Cambridge International AS & A Level

BIOLOGY (9700) PAPER 2

Past Paper Questions By Topic
+ Answer Scheme

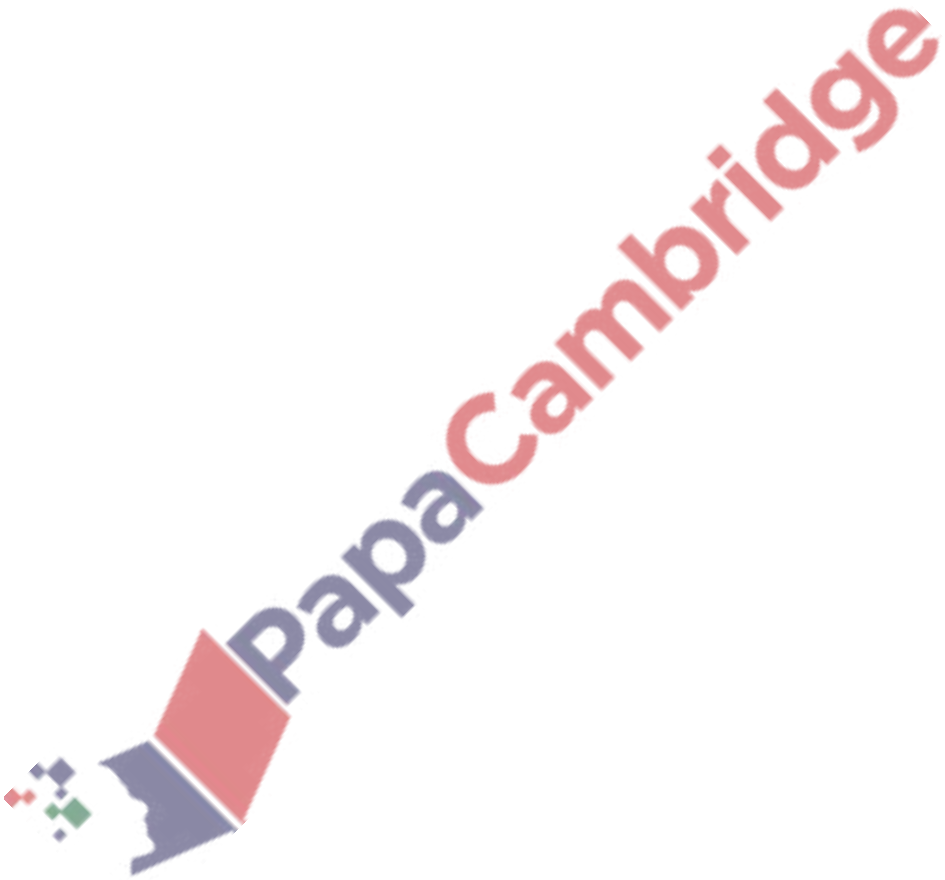
2015 - 2020

Complete Syllabus

PapaCambridge

Chapter 5

The mitotic cell cycle



5.1 Replication and division of nuclei and cells

46. 9700_s20_qp_21 Q: 2

Fig. 2.1 shows some stages of the cell cycle in the meristematic tissue in the root tip of a plant. Three of these stages, **P**, **Q** and **R**, are identified in Table 2.1.

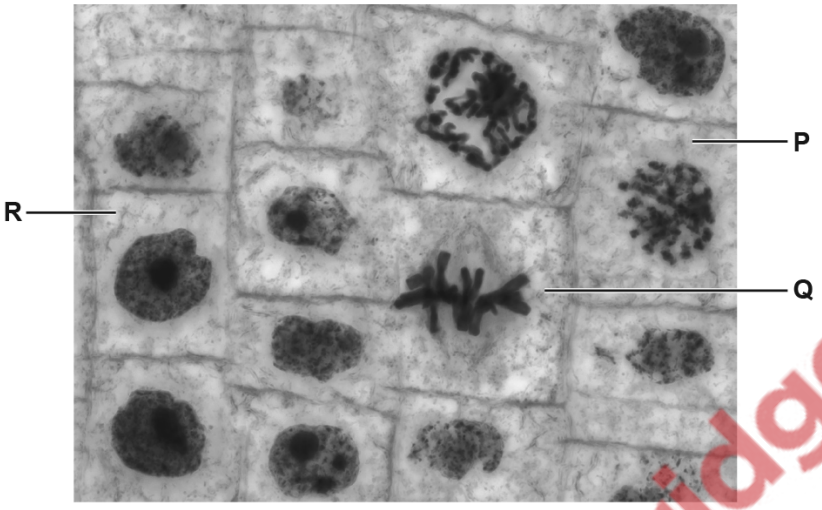


Fig. 2.1

(a) Complete Table 2.1 by stating **one** feature, **visible in Fig. 2.1**, that is used to identify each stage.

