OCR A-LEVEL BIOLOGY A · H420

BIOLOGY



EXAM QUESTION PACK

2.1.6 CELL DIVISION, CELL DIVERSITY AND CELLULAR ORGANISATION

SCORE	PERCENTAGE
/113	%

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Answer **all** the questions.

1(a). A group of microorganisms called slime moulds includes the species *Dictyostelium discoideum.*

The life cycle of *D. discoideum* is shown in Fig. 5.1.

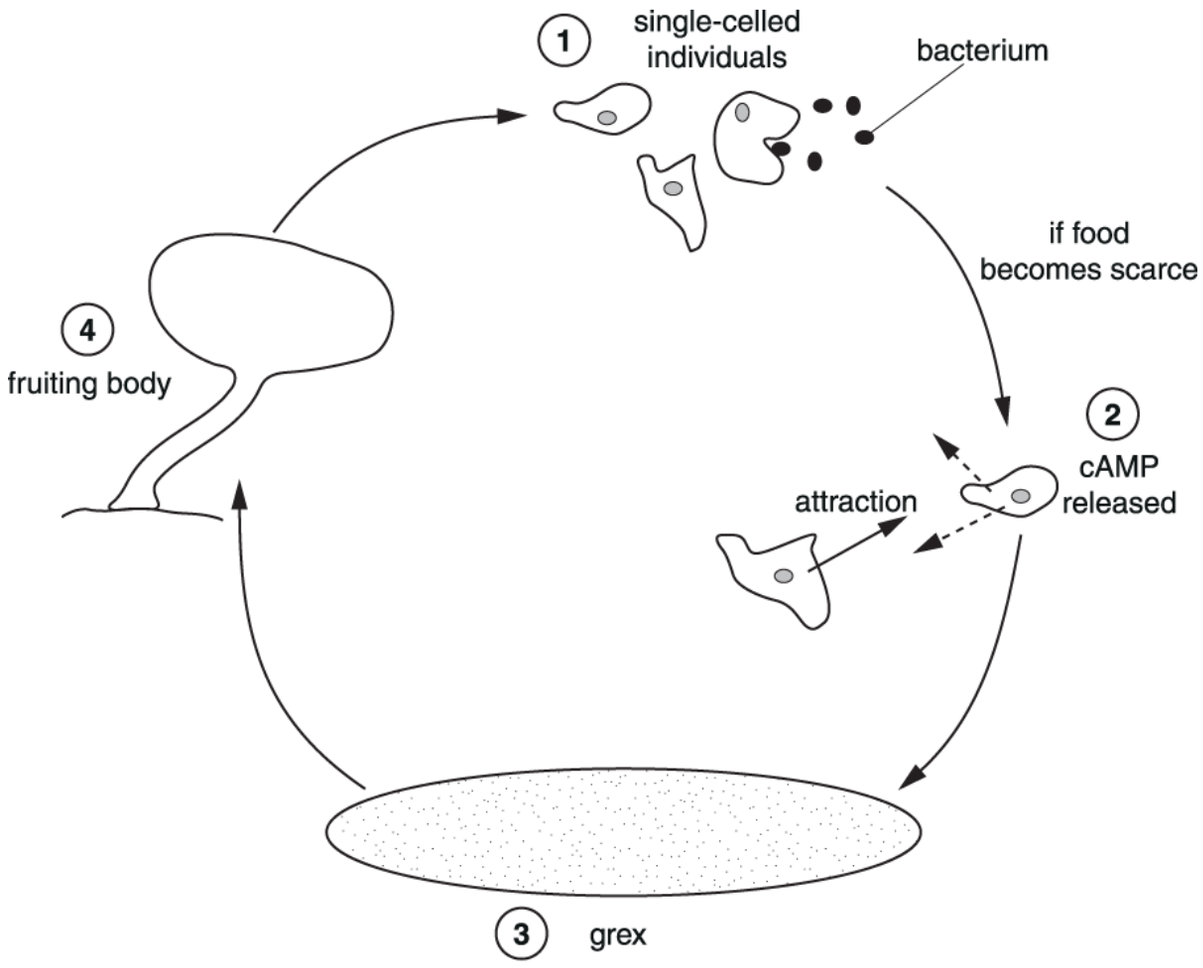


Fig. 5.1

① When plenty of food is available this slime mould exists as single-celled individuals which feed and reproduce asexually.
The slime mould cells feed on bacteria.
The slime mould cells are attracted to folic acid which has been released by the bacteria.
② When food becomes scarce the slime mould cells release a chemical (cAMP) which attracts other slime mould cells.

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③ The slime mould cells then group and stick together to form a multicellular mass called a grex.
The grex moves in a coordinated way in search of a more suitable environment.
As the grex moves, the cells release the chemical DIF. DIF causes some cells to become stalk cells and others to become spore cells.
④ When the grex reaches suitable conditions, it forms a fruiting body consisting of a stalk and spores.
These spores are released and develop into new, individual, slime mould cells.

(i) Suggest the type of cell division used by *D. discoideum* for reproduction during stage ① of its life cycle.

[1]

(ii) At what stage of the life cycle does differentiation begin?

[1]

(b). Individual cells of *D. discoideum* can divide once every hour. A grex may consist of 100 000 individual cells.

Calculate how many hours it would take for one cell to produce enough cells to form a grex.

Answer = _____ hours **[1]**

2(a). State the correct term for each of the following definitions.

A pair of chromosomes that contain genes for the same characteristics.

[1]

(b). A group of organs working together to perform an essential function.

[1]

(c). A type of cell division that produces genetic variation.

[1]

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3. After being mixed with iodine, which of the following would show a blue / black colour?

A potato tuber cells
B erythrocytes
C sieve tube elements
D neutrophils

Your answer ☐

[1]

4. Fig. 9.1 shows some of the checkpoints of the cell cycle.

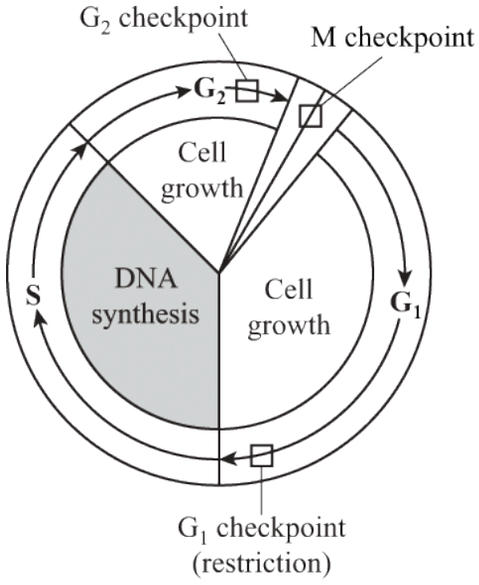


Fig. 9.1

Which statement correctly describes the events that happen if DNA damage is discovered at the G_2 checkpoint?

A The cell cycle continues to mitosis and the DNA will be replicated during metaphase.
B The cell cycle is halted and the cell tries to repair the DNA.
C The cell cycle returns to the G1 phase to try to correct the damage.
D The cell cycle stops and the cell dies.

Your answer ☐

[1]

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5. The mitotic cell cycle is divided into a number of stages.

In which of the following stages will the chromosomes line up at the equator of the cell?

A anaphase
B interphase
C metaphase
D telophase

Your answer ☐

[1]

6. Which of the following statements is a step in meiosis that can lead to variation within a species?

A Mutations occurring during DNA replication.
B Random fusion of gametes.
C Independent assortment of homologous chromosomes.
D Chromosomes forming homologous pairs called bivalents.

Your answer ☐

[1]

7. A student observed mitosis in a prepared slide of a root tip.
The student recorded a description for each of four cells (**A-D**) and then tried to identify which stage of mitosis had been observed.

Which of the mitotic stages has been identified correctly?

