Chromosome Behaviour in Mitosis (5.2): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 46 marks · about 55 minutes. Answer in the spaces, then check the mark schemes at the end.

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(e) Paneth cells, which are secretory cells, are located between intestinal stem cells at the base of the crypt of Lieberkühn, as shown in Fig. 1.1.

A Paneth cell has a very different appearance to an intestinal stem cell.

Fig. 1.2 is a transmission electron micrograph of a Paneth cell.

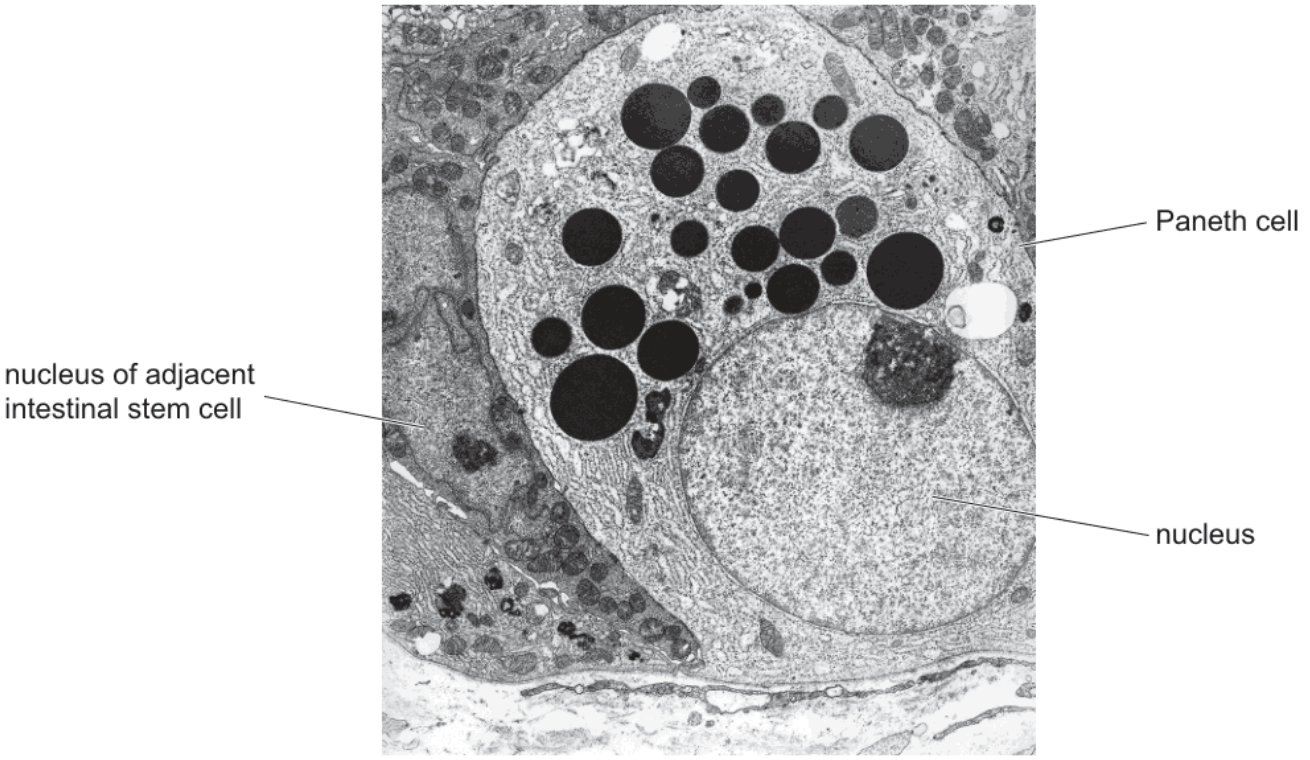


Fig. 1.2

(i) Paneth cells are formed following the mitotic division of an intestinal stem cell during a cell cycle.

Complete the cell cycle shown in Fig. 1.3 by naming, **in sequence**, the stages of mitosis.

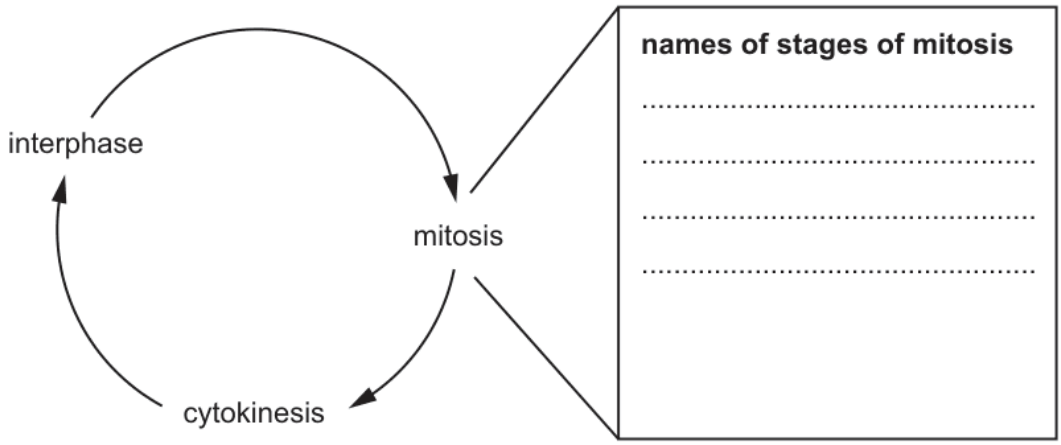


Fig. 1.3

[1]

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Question 2 · Paper 2 · May/June 2024 (22) · Q5(a) · 1 mark

5 During interphase of the cell cycle, individual chromosomes cannot be seen within the nucleus. The genetic material is termed chromatin during this stage.

(a) Changes occur to chromatin during mitosis so that chromosomes become visible.

State what happens to chromatin so that individual chromosomes can be seen during mitosis.

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Question 3 · Paper 2 · October/November 2023 (22) · Q1(b) · 3 marks

(b) When viewed through a microscope, a chromosome is most clearly visible during the metaphase stage of mitosis.

Complete Fig. 1.1 to produce a labelled diagram of the metaphase stage of mitosis in an **animal** cell with **two** chromosomes.