Table 2.1

cell	stage of cell cycle	reason
P	prophase of mitosis	
Q	metaphase of mitosis	
R	interphase	

[3]

(b) **(i)** Draw a labelled diagram to show **one** chromosome at metaphase of mitosis.

On the chromosome you have drawn add labels to show:

- the position of a telomere
- a chromatid
- the centromere.

[4]

(ii) State the type of protein that is associated with DNA in chromosomes.

..... [1]

(iii) Describe how the spindle is involved during the process of mitosis.

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..... [3]

[Total: 11]

47. 9700_w20_qp_21 Q: 1

(a) Fig. 1.1 is a diagram of a human chromosome at a stage in mitosis.

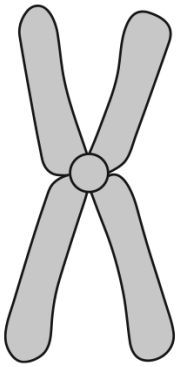

Fig. 1.1

(i) The paragraph describes the structure of the chromosome shown in Fig. 1.1.

Complete the paragraph using the most appropriate term in each space provided.

The chromosome shown in Fig. 1.1 has two genetically identical ..... joined at a ..... . The chromosome is composed of two DNA molecules, each wrapped around proteins known as ..... proteins.

[3]

(ii) State **one** stage during mitosis when the chromosome would appear as shown in Fig. 1.1.

..... [1]

(iii) Suggest the role of ATP in the process of mitosis.

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..... [2]

(b) Prokaryotes divide by a process known as binary fission.

Fig. 1.2 shows some of the stages in binary fission.

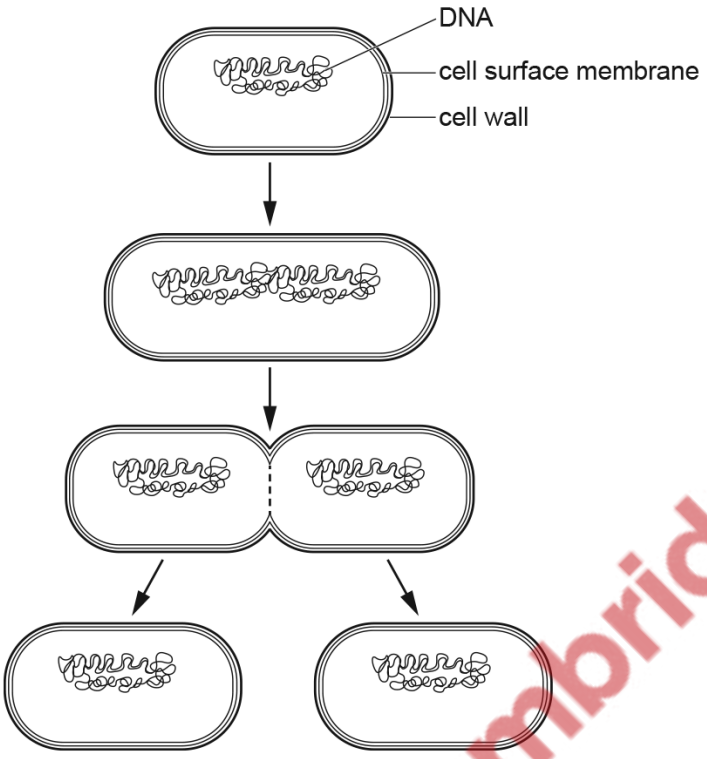

Fig. 1.2

With reference to Fig. 1.2, identify **two** events that occur during binary fission that do **not** occur during mitosis in human cells.

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..... [2]

[Total: 8]

48. 9700_w20_qp_23 Q: 3

Fig. 3.1 shows the nematode worm, *Caenorhabditis elegans*.

magnification ×250

Fig. 3.1

Stem cells of *C. elegans* have been studied.

Fig. 3.2 shows the change in mass of DNA per nucleus in a stem cell during one cell cycle.