	Description	**Mitotic stage identified**
A	Spindle fibres clearly visible	Telophase
B	Chromosomes aligned at equator	Anaphase
C	Sister chromatids pulled to poles of cell	Metaphase
D	Dark bodies visible within nucleus	Prophase

Your answer ☐

[1]

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8. The **second division** of meiosis is different from mitosis because…

A …individual chromosomes line up randomly on the equator.

B …each chromosome replicates during metaphase.

C …chiasmata form between the chromatids of a bivalent.

D …the separating chromatids of a pair are not the same.

Your answer ☐

[1]

9. Name the type of cell present in meristematic tissue and describe how xylem vessel elements are produced from this type of cell.

Type of cell ----------

Description ----------

---

[4]

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10. There are two types of nuclear division, mitosis and meiosis. Meiosis incorporates two divisions of the nucleus.

Which table shows the correct results of nuclear division?

A

	Genetic variation	Reduction division
Mitosis	×	×
Meiosis 1	✓	✓
Meiosis 2	×	×

B

	Genetic variation	Reduction division
Mitosis	×	×
Meiosis 1	✓	✓
Meiosis 2	✓	×

C

	Genetic variation	Reduction division
Mitosis	×	✓
Meiosis 1	✓	×
Meiosis 2	✓	✓

D

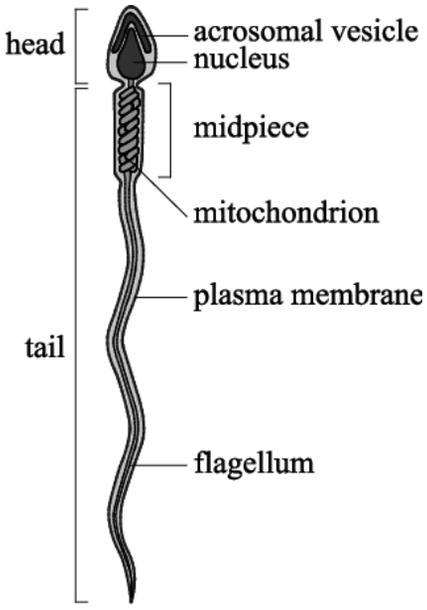
	Genetic variation	Reduction division
Mitosis	×	×
Meiosis 1	✓	✓
Meiosis 2	×	✓

Your answer ☐

[1]

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11. Sperm cells are an example of a specialised cell.



Which statement correctly describes one specialisation of a sperm cell?

A tail contains flagellum which generates ATP
B head contains chromosomes in homologous pairs
C acrosome contains enzymes to digest outer portion of egg
D midpiece contains mitochondria which enter egg

Your answer ☐

[1]

12. Which statement explains the significance of mitosis in the development of whole organisms?

A Mitosis can be controlled at certain points in development, which will change body plans.
B Sex cells are produced by mitosis, which allows new organisms to be produced.
C Mitosis limits the total number of cells in an organism, which will change its shape.
D Budding in yeast is an example of mitosis, producing new multicellular organisms.

Your answer ☐

[1]

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13. Which of the following statements is / are true?

Statement 1: Microtubules are part of the '9 + 2' formation in bacterial flagella.

Statement 2: Microtubules can be prevented from functioning by a respiratory inhibitor.

Statement 3: Microtubules are involved in moving chromosomes from the equator to the poles of the cell during mitosis.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐

[1]

14. The following passage has four key terms missing:

Meristem cells in plants are used to generate new plant tissues. When _____ tissue is formed, _____ impregnates the cell walls, making them impermeable to water. All cytoplasm is lost. When _____ tissue is formed, cytoplasm remains, but the _____ _____ become elongated and lose most of their cytoplasm.

What is the correct order of missing terms?

A sclerenchyma, phloem, lignin, xylem vessels

B xylem, lignin, parenchyma, phloem vessels

C phloem, collenchyma, xylem, sieve tube elements

D xylem, lignin, phloem, sieve tube elements

Your answer ☐

[1]

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15. *Heliamphora*, shown in Fig. 18.1, is a genus of carnivorous plant. Its leaves are adapted to form water-filled traps for insects. The insects are attracted by nectar, then fall into the traps and drown. The plants digest the insects and absorb the mineral ions produced. This allows *Heliamphora* to survive in soils with low mineral content.



Fig. 18.1

Fig 18.2 shows a transverse section of part of a *Heliamphora* stem, with three tissues labelled.

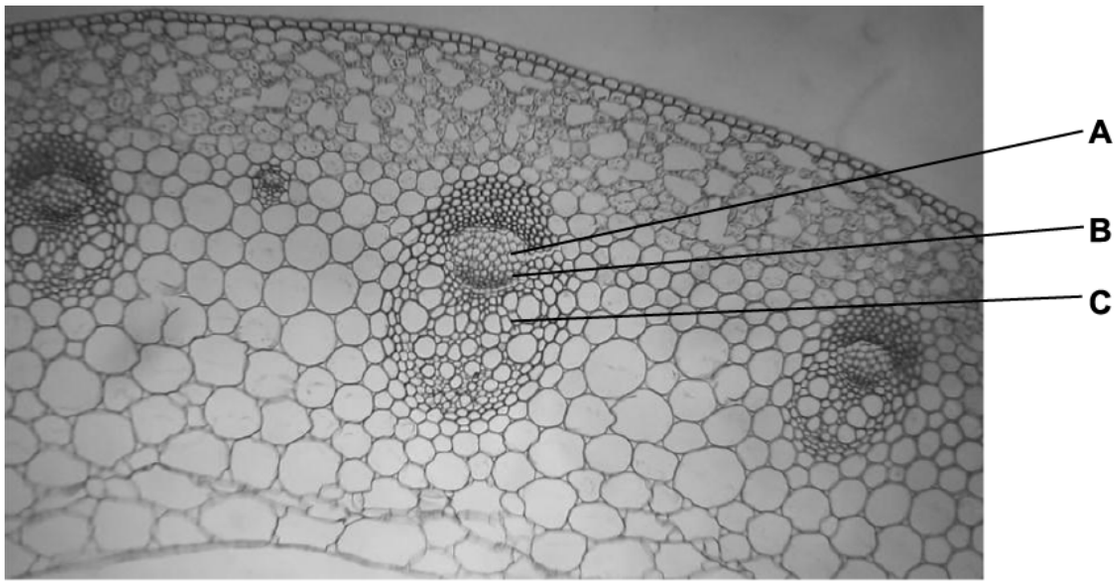


Fig. 18.2

(i) Identify the tissues labelled by the following letters:

A

C

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[2]

(ii) The tissue labelled **B** is cambium.

What type of cell makes up this tissue?

[1]

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16(a). **Fig. 1.1** shows a microscopic image of part of a fish gill.