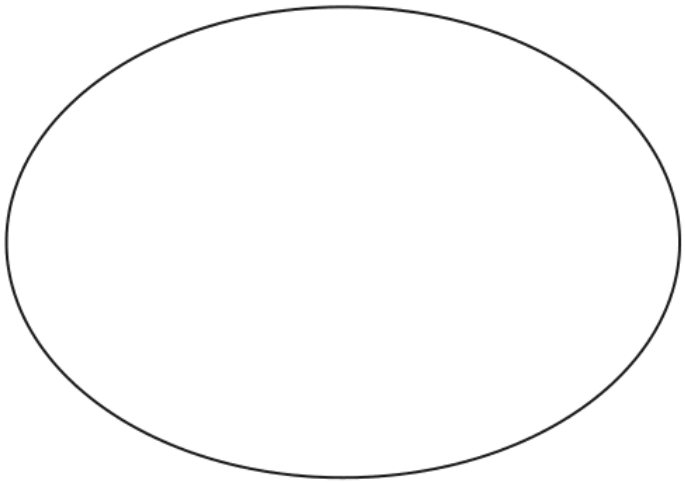


Fig. 1.1

[3]

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Question 4 · Paper 2 · February/March 2025 (22) · Q6(a)(i) · 1 mark

6 **(a)** Fig. 6.1 shows photomicrographs of individual cells from the root tip of an onion, *Allium sp.*, at different times in the mitotic cell cycle.

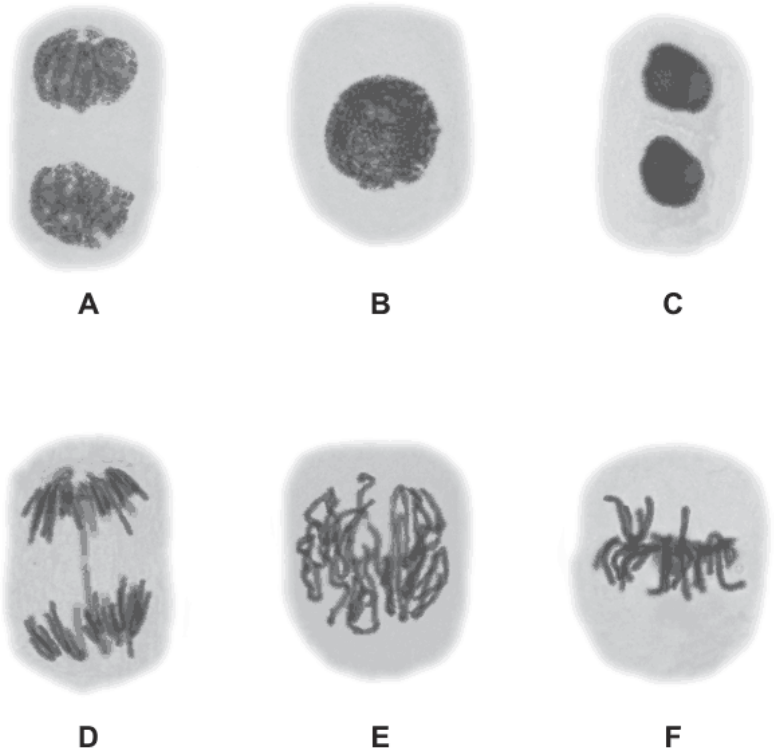


Fig. 6.1

(i) Place the letters representing the individual cells in the correct sequence of the mitotic cell cycle. The first letter has already been filled in.

B					

[1]

Question 5 · Paper 2 · February/March 2025 (22) · Q6(a)(ii) · 2 marks

(ii) Cell **A** in Fig. 6.1 is in one of the main stages of mitosis.

Describe the events that occur during this main stage of mitosis.

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Question 6 · Paper 2 · May/June 2023 (23) · Q1(a)(i) · 2 marks

1 The cells in a tissue are often at different stages of the cell cycle.

(a) Fig. 1.1 shows cells at different stages of the cell cycle.

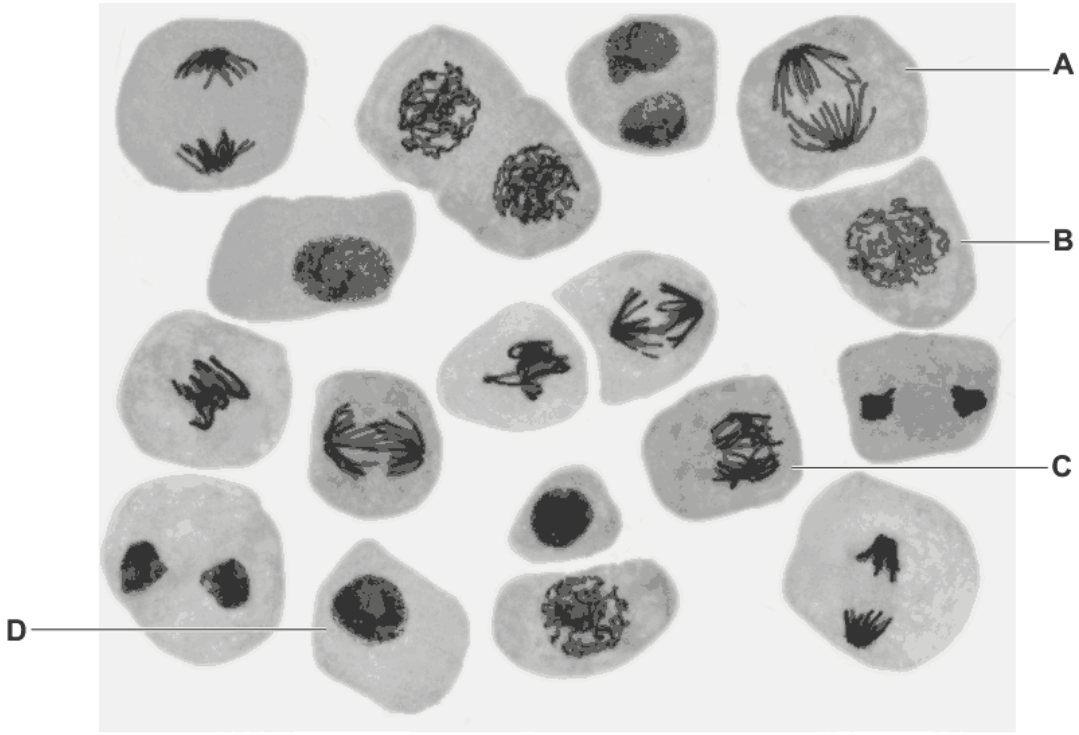


Fig. 1.1

(i) Identify the stages of mitosis occurring in the cells labelled **B** and **C** in Fig. 1.1.

B .....

C .....

[2]

Question 7 · Paper 2 · May/June 2023 (23) · Q1(a)(ii) · 3 marks

(ii) Describe the behaviour of the chromosomes in the stage of mitosis shown in cell **A** in Fig. 1.1.

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2 **(a)** Fig. 2.1 shows a cell at one of the main stages of mitosis in the mitotic cell cycle.