1 pg = 1 × 10^{-12} g

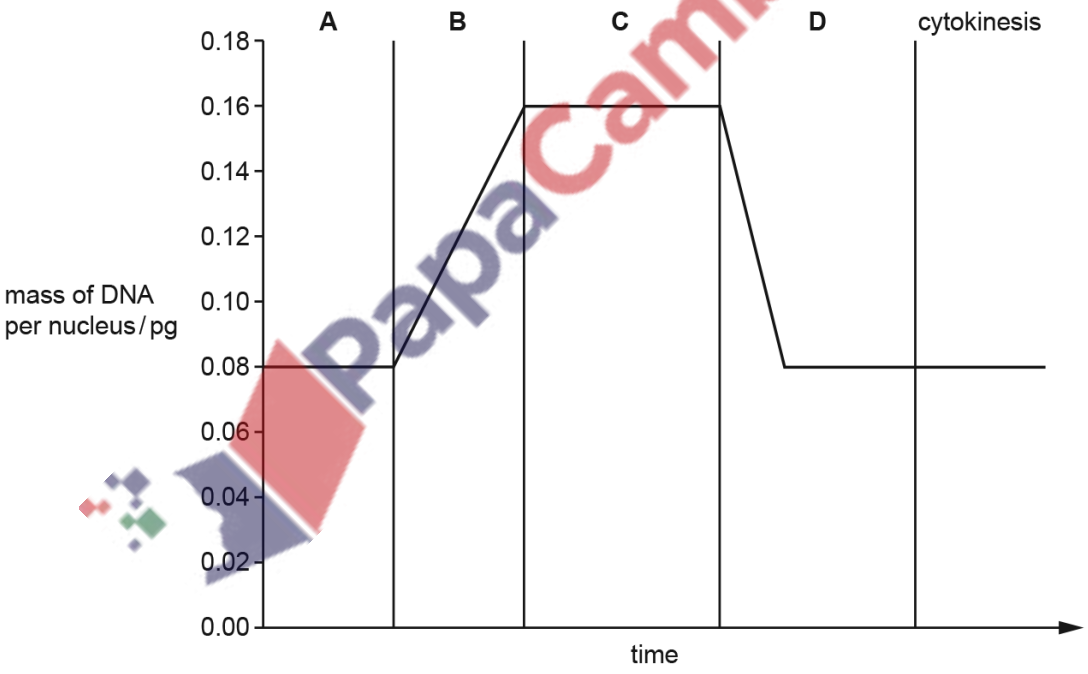

Fig. 3.2

(a) (i) State the phases of interphase shown by **A** and **B** in Fig. 3.2.

A .....

B .....

[2]

(ii) State the stage of mitosis shown by **D** in Fig. 3.2.

..... [1]

(iii) Outline what happens in a cell in preparation for cytokinesis.

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..... [2]

(iv) A stem cell of a female *C. elegans* has 12 chromosomes.

Complete Table 3.1 to show the number of nuclei within the stem cell in stages **A**, **B** and **D** of the cell cycle shown in Fig. 3.2 **and** the number of chromosomes in each nucleus during these stages.

Table 3.1

	stage of the cell cycle		
	A	**B**	**D**
number of nuclei within the stem cell			
number of chromosomes in each nucleus			

[2]

(b) Young nematodes have stem cells throughout the body.

Fig. 3.3 summarises three cell cycles of one of these stem cells.