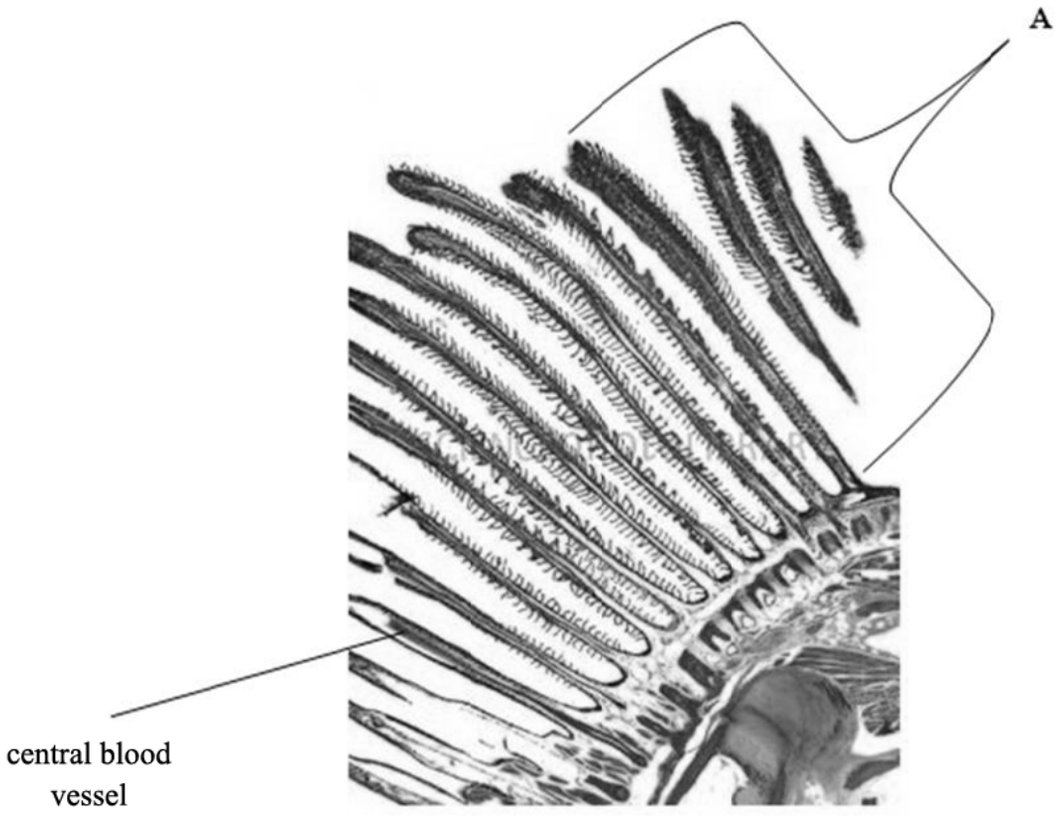


Fig. 1.1

Name structure **A**.

---------- **[1]**

(b). Explain how **Fig. 1.1** shows that gills are adapted for efficient gas exchange.

---------- **[4]**

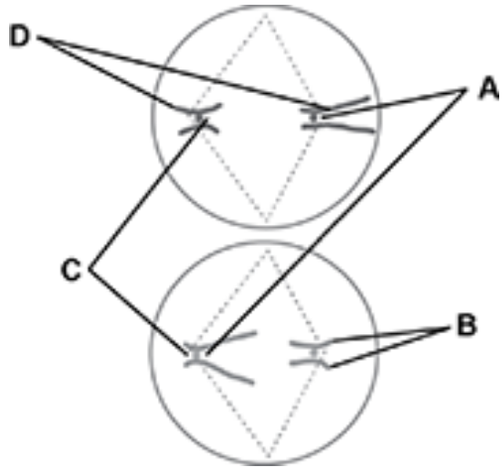
(c). Each gill is supported by a gill arch made of bone. Bone tissue is made of living cells, collagen and an inorganic component.

Explain why bone is described as a tissue and gills are described as organs.

---

[3]

17. The diagram below shows the arrangement of chromosomes in a cell during metaphase 2.



Which letter indicates a homologous pair of chromosomes?

Your answer ☐

[1]

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18. Fig. 19.1 shows a neutrophil responding to a pathogenic bacterium.

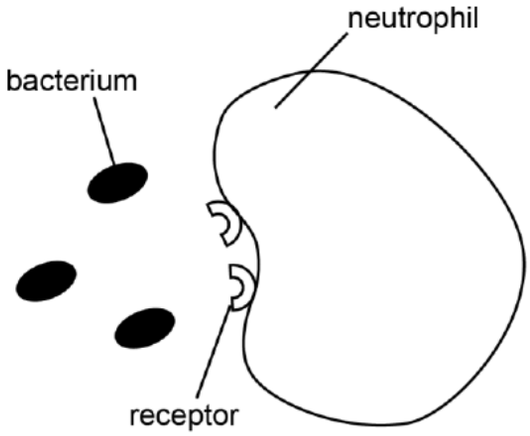


Fig. 19.1a

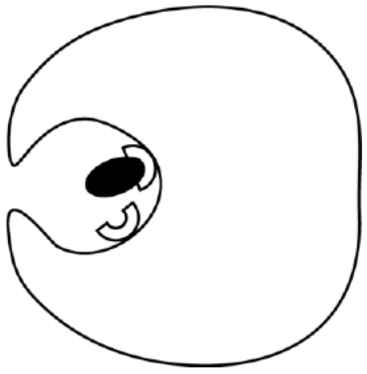


Fig. 19.1b

(i) What is the role of an opsonin during this process?

---

[1]

(ii) Other than having specific receptors, describe **one** way in which the structure of the neutrophil is specialised.

---

[1]

19(a). Bone marrow contains stem cells that can develop into erythrocytes, neutrophils and lymphocytes.

Describe the changes that must occur inside these stem cells as they differentiate to form erythrocytes.

---

[2]

(b). Cells from an embryo can be used for medical research and for research on the development of an organism.

Suggest **three** ways in which the use of embryonic stem cells in research has practical benefits to biological knowledge.

---

[3]

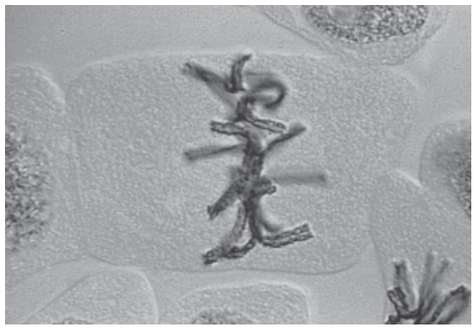
(c). During development, cells become organised into tissues and organs.

Explain the difference between *muscle tissue* and *a muscle.*

---

[2]

20. The image shows a stage in mitosis.



Which of the following options, **A** to **D**, is the stage of mitosis shown above?

A anaphase
B metaphase
C prophase
D telophase

Your answer ☐

[1]

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21. Haemoglobin is found in erythrocytes. Unlike other vertebrates, the mature erythrocytes of mammals lack nuclei and other membrane-bound organelles.

(i) Explain **one** advantage and **one** disadvantage of the lack of nuclei and other membranebound organelles to mammalian erythrocytes.

Advantage _____

_____

Disadvantage _____

_____ **[2]**

(ii) Viruses do not use erythrocytes as host cells, whereas the malarial pathogen *Plasmodium* spends part of its life cycle inside erythrocytes.

Suggest why.

_____

_____

_____

_____

_____ **[2]**

(iii) Explain why erythrocytes do **not** make use of any of the oxygen that they are transporting.

_____

_____

_____

_____

_____ **[2]**

22(a). Mitosis and meiosis play an important role in the life cycles of organisms.

Fig. 2.1 and Fig. 2.2 represent an outline of the life cycles of two different organisms.