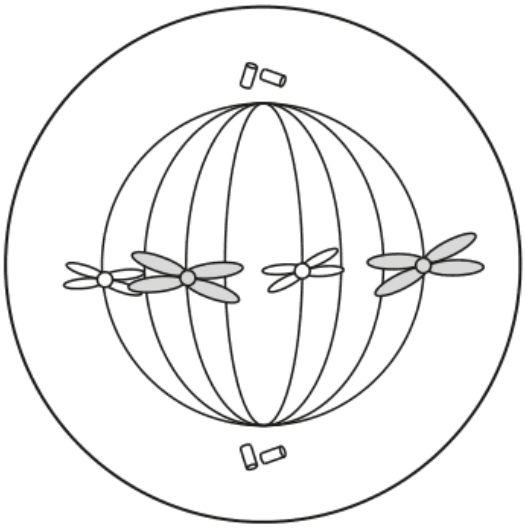


Fig. 2.1

(i) Name the stage of mitosis shown in Fig. 2.1.

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(ii) Fig. 2.2 shows the cell in Fig. 2.1 at the start of cytokinesis.

Complete Fig. 2.2 to show the daughter chromosomes in each nucleus.

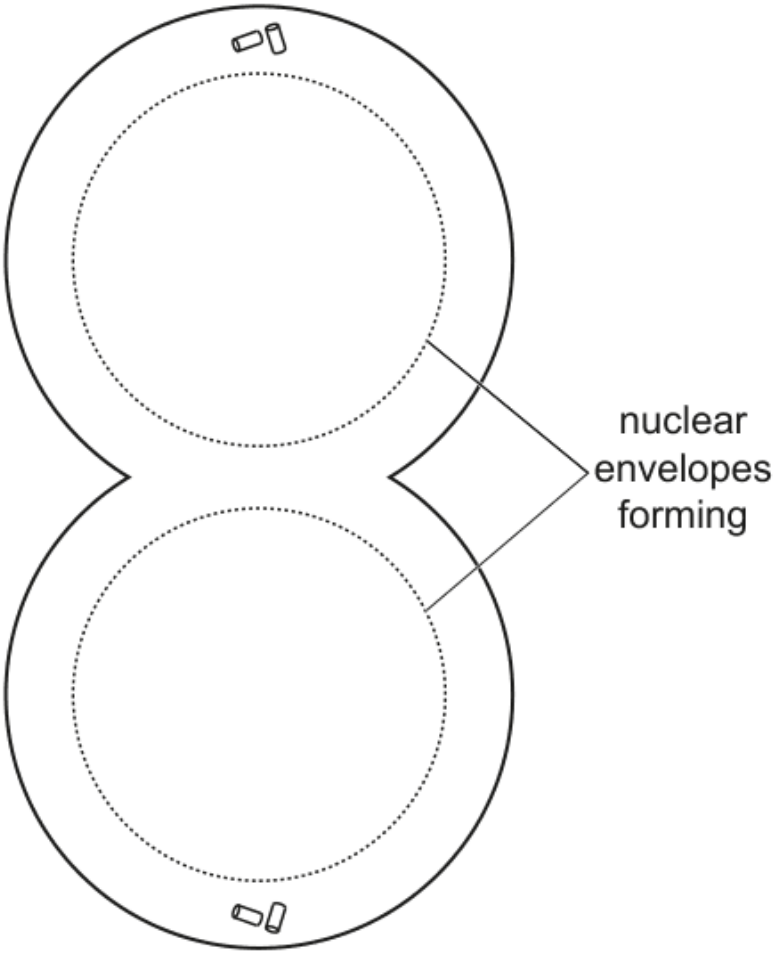


Fig. 2.2

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Question 10 · information from earlier in the question

4 The early development of an animal involves divisions of the zygote and daughter cells by mitosis to form an embryo consisting of genetically identical cells.

Fig. 4.1 shows several cells at various stages of the cell cycle in an embryo of whitefish, *Coregonus artedi*.

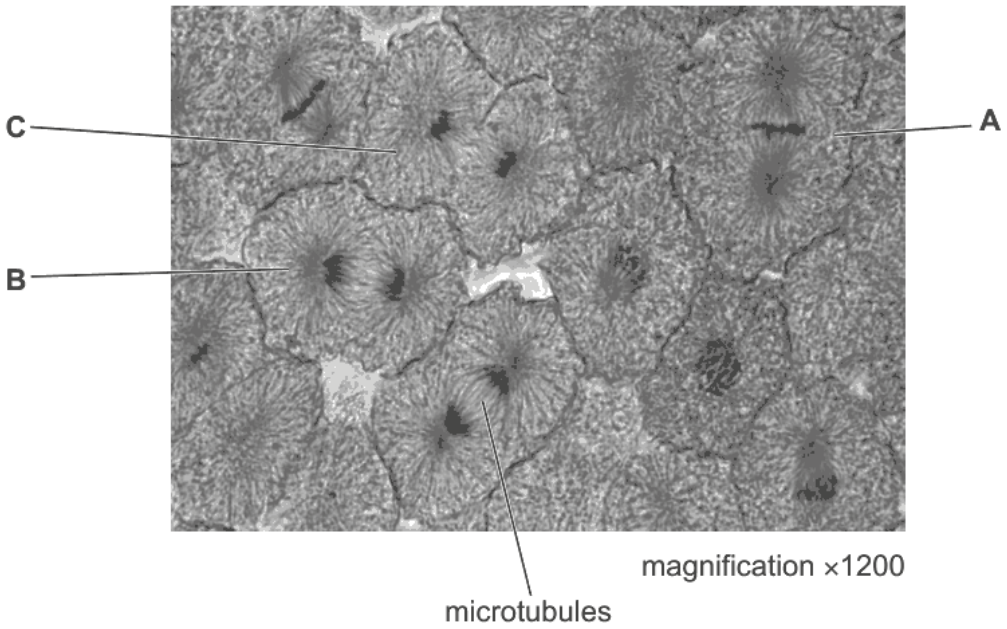


Fig. 4.1

Question 10 · Paper 2 · October/November 2022 (23) · Q4(a)(ii) · 3 marks

(ii) Fig. 4.1 shows microtubules in the cells that are dividing.

Describe the role of microtubules in mitosis.

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Question 11 · Paper 2 · October/November 2022 (23) · Q4(a)(iii) · 3 marks

(iii) State what happens in cell **C**, shown in Fig. 4.1, until two new cells are formed.

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Question 12 · Paper 2 · October/November 2022 (21) · Q6(a)(i) · 1 mark

6 (a) Fig. 6.1 is a photomicrograph of plant cells in stages of the mitotic cell cycle.