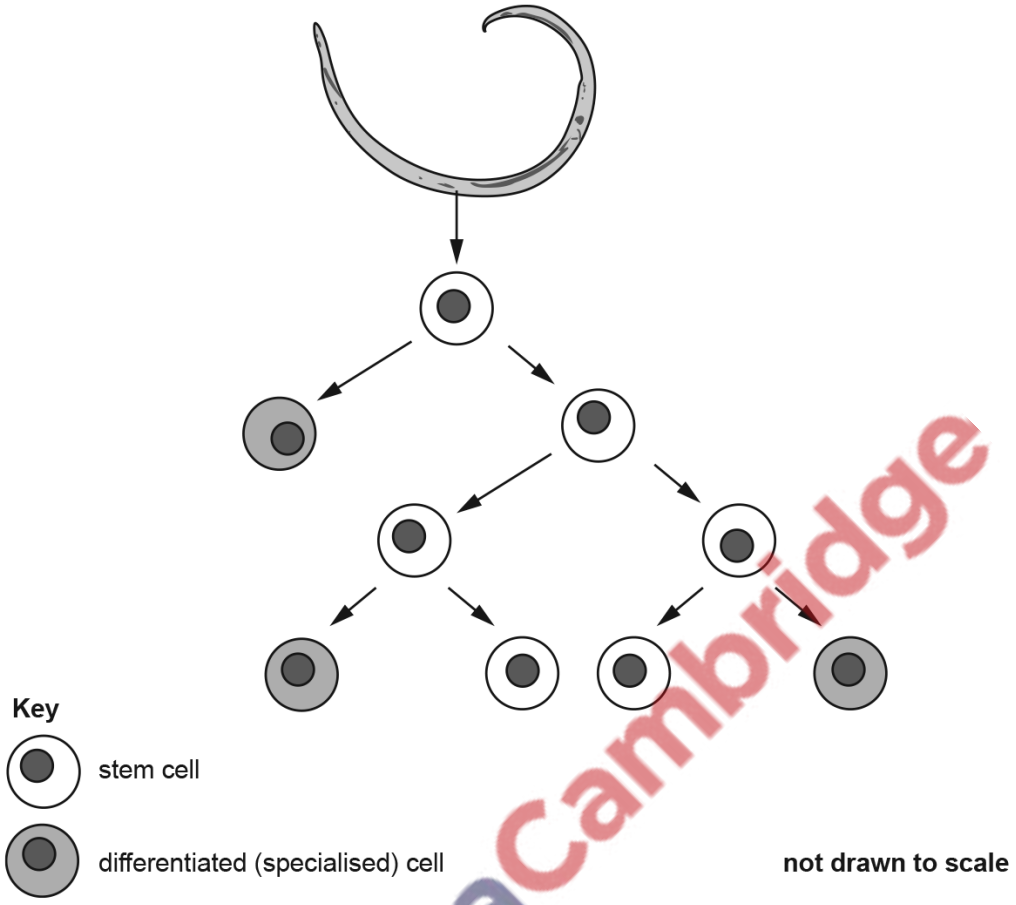

Fig. 3.3

With reference to Fig. 3.3, outline the role of stem cells in animals.

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..... [3]

[Total: 10]

49. 9700_s18_qp_23 Q: 1

Fig. 1.1 is a photomicrograph of root tip meristem. Different stages of the cell cycle are visible. Some cells are in the same stage of the cell cycle and some are in the same stage of mitosis.

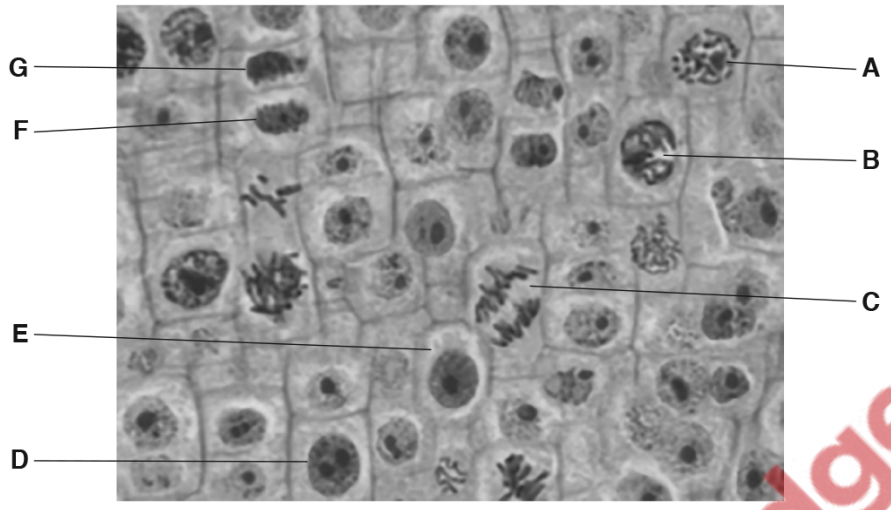

Fig. 1.1

(a) Cell **D** and cell **E** are in the same stage of the cell cycle.

State the difference between the nucleus of cell **D** and cell **E**.

.....

.....[1]

(b) Name the stage of mitosis occurring in each of cells **A**, **B** and **C**.

cell **A** .....

cell **B** .....

cell **C** .....[3]

(c) Cells **F** and **G** are newly formed cells. Cytokinesis has occurred with the formation of a cell plate.

Describe the events that have occurred in the stage of mitosis immediately **before** cytokinesis.

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.....[2]

[Total: 6]

50. 9700_w18_qp_22 Q: 3

The response of the human body to tissue damage depends on the types of tissues involved. Epithelial tissue, liver tissue and cardiac muscle tissue each respond differently to damage.

- Epithelial tissue of the gas exchange system contains stem cells.
- Liver tissue contains cells in a non-dividing state that can enter a cell cycle when stimulated.
- Cardiac muscle tissue contains cells that cannot divide at all. Damage is permanent and is associated with scar tissue formation.

(a) Explain the importance of mitosis in the repair of damaged tissue.

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..... [2]

(b) Explain why stem cells are important in tissue repair.

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..... [2]

(c) Following liver tissue damage, chemicals are produced and released into the circulation. These chemicals are able to stimulate the liver cells to help tissue repair.

Explain how this is an example of cell signalling.

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..... [3]

[Total: 7]

51. 9700_m17_qp_22 Q: 3

Catalase is an enzyme that catalyses the breakdown of hydrogen peroxide, a toxic waste product of metabolism.

$$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$$

Fig. 3.1 shows the results of an investigation into the effect of hydrogen peroxide concentration on the rate of the catalase-controlled reaction, with and without the presence of two different inhibitors.