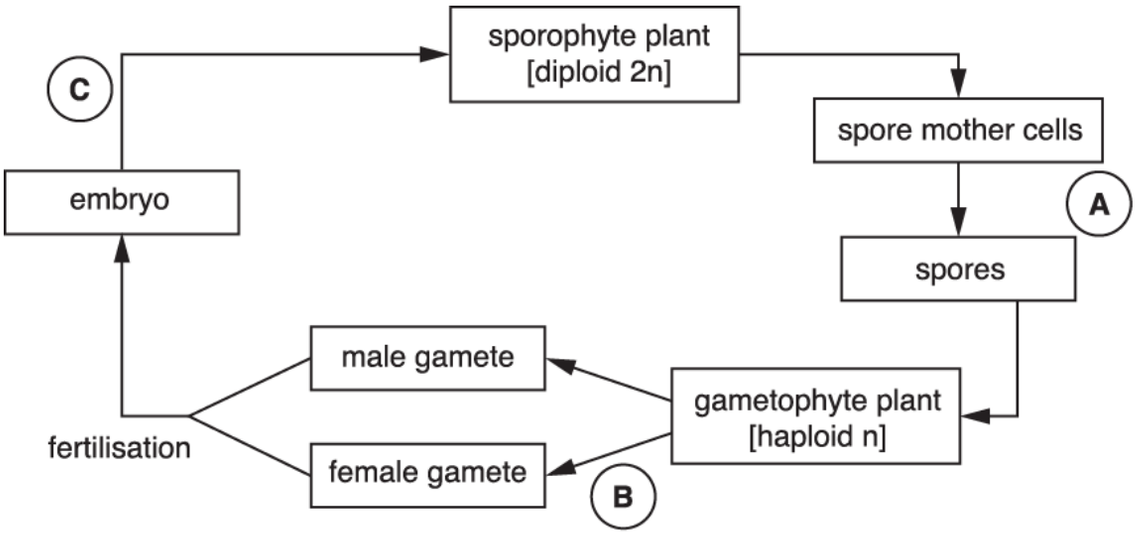
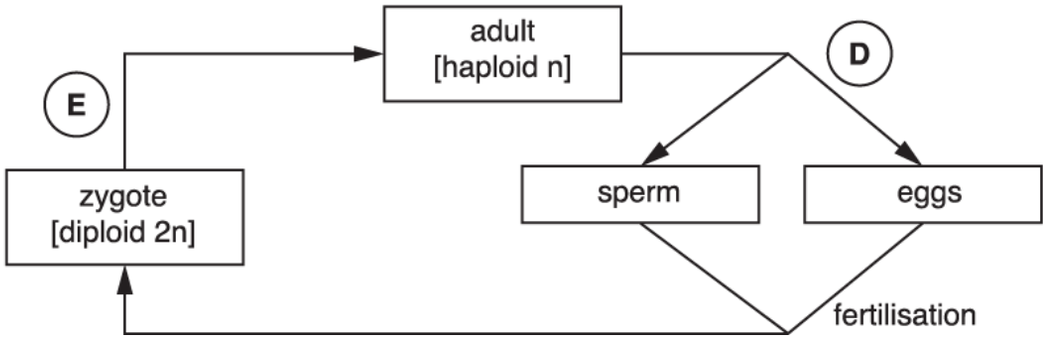


Fig. 2.1



Place a tick (✓) in each row of the table to indicate the type of nuclear division that occurs at each of the letters **A** to **E**.

	Mitosis	Meiosis
A		
B		
C		

	Mitosis	Meiosis
D		
E		

[3]

(b). Fig. 2.3 is a diagram that represents the different phases of the cell cycle.

X, **Y** and **Z** represent checkpoints in the control of the cell cycle.

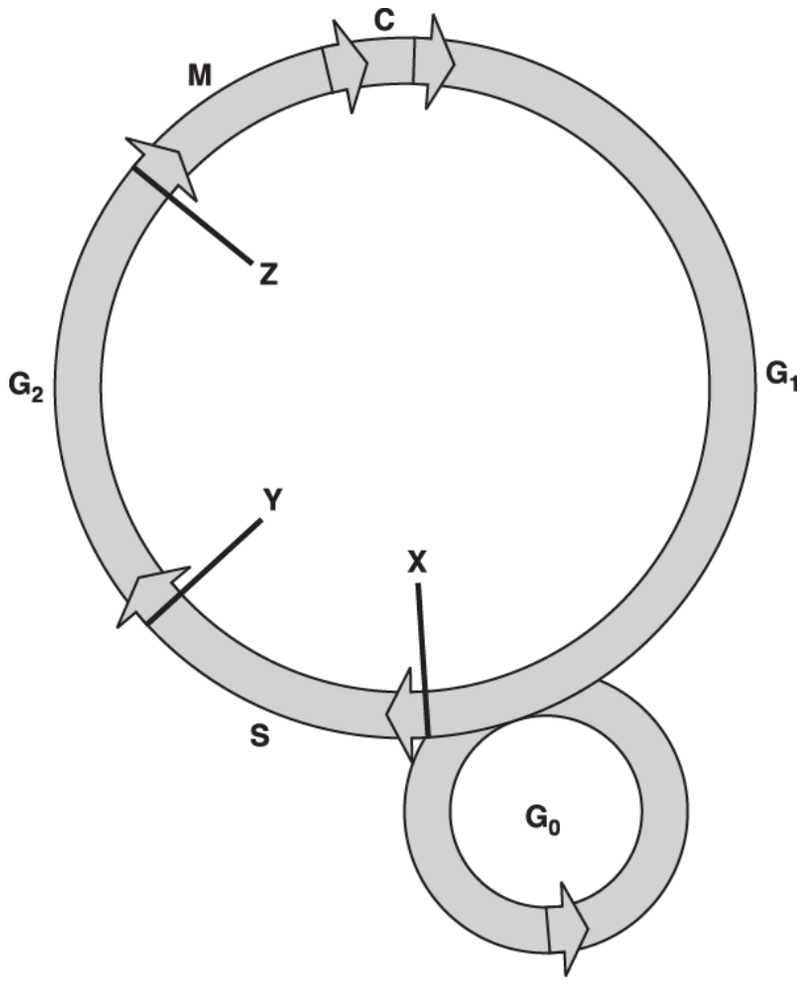


Fig. 2.3

(i) State all the letters in Fig. 2.3 that represent the **phases** of interphase.

---

[1]

(ii) Suggest what is being checked at checkpoint **Y** on Fig. 2.3.

---

[1]

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(c). Table 2.1 The table indicates the relative time spent in different phases of the cell cycle for three different types of cell, **P**, **Q** and **R**.

Cell type	Relative time spent in a phase			
	G_1/G_0	S	G_2	M/C
P	18	50	13	19
Q	18	25	11	16
R	100	0	0	0

(i) Which of the cells **P**, **Q** or **R** takes the shortest time to divide?

---

[1]

(ii) Suggest why cell **P** spends twice as much time in phase **S** than cell **Q**.

---

[1]

(iii) What can be deduced about the behaviour of cell **R**?
Give reasons for your answer.

---

[2]

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(d). An experiment was carried out where a student observed cells in different tissues under the microscope.

- The cells were undergoing mitosis.
- 200 cells were observed for each tissue.
- The number of cells in each stage of mitosis was recorded.

The results are shown in Table 2.2.

Tissue type	Number of cells in stage of mitosis				Total
	Prophase	Metaphase	Anaphase	Telophase	
V	65	55	7	73	200
W	85	59	6	50	200

The student had expected that the results observed for tissue type **W** would not be significantly different from those for tissue type **V**.

(i) Identify the pieces of evidence in Table 2.2 that caused the student to suspect that the results for tissue type **W** might be **significantly** different from those for tissue type **V**.

---**[1]**

(ii) The student decided to analyse the data using a statistical test.

A friend suggested using Student's -test.

Why is Student's -test **not** suitable for dealing with this data?

---**[1]**

(e). The chi-squared (x^2) test can be used to analyse the data.

(i) Complete the rows for metaphase and telophase in the table below and calculate the $\mathbf{x}^2$ value for the data.

The $\mathbf{x}^2$ value is calculated using the following formula:

x^2 = _____ **[3]**

(ii) The value of chi-squared (x^2) can be used to conclude whether the results for cells in tissue type **W** differ significantly from those for tissue type **V**.

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The number of **degrees of freedom** determines which row of the x^2 probability table is used.

The number of degrees of freedom is defined as:

the number of categories - 1

What will be the number of degrees of freedom used in this analysis?

[1]

(iii) The student had expected that the results observed for tissue type **W** would not be significantly different from those for tissue type **V**.
Use your calculated value for x^2 and the information from the x^2 probability table below to conclude whether or not the results observed for tissue type **W** are significantly different from those for tissue type **V**.

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

Conclusion

[2]

23. Stem cells can specialise to form a variety of cell types.

What other feature is shown by stem cells but not by specialised cells?