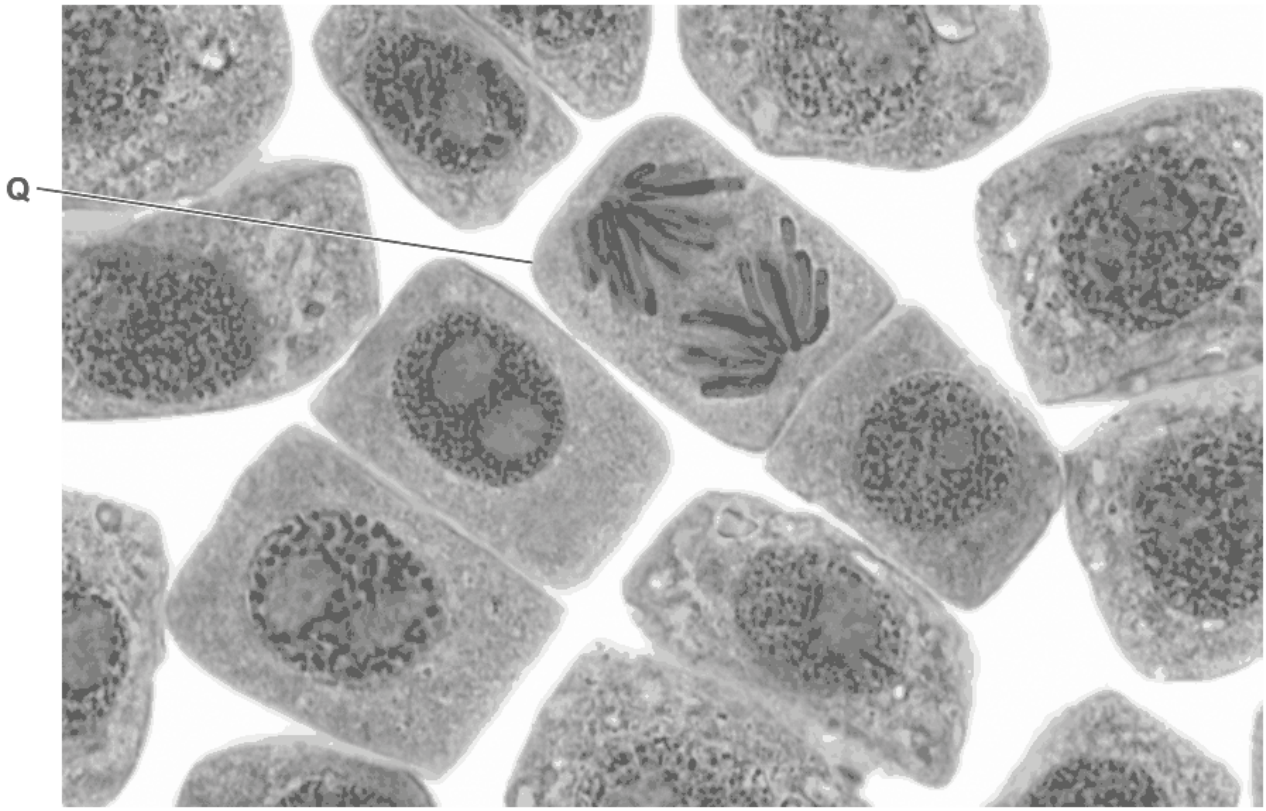


Fig. 6.1

(i) Name the stage of mitosis shown in cell **Q**.

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(b) Uncontrolled mitosis can cause cancer in humans.
Paclitaxel is a drug used in the treatment of some forms of cancer.

Researchers investigated the effect of Paclitaxel on the mitotic cell cycle of cancer cells.

- The cancer cells were grown for two days and then divided into groups.
- Each group was treated with a different concentration of Paclitaxel.

After 28 hours (one cell cycle):

- the percentage of cells in stages of mitosis was calculated
- the ratio of the number of cells in anaphase to the number of cells in metaphase was determined.

The results of the investigation are shown in Fig. 6.2.

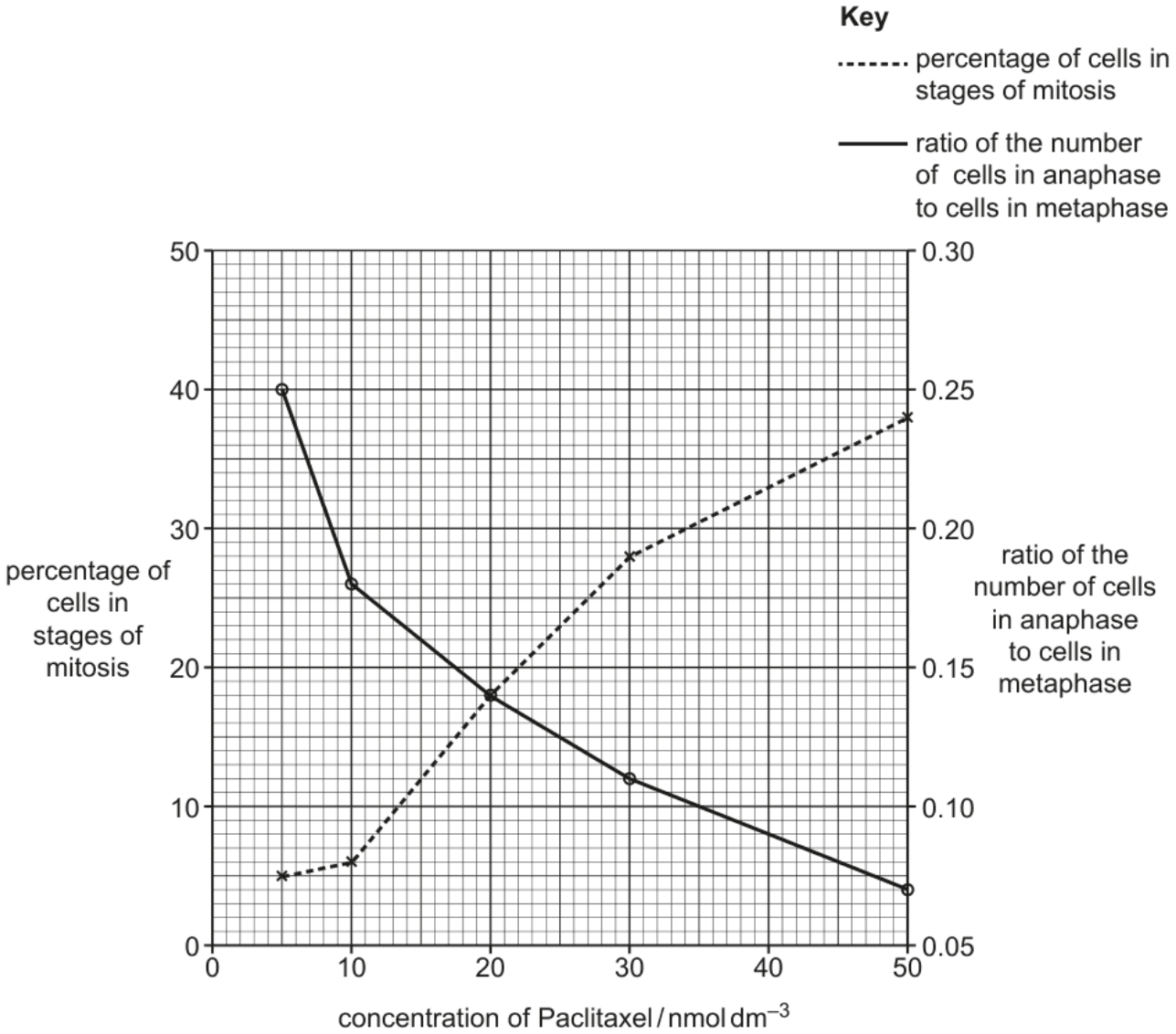


Fig. 6.2

With reference to Fig. 6.2, describe the results and suggest an explanation for the effect of Paclitaxel on the mitotic cell cycle.