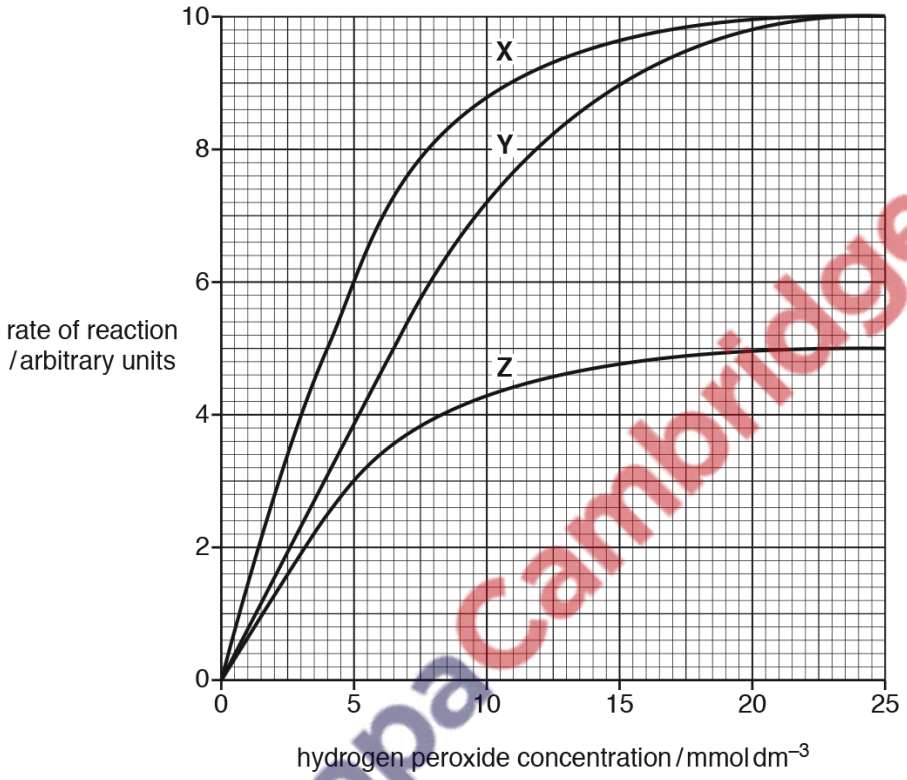

Fig. 3.1

(a) The inhibitors used in the investigation have different modes of action.

Identify which of curves **X**, **Y** and **Z** are the results for:

- the reaction with the non-competitive inhibitor
- the reaction with the competitive inhibitor
- the reaction without any inhibitor.

non-competitive inhibitor .....

competitive inhibitor .....

without any inhibitor .....

[1]

(b) With reference to Fig. 3.1, compare the maximum rate of reaction, V_{max}, and the Michaelis-Menten constant, K_m, for curves **X**, **Y** and **Z**.

V_{max} .....

.....

.....

.....

K_m .....

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[4]

Hydrogen peroxide has a harmful effect on cells. One effect is to damage DNA.

(c) Describe the structure of DNA.

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..... [4]

(d) The cell has mechanisms to repair the damage to DNA caused by hydrogen peroxide. Errors in repair may cause a change to the structure of DNA.

Studies have investigated possible risks associated with foods and drinks that contain hydrogen peroxide. This is because the compound can be considered a mutagen. Mutagens cause mutations.

Explain why hydrogen peroxide can be considered a mutagen.

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..... [2]

[Total: 11]

52. 9700_w17_qp_21 Q: 1

Fig. 1.1 is a photomicrograph of plant cells showing stages in cell division.

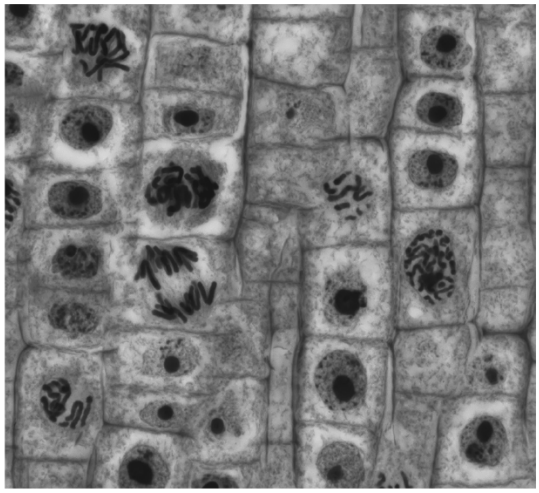

Fig. 1.1

(a) On Fig. 1.1, draw a circle around a cell in anaphase. [1]

(b) Suggest the advantages of using a light microscope, rather than an electron microscope, to study cell division.

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..... [2]

(c) Mitosis is important in producing more cells for plant growth.

Describe **three other** ways in which mitosis is important in plants.