[1]

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24(a). The figure shows a cell during mitosis.



Fig. 4.1

(i) Name the stage of mitosis shown.

---

[1]

(ii) From the start of mitosis, describe the events that have taken place in this cell to enable it to reach the stage shown in Fig. 4.1.

In your answer you should use appropriate technical terms, spelled correctly.

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[5]

(b). Mitosis occupies only a small part of the cell cycle.

Outline the events that take place in the rest of the cell cycle.

[3]

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25. Mosses are small plants with no true roots. Each plant is anchored by simple root-like structures which do not contain vascular tissue.

The leaves of moss plants are usually one cell thick and are attached to a thin stem. Neither the leaves nor stem contain vascular tissue.

Fig. 5.1 shows a leaf from a typical moss plant.

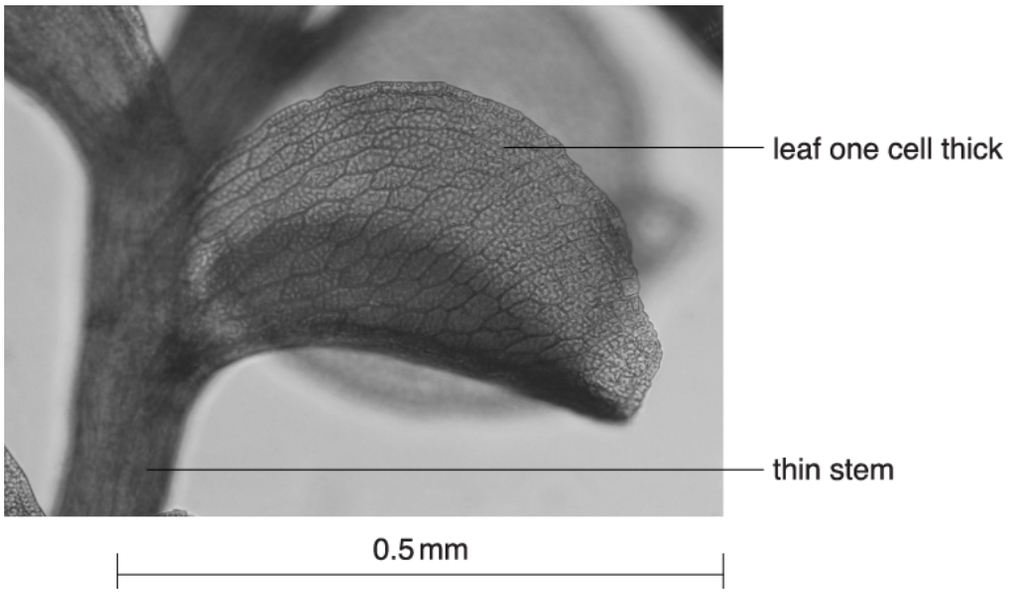


Fig. 5.1

(i) What is meant by the term *tissue*?

---

[2]

(ii) Leaves of dicotyledonous plants contain types of cells that are not found in the leaves of mosses, such as that shown in Fig. 5.1.

Other than the cells found in vascular tissues, name **two** types of cell found in the leaves of dicotyledonous plants that are not found in the leaves of mosses.

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[2]

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26. Fig. 2.1 shows some undifferentiated plant cells, such as those found at the tips of roots and shoots.

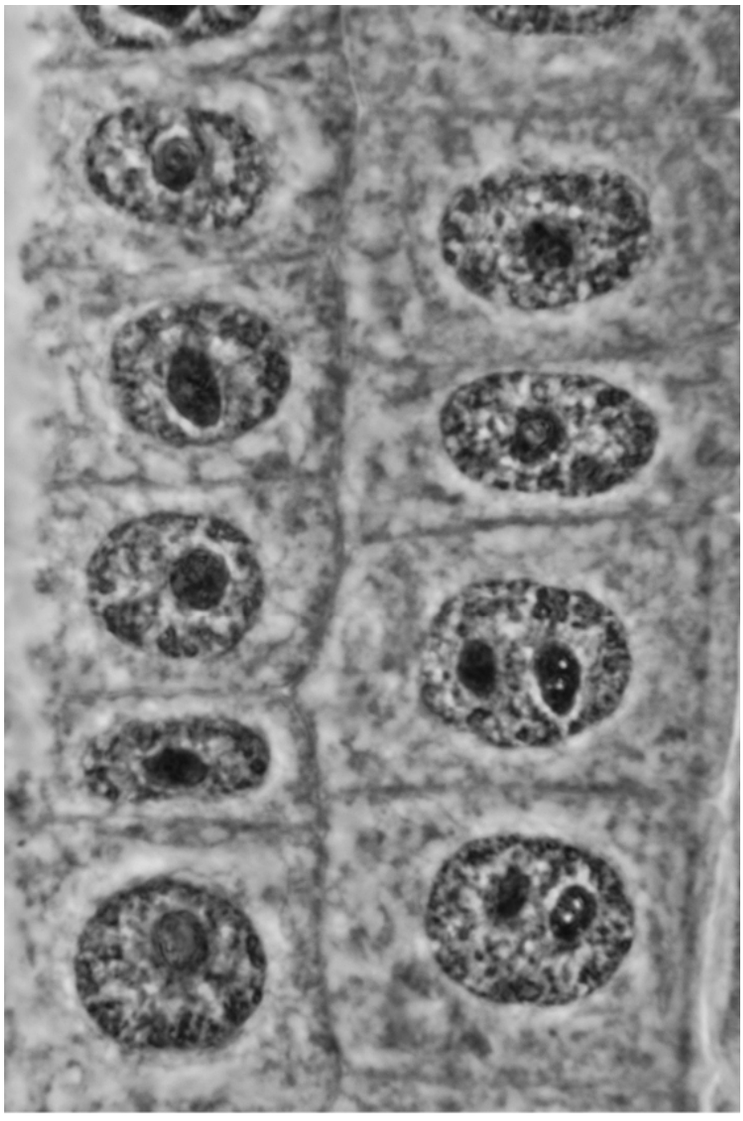


Fig. 2.1

(i) Name the type of tissue that undergoes cell division to form these undifferentiated plant cells.

---------- **[1]**

(ii) State the features shown in Fig. 2.1 that would **not** be found in mature xylem vessels.

---------- **[2]**

(iii) Describe how the structure of the cell walls in xylem vessels would differ from the cell walls shown in Fig. 2.1.

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---[2]

27(a). Fig. 1.1 shows changes over time in the mass of nuclear DNA in some of the cells of thetestes of a diploid organism.

During this time period, two different types of nuclear division occurred.