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Question 14 · Paper 2 · May/June 2021 (22) · Q1(a)(i) · 2 marks

1 **(a)** Fig. 1.1 is a photomicrograph of a region of eukaryotic tissue. Some of the cells are in stages of mitosis.

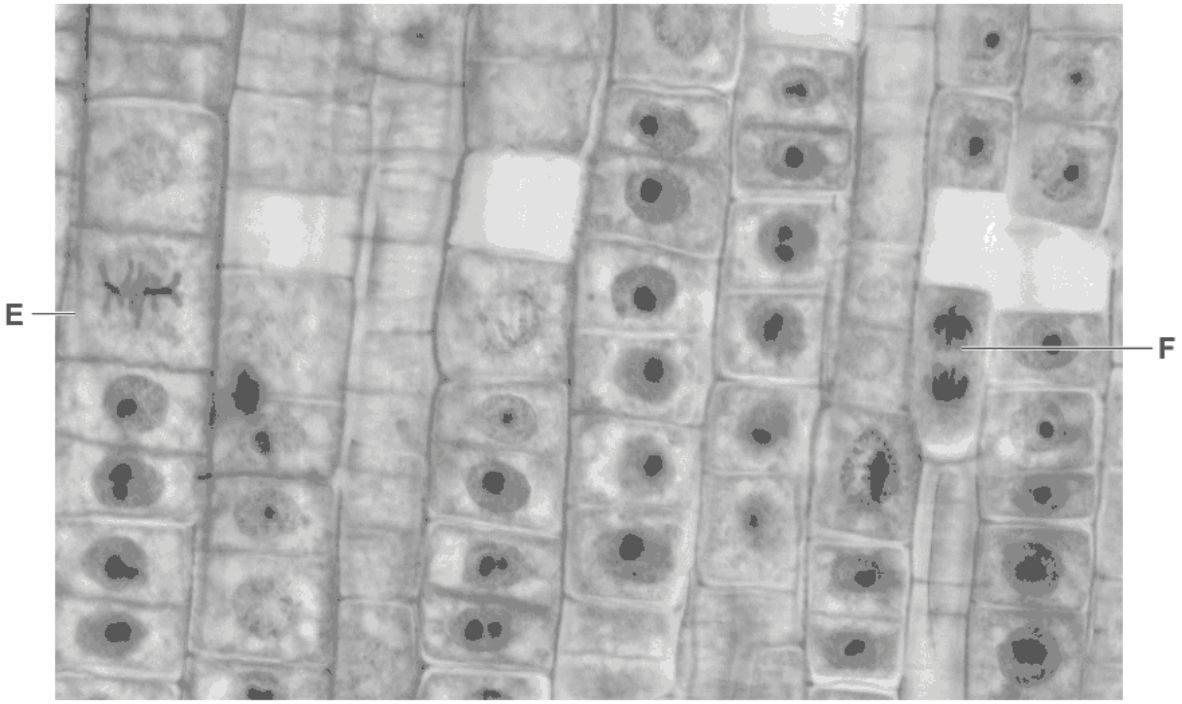


Fig. 1.1

(i) Identify which stage of mitosis is shown in cell **E** and in cell **F** in Fig. 1.1.

E .....

F ..... [2]

Question 15 · Paper 2 · May/June 2021 (22) · Q1(a)(ii) · 1 mark

(ii) Microtubules are present within the cells that are in stages of mitosis, but these are not visible in Fig. 1.1.

State the function of microtubules in mitosis.

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Question 16 · Paper 2 · May/June 2018 (22) · Q4(a) · 3 marks

4 Fig. 4.1 is a photomicrograph showing some cells in interphase and some cells in stages of mitosis.

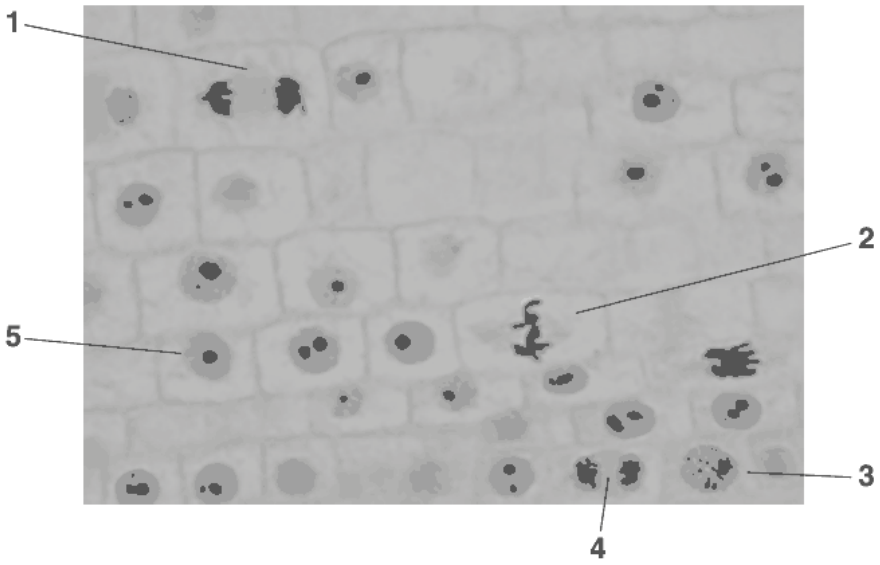


Fig. 4.1

(a) Choose from the cells labelled **1** to **5** in Fig. 4.1 to identify the cell in which:

- the nuclear envelope is reassembling .....
- the spindle begins to form .....
- there is a high rate of transcription and translation .....

[3]

Question 17 · Paper 2 · May/June 2018 (22) · Q4(b) · 2 marks

(b) Cell **2** is in a stage of mitosis that occurs before the stage of mitosis shown in cell **1**.

Outline the changes that would occur from the stage of mitosis shown in cell **2** to the stage shown in cell **1**.

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Question 18 · Paper 2 · February/March 2018 (22) · Q6(b)(i) · 3 marks

(b) Fig. 6.2 is a photomicrograph of root tip cells at different stages in the cell cycle. A cell in interphase is labelled.