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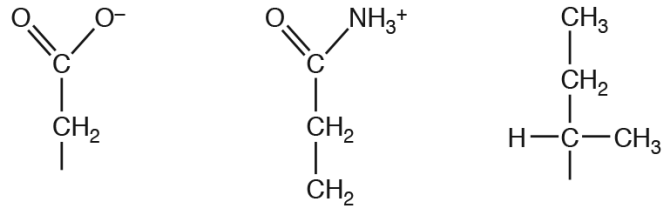
..... [3]

[Total: 6]

53. 9700_w17_qp_21 Q: 4

Fig. 4.1 shows the structure of the R groups of three amino acids, aspartate (Asp), glutamine (Gln) and isoleucine (Ile).



Asp R group **Gln R group** **Ile R group**

Fig. 4.1

(a) One of the mRNA codons for the amino acid Gln is CAA.
A mutation could change this codon from CAA to UAA.

UAA is a STOP codon.

State what is meant by a STOP codon.

.....

.....

.....[1]

(b) Many proteins that contain the amino acids shown in Fig. 4.1 are globular.

Describe how the three R groups in Fig. 4.1 can contribute to the globular structure of a protein.

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.....[4]

(c) An example of a globular protein is the enzyme starch phosphorylase. This enzyme catalyses the conversion of starch to glucose-1-phosphate.

Name the type of bond that is broken when starch is converted to glucose-1-phosphate.

.....[1]

An investigation was carried out to find out how the activity of starch phosphorylase varied with temperature, when free in solution and when immobilised in alginate.

The results are shown in Fig. 4.2.

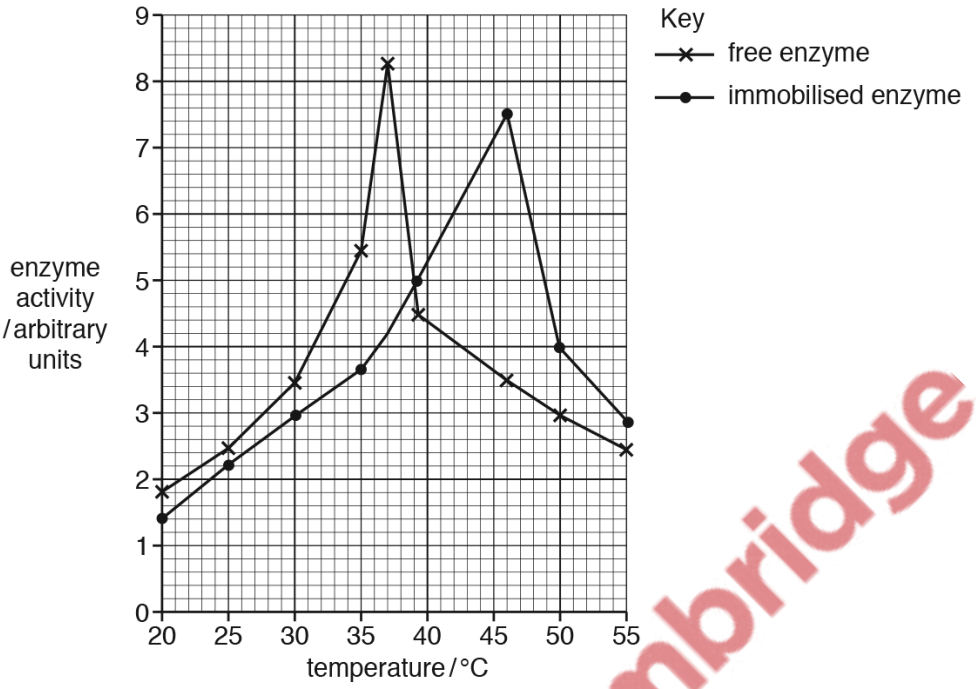

Fig. 4.2

(d) With reference to Fig. 4.2, compare the results for the enzyme activity when free in solution and when immobilised.

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.....[4]

(e) State how the Michaelis–Menten constant (K_m) is derived from V_{max} for an enzyme.

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.....[1]

(f) The K_m values for starch phosphorylase were determined when free in solution and when immobilised.

The K_m values were:

- free in solution, $K_m = 0.34\,\text{mmol}\,\text{dm}^{-3}$
- immobilised, $K_m = 0.84\,\text{mmol}\,\text{dm}^{-3}$.

Suggest an explanation for the difference between the two values.

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.....[2]

[Total: 13]

54. 9700_w16_qp_21 Q: 1

Fig. 1.1 is a transmission electron micrograph of part of an animal cell.