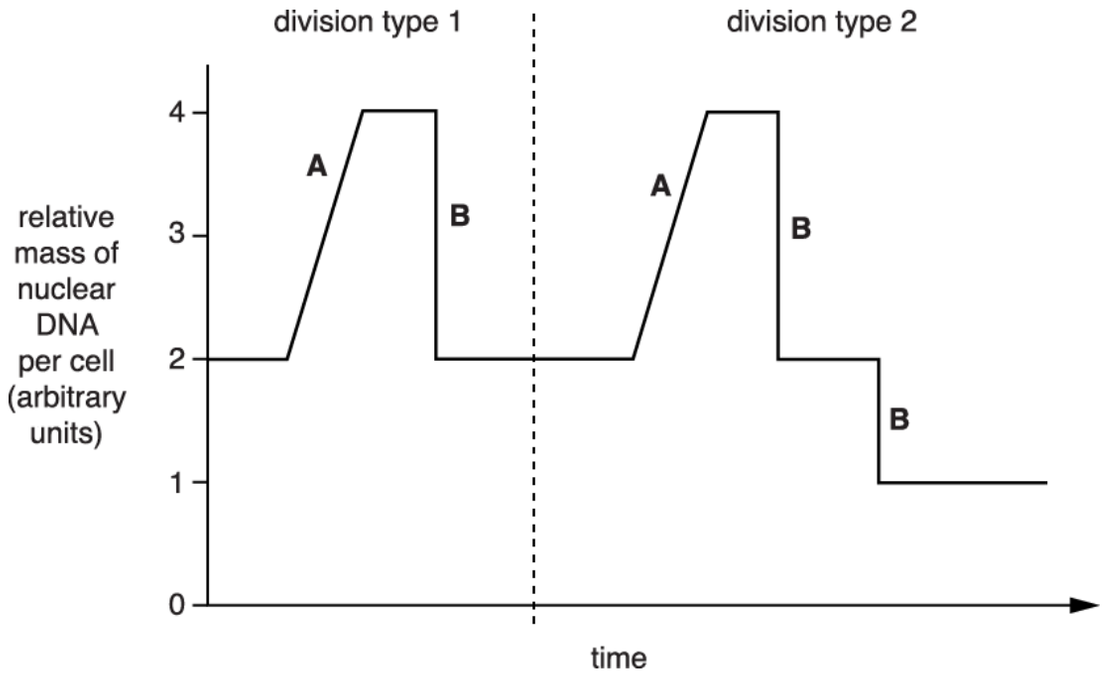


Fig. 1.1

(i) Identify the two types of division represented in Fig. 1.1.

division type 1 _____

division type 2 _____

[1]

(ii) Name the processes that are occurring at the points labelled **A** and **B**, which cause the change in the mass of DNA per cell.

A _____

B _____

[2]

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(b). Discuss the ways in which genetic variation is produced, including the role of nuclear division.



In your answer you should link the processes to the ways in which the genetic variation is produced.

[9]

28. Identical twins in humans are natural clones. They form when a fertilised egg cell divides by mitosis into two entirely separate groups of cells. Each group of cells develops into a baby.

Two brothers, who were identical twins, married two sisters, who were also identical twins. Each couple had one child.

Fig. 1.3 shows the relationships between these six people.

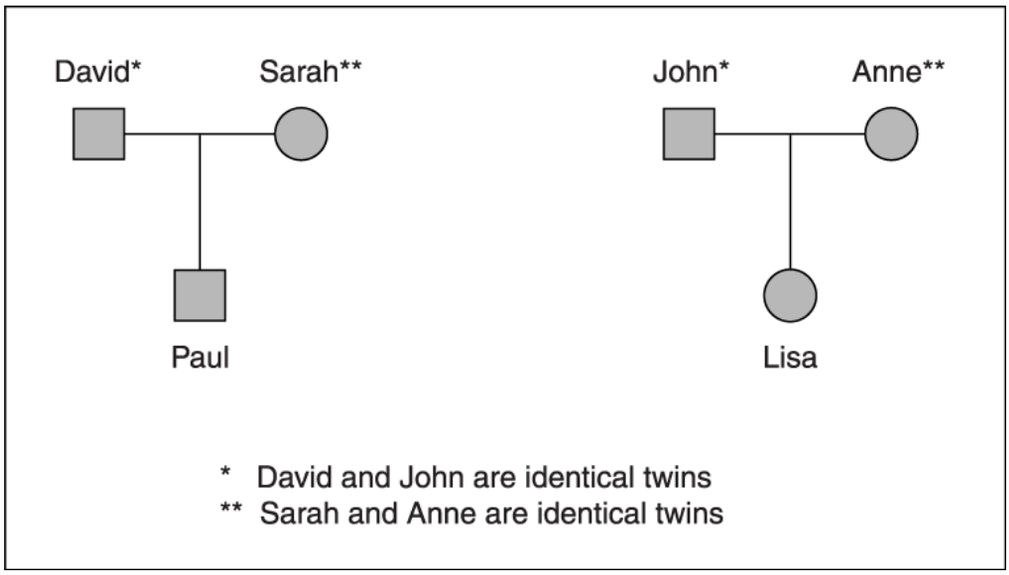


Fig. 1.3

Using your knowledge of mitosis and meiosis, estimate the percentage of alleles shared by the individuals listed in the table below.

Individuals	% of alleles shared
David and John	
Anne and Lisa	
Sarah and Lisa	

[3]

29. One function of healthy kidneys is to make the hormone erythropoietin (EPO), which stimulates the production of red blood cells. Patients with kidney failure may need to be given supplements of EPO.

State the type of cell from which red blood cells are formed **and** where this type of cell is located.

type of cell ----------

location ---------- **[1]**

30. Which of the diagrams, **A** to **D**, is a stem cell?

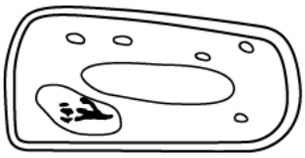
A



B



C



D



Your answer

[1]

31. Which of the following, **A** to **D**, is an **incorrect** statement about blood cells?

A Erythrocytes and neutrophils are derived from the same stem cells.
B Erythrocytes develop large numbers of ribosomes early in their differentiation.
C The majority of organelles in red blood cells are broken down by hydrolysis.
D Neutrophils undergo mutation during differentiation.

Your answer

[1]

32. Multicellular organisms, such as plants, have evolved internal transport systems.

(i) Explain the benefit to plants of internal transport systems.

[2]

(ii) The transport systems of plants contain cells that are specialised to perform a particular function.

The table below shows information about three types of specialised plant cell. Three boxes have been completed already.

Complete the rest of the table by placing the correct responses in the empty boxes.

Cell	Location	Example of a substance transported	Contains chloroplasts? (□ or □)
Guard cell		carbon dioxide	
Companion cell			□
Root hair cell	roots		

[3]

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33. Cells can be counted and analysed using a technique called flow cytometry. DNA in the cells is stained with a fluorescent dye before analysis. The degree of fluorescence is dependent on the amount of DNA present.

(i) Use your knowledge of the cell cycle to name the stages of interphase that match the following descriptions.

The stage in which a cell produces the least fluorescence

The stage in which a cell produces the most fluorescence

The stage in which the highest number of cells is recorded

---

[3]

(ii) Scientists analysed a sample of liver cells. Of these cells, 27.2% were found to be undergoing cell division or nuclear division. An adult human's liver contains approximately 180 billion cells.

Estimate the number of cells in interphase in an adult human's liver.

Write your answer in standard form to **two** significant figures.

Answer = _____ **[1]**

(iii) Suggest why the use of fluorescent dyes in flow cytometry is inappropriate when analysing red blood cells.

---

[1]

END OF QUESTION PAPER

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Question			Answer/Indicative content	Marks	Guidance
1	a	i	mitosis ;	1	**CREDIT** correct spelling only **ACCEPT** binary fission **Examiner's Comments** Most candidates were able to identify the type of cell division and the stage of the life cycle where differentiation takes place.
		ii	in the grex / 3 ;	1	**Examiner's Comments** Most candidates were able to identify the type of cell division and the stage of the life cycle where differentiation takes place.
	b		17 (hours) ;	1	**Examiner's Comments** A simple calculation was required to determine how many hours it would take a single cell to reproduce a sufficient number of times to produce a mass of at least 100 000 cells. The best candidates achieved this mark. Most candidates, however, were unable to make the calculation which simply needed them to double the number each hour until they reached a total of over 100 000.
			Total	**3**	
2	a				**Mark the first answer for each question part.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** This was a straightforward question testing candidates' knowledge of terms. Most candidates knew many of the terms but a couple were less well known.