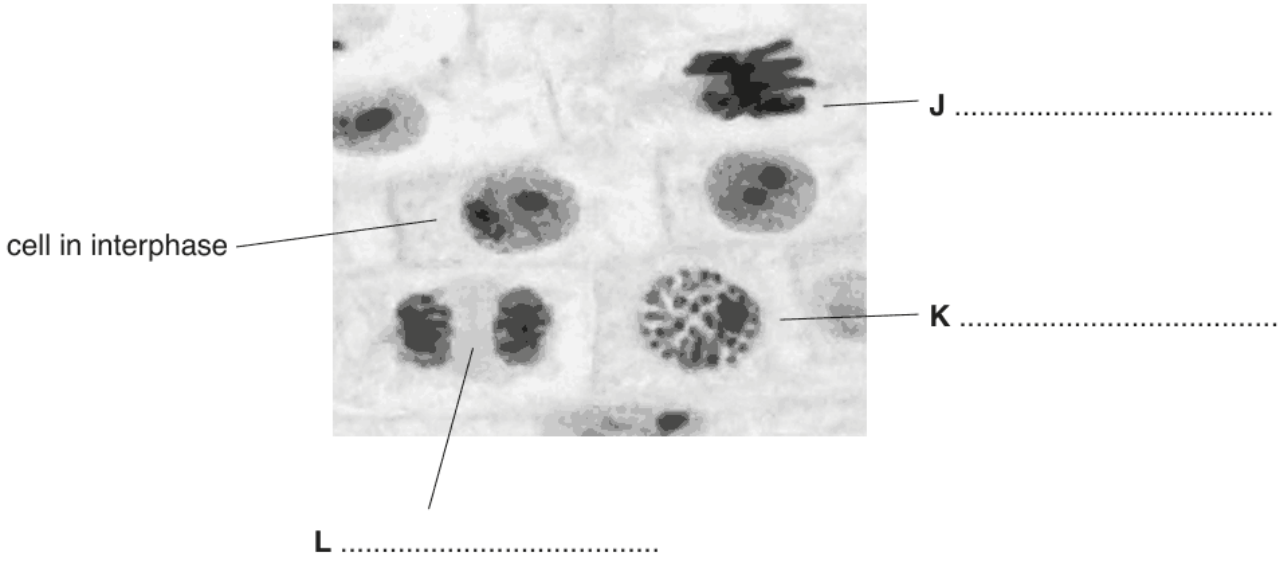


Fig. 6.2

(i) Name the stage of mitosis shown in each of cells **J**, **K** and **L** in Fig. 6.2.

Write your answer in the space next to each letter on Fig. 6.2. [3]

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Question 19 · Paper 2 · October/November 2017 (22) · Q1(a) · 1 mark

1 The root apical meristem is a region of undifferentiated cells in the root tips of plants. Mitosis occurs in this region.

(a) Fig. 1.1 is an image of the root tip of *Allium* as observed using a microscope with a low-power objective lens.

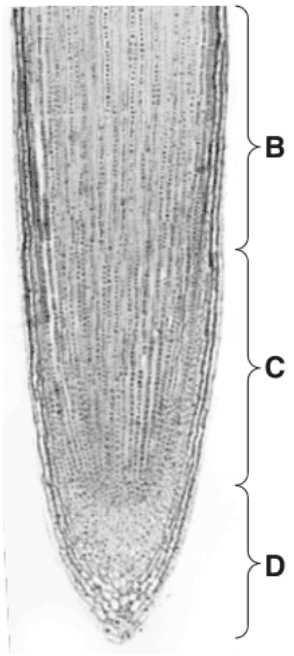


Fig. 1.1

State which region, **B**, **C**, or **D**, should be chosen in order to observe the highest proportion of cells in stages of mitosis.

Question 20 · Paper 2 · October/November 2017 (22) · Q1(b)(ii) · 2 marks

(ii) Describe the behaviour of the nuclear envelope during mitosis.

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2 Fig. 2.1 is a photomicrograph of a longitudinal section (LS) through a root tip. Two different regions are visible:

- the root apical meristem
- the root cap.

Cells in the root cap synthesise a gel-like, sticky secretion known as mucilage, which is important in reducing friction between soil and the growing root. It is composed mainly of polysaccharides and also contains some amino acids and enzymes.

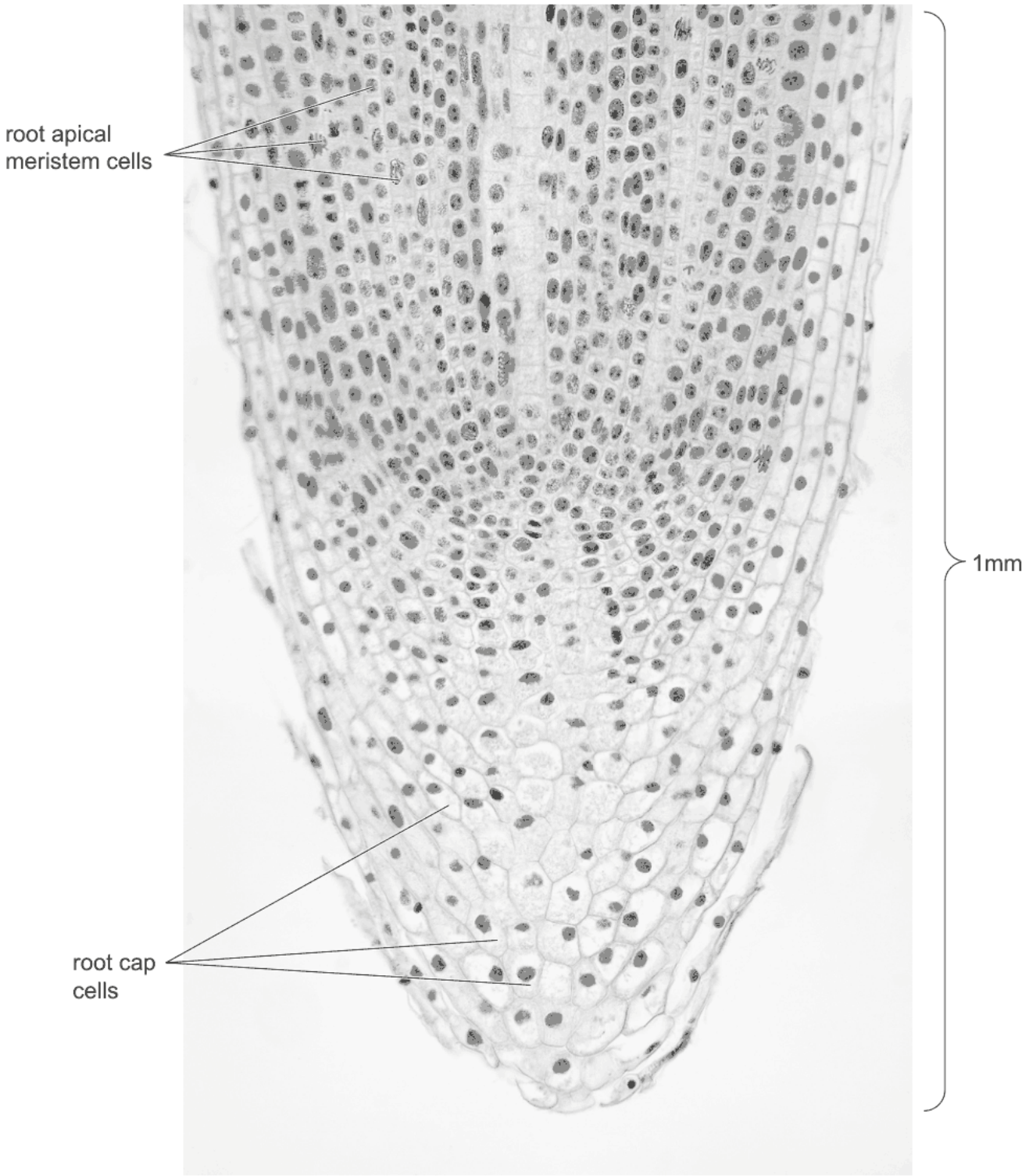


Fig. 2.1

(a) Describe **three** differences, **visible** in Fig. 2.1, between root apical meristem cells and root cap cells.