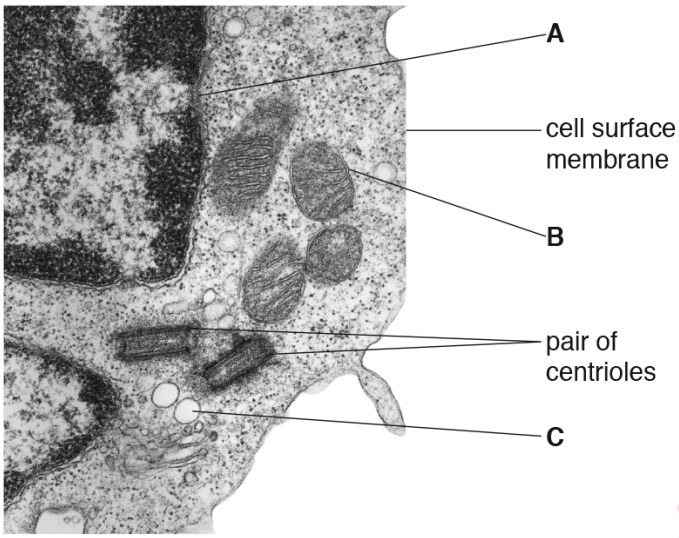

Fig. 1.1

(a) Name the structures **A**, **B** and **C**.

A .....

B .....

C .....[3]

(b) Name **one** structure, visible in Fig. 1.1, that would also be present in a prokaryotic cell.

.....[1]

(c) Cells such as that in Fig. 1.1 can divide by mitosis.

Describe the role of centrioles in mitosis.

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.....[2]

(d) Sodium ions cross cell surface membranes using facilitated diffusion or active transport.

Explain why sodium ions cross cell surface membranes by these mechanisms and **not** by simple diffusion.

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.....[3]

[Total: 9]

5.2 Chromosome behaviour in mitosis

55. 9700_w19_qp_22 Q: 6

Telomerase is an enzyme that is important in maintaining the telomeres that are located at the ends of chromosomes.

(a) Explain the importance of telomeres.

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..... [2]

(b) Suggest why telomerase is present in much higher quantities in stem cells and cancer cells than in other cell types.

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..... [1]

(c) Studies suggest that telomerase is a flexible molecule when binding its substrate. The active site changes its shape slightly to allow the formation of the enzyme-substrate complex.

Name the theory that describes this mode of enzyme action.

..... [1]

(d) An investigation was carried out into the effect of substrate concentration on the activity of telomerase.

The results are shown in Fig. 6.1.

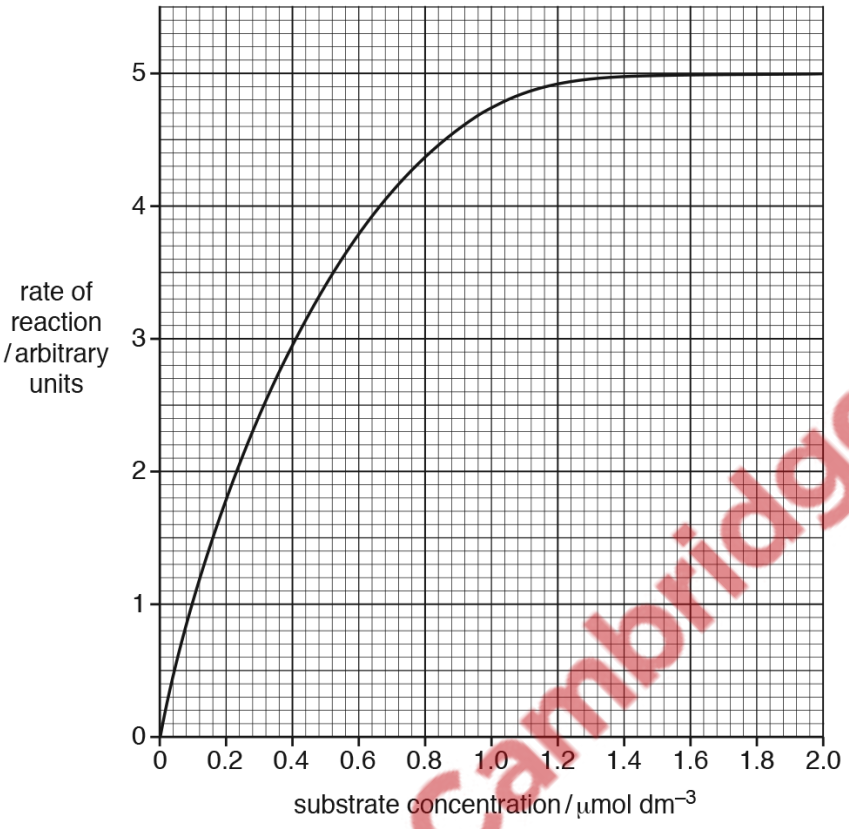

Fig. 6.1

With reference to Fig. 6.1, explain the difference in the rates of reaction obtained for telomerase at a substrate concentration of 0.2 μmol dm^{-3} compared with a substrate concentration of 1.6 μmol dm^{-3}.