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Question			Answer/Indicative content	Marks	Guidance
			homologous (chromosomes) **OR** homologue(s) ;	1	**IGNORE** bivalent **Examiner's Comments** This term was well known to the majority of candidates.
	b		(organ) system ;	1	**DO NOT CREDIT** specific named system unless given as example **Mark the first answer for each question part.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** This term was well known to the majority of candidates.
	c		meiosis ;	1	**CREDIT** correct spelling only **Mark the first answer for each question part.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** This term was well known to the majority of candidates. However, fewer candidates were able to spell meiosis correctly.
			Total	**3**	

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Question			Answer/Indicative content	Marks	Guidance
3			A	1	
			Total	**1**	
4			B	1	
			Total	**1**	
5			C	1	
			Total	**1**	
6			C	1	
			Total	**1**	
7			D	1	
			Total	**1**	
8			D	1	
			Total	**1**	
9			*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**	
10			B	1	
			Total	**1**	
11			C	1	
			Total	**1**	
12			A	1	
			Total	**1**	
13			C	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
14			D	1	
			Total	**1**	
15		i	**A** phloem (1) **C** xylem (1)	2	
		ii	meristem	1	**ALLOW** meristematic **DO NOT ALLOW** stem cells / undifferentiated cells
			Total	**3**	
16	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**	

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Question			Answer/Indicative content	Marks	Guidance
17			A	1	
			Total	**1**	
18		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**	
19	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**	

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Question			Answer/Indicative content	Marks	Guidance
20			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**	

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Question			Answer/Indicative content	Marks	Guidance
21		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

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Question			Answer/Indicative content	Marks	Guidance
					or what entered or left the cell.
		ii	*virus* virus is unable to / cannot, replicate / reproduce, on its own / outside a 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) ☐	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 **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

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Question			Answer/Indicative content	Marks	Guidance
					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 need, energy / ATP, to move **or** needs less, energy / ATP (for metabolic processes) □	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 **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**	

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Question			Answer/Indicative content	Marks	Guidance
22	a			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 1 2 ☐ = 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.

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Question			Answer/Indicative content	Marks	Guidance
	b	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.
	c	i	Q ☐	1	**If an additional incorrect answer is given = 0 marks** **Examiner's Comments** Most candidates correctly identified cell Q.

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Question			Answer/Indicative content	Marks	Guidance
		ii	1 it / P, needs to synthesise / contains / has, more DNA / longer DNA / more genetic material / more chromosomes ☐ 2 AVP ☐	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 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.

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Question			Answer/Indicative content	Marks	Guidance
		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.

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Question			Answer/Indicative content	Marks	Guidance
	d	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.
		ii	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.

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Question			Answer/Indicative content	Marks	Guidance
	e	i	*calculation* **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** **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.

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Question			Answer/Indicative content	Marks	Guidance
		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 (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☐	2	**ALLOW** ecf from candidate's calculated x^2value in **(i)** using the number of degrees of freedom theystated in **(ii)**. 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	**17**	

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Question			Answer/Indicative content	Marks	Guidance
23			(ability to continue) dividing;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** The vast majority of candidates responded by saying that stem cells could differentiate. This suggests that many have not understood the concept that cells differentiate to become specialised. No mark was awarded for 'able to differentiate' as the ability to form specialised cells was given in the question. Few candidates recalled that stem cells are able to keep dividing – which is perhaps their main role.
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
24	a	i	anaphase;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** Anaphase is possibly the easiest stage to identify and the majority of candidates did so correctly.
		ii	1. **chromosomes** coil / **supercoil** / **condense;** **2. nuclear envelope** disintegrates; **3. nucleolus,** no longer visible / disappears; **4. centrioles** move to opposite, ends of cell / **poles;** 5. chromosomes attached to **spindle** fibres at **centromere;** **6.** chromosomes align at **equator;** 7. chromosomes move towards opposite, poles / ends of cell; 8. spindle fibres change length / shorten; **max 4** QWC; **max 1**	max 5	**ACCEPT** chromatid for chromosome throughout Note: There is no mark for naming phases, but if phase is mentioned and description is incorrect for named phase then **DO NOT CREDIT** Accept mp 1-5 in prophase, mp 6 metaphase, mp 7 anaphase mp 8 in any phase **IGNORE** ref to events in telophase and cytokinesis, as they occur *after* anaphase **ACCEPT** chromatin **ACCEPT** nuclear membrane **IGNORE** dissolves **DO NOT CREDIT** pairs of chromosomes line up **ACCEPT** pairs of chromatids line up **IGNORE** spindle fibres contract Place a green blob next to each word and a tick next to the pencil. Award if any two terms spelt correctly and used in correct context from: **chromosomes / chromatids / chromatin** **supercoil** **nucleolus** **condense** **centromere** **nuclear envelope** (but not membrane) **centriole** **pole** **spindle** **equator**

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Question			Answer/Indicative content	Marks	Guidance
					Examiner's Comments As the question started with 'From the beginning of mitosis..', it was very disappointing to see how many candidates described the processes in interphase such as DNA replication and checking before describing the events in prophase. However, most candidates had a good grasp of the events in mitosis and only a few confused it with meiosis by describing pairing of homologous chromosomes during prophase. Some candidates were able to provide a good number of details. The majority of candidates who described attachment of spindle fibres to the centromere placed this in metaphase after the chromosomes had moved to the equator. In fact the attachment occurs in a sub-stage of prophase known as prometaphase. It should be clear to students that the chromosomes will not migrate to the equator on their own – they need the spindle fibres to pull them. Another misconception held by many candidates was that the spindle fibres contract to move the chromosomes. Some confusion between chromosomes and chromatids was also evident and centres should be sure their students can make a clear distinction such as calling them chromatids while they are still attached at the centromere but chromosomes once the centromere has split. Thus, one chromosome consisting of two chromatids becomes two chromosomes as soon as the centromeres split apart.

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Question			Answer/Indicative content	Marks	Guidance
	b			max 3	**For mp 1 & 2 where candidates link events to S & G phases then description must be correct for phase.** **S phase is DNA synthesis only** **G phases contain protein synthesis, increasing numbers of organelles, growth, increased respiration and checking of DNA.**
			DNA / genetic material, replicated / synthesised / checked; cell growth / increased respiration / protein synthesis / increase in number of organelles; cytokinesis / cell surface membrane constricts / cytoplasm splits in two / cell plate forms (plants); ref to G and S phases;		**IGNORE** chromosomes replicate / DNA copied / DNA doubles **ACCEPT** more ATP **ACCEPT** Gap or 'growth' for G and Synthesis for S throughout **ACCEPT** in context of diagram
			Total	**9**	
25		i	group of cells; working together / performing a function;	2	**ACCEPT** cells derived from same stem cell sourc **Examiner's Comments** Almost all candidates achieved full marks for this simple definition. Many candidates gained credit
		ii	palisade (mesophyll); spongy mesophyll; guard cells; (upper / lower) epidermal cells; AVP;	2 max	**Mark the first two answers.** If two correct responses are given followed by one or two incorrect responses or which contradict the correct answers then = **1 or 0 marks** e.g. parenchyma, collenchyma, sclerenchyma **Examiner's Comments** for naming palisade, epidermal, spongy mesophyll or guard cells. Weaker candidates lost credit as they named companion cells, sieve tube elements or even root hair cells and stomata.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
26		i	meristem(atic);	1	**IGNORE** position in plant such as 'root tip', cambium **Examiner's Comments** This was well answered with the majority of candidates giving the correct response (meristem). The most common error was to name the sites in the plant where meristematic tissue is found (root tip or shoot tip) or stating 'cambium'.
		ii	nucleus / nucleolus / chromatin; cytoplasm; cross / end, (cell) walls;	2 max	**Read through and award marks for correct features** **IGNORE** ref to other individual organelles / vacuole **IGNORE** nucleous **DO NOT CREDIT** 'two nuclei in one cell' **CREDIT** end plates **ACCEPT** no end walls / no nucleus / no cytoplasm **IGNORE** walls between cells **Examiner's Comments** A good proportion of candidates gained full credit for stating 'nucleus' and 'cytoplasm'. Some correctly described 'no end walls'. The most common misconceptions were 'vacuole' and 'other organelles' or naming specific organelles such as 'mitochondria' – none of these features are visible in the photograph supplied. There was a feeling that many less able candidates were simply listing differences from memory rather than referring to the photographs.

