candidates who did spot the mouse with an unexpectedly low value did not refer to it as an anomaly or outlier or even specify which group it was in. Few candidates used the error/SD bars to look for any overlap and thus compare the groups, nor did they refer to mean values. **Exemplar 3**

			10 group 4 has more mice which could affect, results / analysis ✓ **11** *idea that* thyroxine concentration may not be a measure of (differentiation into) functional thyroid tissue ✓		 A good response is seen in this exemplar where supporting and non-supporting statements for the scientists' conclusion were provided for a balanced argument.
		iii	***Supports*** less / no, risk of rejection ✓ ***Does not support*** (adult stem cells) may have accumulated mutations **or** iPSCs may increase risk of, cancer / tumour formation **or** may still carry the allele for hypothyroidism ✓	2 (AO3.2)	**IGNORE** reference to ethics **ALLOW** no need for immunosuppression **Examiner's Comments** Some candidates were able to describe the lower risk of rejection for the iPSCs to gain 1 mark, but very few went on to describe a reason for why the use of iPSCs might not be supported. Several candidates made statements regarding the ethics of using embryos as a source of stem cells despite the question being about the use of iPSCs.
			Total	**7**	
2 1	a		(source of), undifferentiated / unspecialised, cells ✓ for growth / to repair (damaged) tissue ✓ can differentiate into, other / named, tissues or cells ✓	Max 2	**ALLOW** where undifferentiated cells are produced **DO NOT ALLOW** growth of cells e.g. xylem vessel (elements) / phloem sieve tube (elements) **ALLOW** specialize **Examiner's Comments** Most candidates correctly stated that these are undifferentiated cells and that they had the ability to produce specialised cells. However, less able candidates suggested that these cells had either a transport or support role in the plant.
	b		(medical) research ✓ treatment of, Alzheimer's / Parkinson's / named neurological condition ✓	Max 1	e.g. spinal cord injury, retinopathy, paralysis

			to, repair / replace, (damaged) tissue / named (damaged) tissue ✓ AVP ✓		e.g. skin / pancreatic tissue / islets of Langerhans / heart tissue / bone marrow / nervous tissue / nerves e.g. transplant stem cells for treatment of leukaemia / growing organs for transplant / treatment of blindness **Examiner's Comments** Many candidates gave a suitable response to gain credit. However, too many were imprecise in their wording stating that these cells could be used to 'treat cancer' or 'treat diabetes' without giving any indication that tissues were needed to be replaced to achieve this aim.
			Total	**3**	