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(d) Fig. 1.2 shows plant cells in a root tip where cell division by mitosis is taking place.

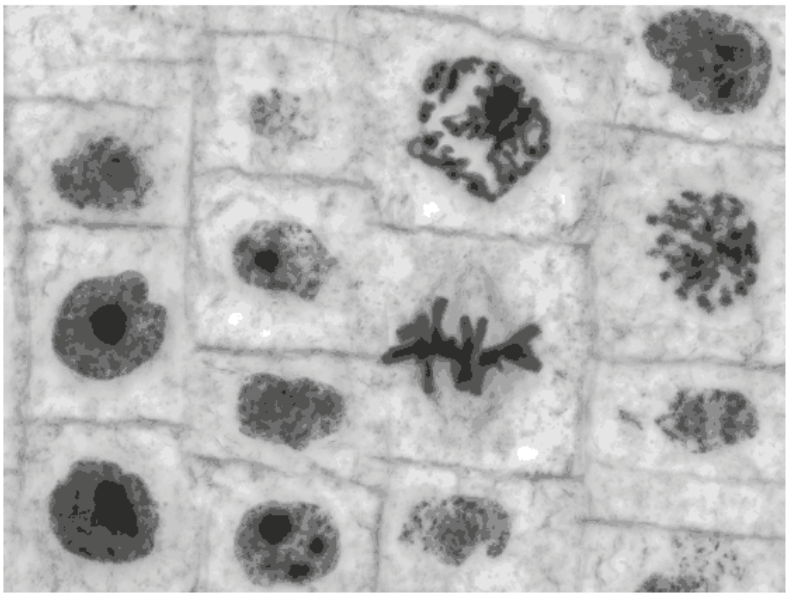


Fig. 1.2

Identify **two** cells in Fig. 1.2 that are in different stages of mitosis.

Draw a label line to each cell and add the name of the stage of **mitosis** that is shown by the cell. [2]

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Mark schemes

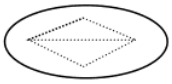
Question 1 · Paper 2 · October/November 2025 (22) · Q1(e)(i) · 1 mark

1(e)(i)	prophase metaphase anaphase telophase ; **R** if interphase or cytokinesis stated	1

Question 2 · Paper 2 · May/June 2024 (22) · Q5(a) · 1 mark

5(a)	coiling / supercoiling / condensation / becomes more compact / AW ; e.g. becomes shorter and fatter	1

Question 3 · Paper 2 · October/November 2023 (22) · Q1(b) · 3 marks

1(b)	*max 2 if the spindle / centrioles extend outside the cell*	3
	1 two chromosomes, each with two chromatids, drawn approximately along central equator area ; **R** if drawn as a, bivalent / homologous pair (close together or further apart) **A** if equator is drawn across wider diameter	
	2 plus one other drawn feature ; e.g. spindle  *diamond/oval shape, minimum three spindle fibres as shown* **or** spindle fibre from each pole connecting to centromere area of one chromosome **or** centromere drawn holding sister chromatids together **or** pair of centrioles at each pole	
	3 any three labels ; **I** label to chromosome e.g. (sister / identical) chromatid/s centromere spindle / spindle fibres spindle equator / metaphase plate **A** equator *if spindle / spindle fibre label given* centriole/s **A** centrosome(s) / pole(s)	
	annotations may contain more than one acceptable label *label lines to touch structure*	

Question 4 · Paper 2 · February/March 2025 (22) · Q6(a)(i) · 1 mark

6(a)(i)	**B** E F D A C ;	1

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Question 5 · Paper 2 · February/March 2025 (22) · Q6(a)(ii) · 2 marks

6(a)(ii)	*any **two** from:* nuclear envelope re-forms (around each group of chromosomes) ; nucleolus / nucleoli, re-form(s) ; (daughter) chromosomes uncoiling / AW ; spindle breaking down / AW ;	**2**

Question 6 · Paper 2 · May/June 2023 (23) · Q1(a)(i) · 2 marks

1(a)(i)	**B** prophase ; **I** early / mid / late **C** metaphase ; **A** early anaphase	**2**

Question 7 · Paper 2 · May/June 2023 (23) · Q1(a)(ii) · 3 marks

1(a)(ii)	*any **three** from:* **A** identical chromatids for sister chromatids *assume points are related to anaphase, unless stated as telophase* sister / identical, chromatids (of each chromosome) separate / AW ; **A** *idea of spindle fibres pulling apart sister chromatids in context of end of metaphase / start of anaphase* movement of / AW, daughter chromosomes / chromosomes / (sister) chromatids, to (opposite) poles (of cell) ; **R** *if context is a chromosome composed of two chromatids* **R** *if context is movement of sister chromatids to same pole* **I** ends of cell movement (to opposite poles) by spindle fibres, contracting / pulling ; **I** moved by spindle fibres centromeres, qualified ; e.g. centromeres divide at start of anaphase (to separate sister chromatids) centromeres leading (during movement so arms of chromosome lagging) *if telophase stated, mark behaviour of chromosomes in telophase to max 2:* (daughter) chromosomes at poles ; **A** sister chromatids at poles **A** *ref. to* two separate groups of (daughter) chromosomes (chromosomes) become diffuse / become long and thin / decondense / uncoil ; **A** become chromatin *ref. to* re-forming nucleolus ;	**3**

Question 8 · Paper 2 · February/March 2022 (22) · Q2(a)(i) · 1 mark

2(a)(i)	metaphase ;	1

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Question 9 · Paper 2 · February/March 2022 (22) · Q2(a)(ii) · 2 marks

2(a)(ii)	4 chromosomes within dotted line of both newly forming cells **and** each chromosome consisting of one chromatid ; **ignore** shape / shading labels not required centromeres do not need to be shown two obvious pairs (of chromosomes) shown in each of the two re-forming nuclei ; e.g. two dark and two light two longer and two shorter	**2**