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Question			Answer/Indicative content	Marks	Guidance
		iii	thicker;	2max	**IGNORE** stronger
			lignified;		**CREDIT** have lignin /contain lignin / reinforced with lignin / impregnated with lignin **DO NOT CREDIT** have lignin on the walls / lined by lignin / surrounded by lignin **IGNORE** ref to pattern of thickening
			contain (bordered) pits;		**IGNORE** 'pore'
					Examiner's Comments Many candidates correctly stated that xylem vessel walls are 'impregnated with lignin' or some variation of this. However some failed to achieve credit because of poor expression - stating that lignin 'lined' or 'coated' the cell walls. Many candidates also correctly identified the pits in the walls of mature xylem vessels, although a few erroneously referred to these as 'pores' or 'plasmodsemata'. Only a very few candidates stated that the walls would be thicker. Unfortunately, a number of less able candidates lost marks because they described the adaptations of xylem tissue forming hollow tubes or referred to a lack of end walls between the cells rather than referring to the structure of the wall itself.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
27	a	i	*division type 1* mitosis **and** *division type 2* meiosis;	1	**Mark the first answer on each prompt line**. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** correct spelling only **ACCEPT** correct spelling only **CREDIT** meiosis I **and** II **DO NOT CREDIT** meiosis I / meiosis II alone **Examiner's Comments** Most candidates realised that division 1 was mitosis and division 2 was meiosis: however, some candidates lost the mark for listing just meiosis I or II, or for misspelling meiosis.
		ii	**A** (DNA) replication; **B** cytokinesis;	2	**Mark the first answer on each prompt line**. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** stages of cell division **IGNORE** cell division / stages of cell division **Examiner's Comments** Many candidates misread the question and thought that they needed to give the **stage** of division occurring at points A and B rather than the **processes** occurring at A and B, and gave the responses of interphase and telophase / cell division, which gained no credit.
	b		**A1** independent assortment / random segregation, of (homologous) chromosomes / bivalents; **A2** in, metaphase **I** / meiosis **I**;	8 max	**A1 ACCEPT** Random assortment / independent segregation **A2 / A3 DO NOT CREDIT** metaphase / meiosis, I **and** II **A2 / A3 ACCEPT** correct anaphase stage

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Question	Answer/Indicative content	Marks	Guidance
	A3 *of* chromatids in, metaphase II / meiosis II;		linked to segregation **A2** must be in context of independent assortment / random segregation
	A4 (so) homologous chromosomes, have different alleles / come from different parents;		**A4 / A5 DO NOT CREDIT** genes **A4 ACCEPT** pairs of chromosomes / maternal **and** paternal chromosomes, have different alleles / come from different parents
	A5 produces large number of allele combinations;		**A5 ACCEPT** different combinations of, chromatids / chromosomes, in gametes **CREDIT** figures e.g. for humans 2^{23} possible combinations
	C1 crossing over / (formation of) chiasma(ta); **C2** in, prophase **I** / meiosis **I**; **C3** (so) chromatids will have new combination of alleles;		**C1 DO NOT CREDIT** between sister chromatids **C2 DO NOT CREDIT** prophase / meiosis, I **and** II **C2** must be in context of crossing over **C3 ACCEPT** shuffles / swaps / exchanges, alleles on chromatids
	C4 amount of variation depends on distance between crossover points;		**C4** e.g. more variation the further apart the crossovers occur
	M1 mutation; **M2** changes the (DNA) nucleotide/ base, sequence;		**M2 IGNORE** 'pairs' **M2 CREDIT** deletion, / substitution / addition, of, base / nucleotide
	M3 DNA checks (during duplication) did not recognise damage;		**M3 ACCEPT** proof reading did not recognise damage
	M4 *idea of* differences in (named) protein(s);		**M4** e.g. change in, amino acid sequence / primary structure
	N1 non-disjunction;		**N1 CREDIT** inversion / translocation (chromosome mutation)
	N2 homologous chromosomes do not separate (in metaphase I);		**N2 CREDIT** description of inversion / translocation
	N3 one, more / less, chromosome present;		**N3 CREDIT** examples of chromosome changes e.g. Trisomy 21
	F1 random, mating / fusion of gametes/ fertilisation; **F2** gametes are not genetically identical;		**F2 ACCEPT** gametes are genetically different
	F3 produces large number of (allele) combinations;		**F3 DO NOT CREDIT** produce large number of gene combinations

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Question	Answer/Indicative content	Marks	Guidance
	QWC;	1	**Awarded for one change and consequence of that change** **Award if ONE of the following has been awarded** mp **A1 or A2 or A3 <u>and</u>** mp **A4** or **A5** **OR** mp **C1 or C2 <u>and</u>** mp **C3 or C4** **OR** mp **M1 or M2 <u>and</u>** mp **M3 or M4** **OR** mp **N1 or N2 <u>and</u>** mp **N3** **OR** mp **F1 or F2 <u>and</u>** mp **F3** **Examiner's Comments** This question discriminated well across the mark range, with many candidates able to relate genetic variation to the stages of meiosis. Weaker candidates merely listed the events of each stage of meiosis, without linking them to the way in which genetic variation was achieved, gaining no credit. Candidates should be encouraged to read the question again after they have answered it to check they have followed the instructions correctly. The most common responses seen talked about independent assortment of chromosomes in metaphase I and chromatids in metaphase II,crossing over in prophase I, mutation and random fertilisation, all of which gained credit. However, some candidates confused the terms chromosomes and chromatids, for example talking about crossing over between sister chromatids, which lost the marking point. Other common errors were a lack of appropriate detail, for example fertilisation rather than random fertilisation, daughter cells rather than gametes, which meant that the marking points F1 and F2 could not be awarded. Few candidates related the processes involved in creating genetic variation to the consequences of that process, i.e. the

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>production of new combinations of alleles in the gametes, and so failed to gain the QWC mark.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>12</td><td></td></tr>
<tr><td>28</td><td></td><td></td><td><table><tr><th>Individuals</th><th>% of alleles shared</th></tr><tr><td>David and John</td><td>100</td></tr><tr><td>Anne and Lisa</td><td>50</td></tr><tr><td>Sarah and Lisa</td><td>50</td></tr></table>;
;
;</td><td>3</td><td>Mark the first answer in each box. If an additional answer is given that is incorrect or contradicts the correct answer, then = 0 marks

Examiner's Comments

Most candidates got full marks for this question. However, some answers had values such as 99% or 49%, indicating that the idea of inheriting half of each parent's alleles had not been applied correctly.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>3</td><td></td></tr>
<tr><td>29</td><td></td><td></td><td>stem / erythropoietic, cell(s)
and
bone marrow;</td><td>1</td><td>Examiner's Comments

Many candidates gave the correct answers to this question. The most common pair of incorrect responses was hepatocytes and liver. Candidates were possibly recalling the answer to a similar looking question from last year's paper. This was a question where they needed to draw on their AS knowledge and consider the question context. All A2 units contain questions that draw on previous knowledge and candidates should be prepared to make use of such knowledge.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>30</td><td></td><td></td><td>D ☒</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>31</td><td></td><td></td><td>D ☒</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
32		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>Example of a substance transported</th><th>Contains chloroplasts? (✓ or X)</th></tr><tr><td>Guard cell</td><td>Leaf</td><td>carbon dioxide</td><td>✓</td></tr><tr><td>Companion cell</td><td>Vascular tissue / phloem / next to sieve tube</td><td>Sucrose</td><td>X</td></tr><tr><td>Root hair cell</td><td>roots</td><td>Nitrate ions</td><td>X</td></tr></table> ✓ ✓ ✓	3	
			Total	**5**	
33		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**	

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