Question 10 · Paper 2 · October/November 2022 (23) · Q4(a)(ii) · 3 marks

4(a)(ii)	*any **three** from:* *prophase* **1** form spindle, apparatus / fibres ; **2** attached to, centromere / kinetochore ; **A** remain attached to centromere during, prophase / metaphase / anaphase *(late) prophase* **3** move / AW, chromosomes / sister chromatids, to, (spindle) equator / metaphase plate **or** *during metaphase / until anaphase* maintain chromosomes at (spindle) equator ; **A** sister chromatids **R** chromatids unqualified *anaphase* **4** disassembly / shortening, of microtubules / spindle fibres ; **5** centromeres divide **or** chromatids move to (opposite), poles ; AW **R** sides **6** daughter nuclei receive, one chromatid of each chromosome ; **A** daughter nuclei receive a full complement of chromosomes / AW **7** AVP ; e.g. pole to pole spindle fibres lengthen to extend the cell	**3**

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Question 11 · Paper 2 · October/November 2022 (23) · Q4(a)(iii) · 3 marks

4(a)(iii)	**I** telophase *any **three** from:* **1** nuclear envelope (re)forms around each group of chromosomes **;** **R** nuclear membrane **2** uncoiling / decondensing / AW, of chromosomes **;** **A** ref. to chromatin **3** nucleolus / nucleoli (in each nucleus), reform(s) / reappears / visible **;** **4** organelles distributed between two halves of cell **;** **5** cytokinesis / division of cytoplasm **; A** cytoplasm splits **6** cleavage furrow forms **;** **A** described e.g. 'pinching in' of (cell surface) membrane **A** equator of cell pinches in / cell membrane constricts **R** cell plate **7** AVP **;** e.g. ref to ring of microfilaments / contractile ring, draws membrane closer together / AW **I** microtubules	**3**

Question 12 · Paper 2 · October/November 2022 (21) · Q6(a)(i) · 1 mark

6(a)(i)	anaphase ; **1**

Question 13 · Paper 2 · October/November 2022 (21) · Q6(b) · 4 marks

6(b)	*any **four** from:* as concentration of Paclitaxel increases, the ratio of cells in anaphase to those in metaphase reduces / there are a greater proportion of cells in metaphase than in anaphase **;** as the concentration of Paclitaxel increases, the percentage of cells in mitosis is increasing **;** use of data to support a described trend **;** *idea that* as the concentration increases, more cells, stop in metaphase / spend more time in metaphase / fewer cells are able to move into anaphase **;** suggested mechanism for halt in metaphase **;** e.g. centromeres do not divide prevents spindle fibres shortening prevents movement of chromatids to opposite poles (because sister chromatids still held together) cells do not pass the (metaphase) checkpoint AVP **;**	**4**

Question 14 · Paper 2 · May/June 2021 (22) · Q1(a)(i) · 2 marks

1(a)(i)	**E** = metaphase **;** **F** = anaphase **; I** early / mid / late **R** more than one stage given for either **E** or **F**	**2**

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Question 15 · Paper 2 · May/June 2021 (22) · Q1(a)(ii) · 1 mark

1(a)(ii)	*any one from* (assemble) to form / become part of / AW, spindle fibres / spindle ; attach to, centromere ; **A** kinetochore *for centromere* **A** form (part of) kinetochore **A** to connect, chromatid / chromosome, to, spindle / spindle fibres **I** to connect, chromosome / centromere, to centrosome example of allowing movement of, chromosomes / chromatids ; e.g. **A** to, pull chromosomes / orientate chromosomes, at equator **A** to pull (sister) chromatids apart (at anaphase) **A** to move, (sister) chromatids / daughter chromosomes, to poles	**1**

Question 16 · Paper 2 · May/June 2018 (22) · Q4(a) · 3 marks

4(a)	1 / 4 ; 3 3 ; 5 ;

Question 17 · Paper 2 · May/June 2018 (22) · Q4(b) · 2 marks

4(b)	*two from:* centromere (of each chromosome) divides ; **A** sister chromatids separated at the centromere spindle fibres, contract / shorten ; **A** spindle contracts (sister / identical) chromatids / daughter chromosomes, pulled / move, to opposite poles ; **A** (sister) chromatids separated **I** chromosomes are at opposite poles centromeres, leading (towards poles) / AW ; **A** ref. to V-shape / diagram	**2**

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Question 18 · Paper 2 · February/March 2018 (22) · Q6(b)(i) · 3 marks

6(b)(i)	**J** metaphase ; **K** prophase ; **L** telophase ; **A** anaphase	**3**

Question 19 · Paper 2 · October/November 2017 (22) · Q1(a) · 1 mark

1(a)	**C** ; **R** if more than one area given	**1**

Question 20 · Paper 2 · October/November 2017 (22) · Q1(b)(ii) · 2 marks

1(b)(ii)	*two from* disassembles / breaks down / disintegrates / AW, at, prophase **; A** prometaphase re-forms / re-assembles / AW**,** after anaphase / at telophase **;** *if mp 1 and 2 not gained, one mark can be awarded for knowledge of disassembles and then reassembles* detail **;** e.g. breakdown into vesicles re-forms from vesicles / vesicles fuse to form new membranes re-forms around both sets of (daughter) chromosomes	**2**

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Question 21 · Paper 2 · May/June 2023 (22) · Q2(a) · 3 marks

2(a) *one mark each row to max 3* **3**
or = *requires either root apical meristem or root cap cells statement*

root apical meristem cells		***root cap cells***
(some) cells in, mitosis / different stages of cell cycle ;	**or**	no cells in mitosis / all cells in interphase ; **A** no chromosomes visible / only chromatin visible
(some) cells in, prophase / metaphase / telophase ; **A** chromosomes visible (in some cells)		N/A
(generally) smaller (size) ; **A** less cytoplasm	**or**	(generally) larger (size) ; **A** more cytoplasm
larger nucleus in proportion to, size of cell / quantity of cytoplasm ;	**or**	smaller nucleus in proportion to, size of cell / quantity of cytoplasm ;
nucleoli / nucleolus, (more) visible / prominent / AW ;	**or**	nucleoli / nucleolus, not visible / not prominent / AW ;
(generally all) cuboidal / same shape ; **A** rectangular / regular (shape)	**or**	variety of shapes / shape described ; **A** irregular / circular
ref. arrangement of cells ; e.g. rows / chains / tightly packed / compact / uniform / regular	**or**	*ref.* arrangement of cells ; e.g. irregular / loosely packed / more intercellular spaces
AVP ; e.g. all / more, cells have nuclei cells not, sloughing off / detaching	**or**	AVP ; e.g. some have no nucleus some cells, sloughing off / detaching

Question 22 · Paper 2 · October/November 2021 (22) · Q1(d) · 2 marks

1(d)	metaphase label to metaphase cell ; prophase label to one of the prophase cells ;	**2**

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