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..... [2]

[Total: 6]

56. 9700_w19_qp_23 Q: 2

Meristematic tissue is found in the growing region of plants, such as root tips.

Fig. 2.1 shows a section through the meristematic region of a root tip of onion, *Allium cepa*.

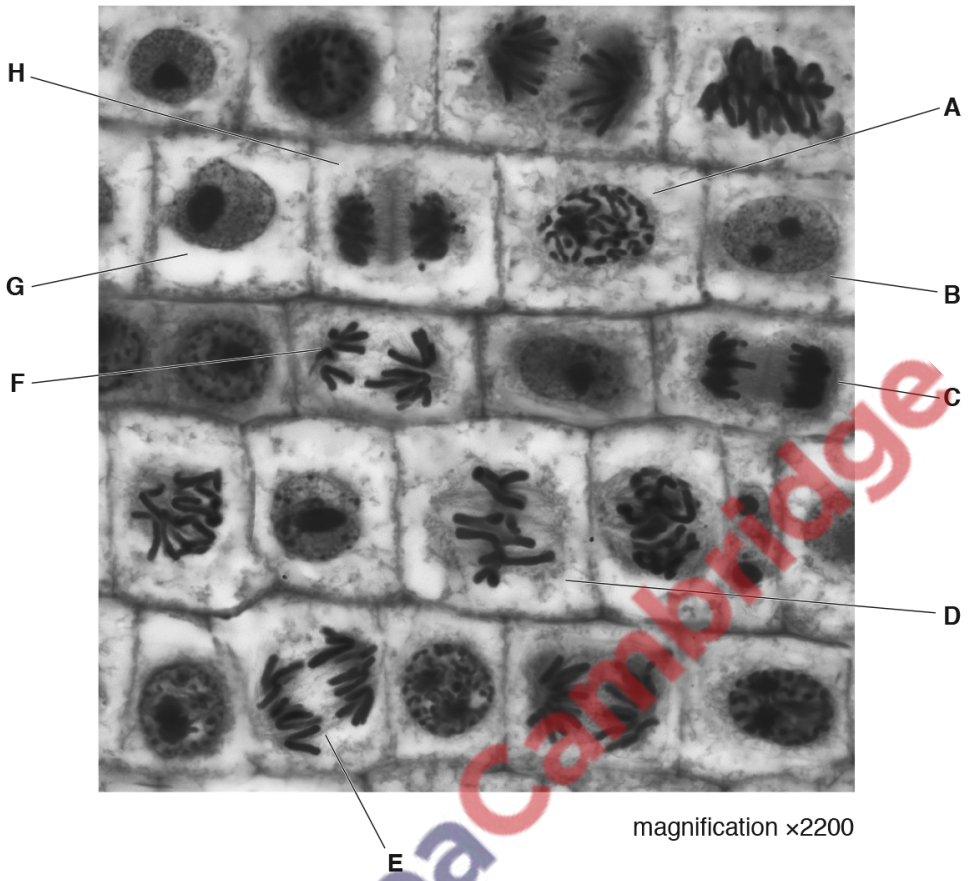

Fig. 2.1

Table 2.1 shows the numbers of cells in different stages of the cell cycle that were observed in sections of the meristematic regions of root tips of *A. cepa*.

Table 2.1

stage of cell cycle	one example of cell from Fig. 2.1	number of cells counted in each stage			
		replicate 1	replicate 2	replicate 3	mean
interphase		4686	4709	4808	4734
prophase		148	159	155	154
metaphase		38	47	40	42
anaphase		25	33	28	29
telophase		38	47	39	41
				total	5000

(a) Complete Table 2.1 by using the letters **A** to **H** from Fig. 2.1 to identify **one** cell in each stage of the cell cycle. [3]

(b) The total length of time taken for meristematic cells of *A. cepa* to complete one cell cycle at 25 °C is 12 hours.

Using sections similar to the one in Fig. 2.1, the length of time spent in each stage of the cell cycle can be estimated. To obtain the estimate, the percentage of cells in that stage is calculated.

Using the data in Table 2.1, calculate:

- the percentage of cells in anaphase
- the mean length of time in **minutes** for anaphase.

Show your working.

percentage of cells in anaphase = ... %

mean length of time in anaphase = ... min
[2]

(c) State **one** event that occurs during cytokinesis in the cell cycle of plant cells, such as those shown in Fig. 2.1.

.....

..... [1]

[Total: 6]

57. 9700_s18_qp_21 Q: 1

Fig. 1.1 is a transmission electron micrograph of a cell from the root of thale cress, *Arabidopsis thaliana*.

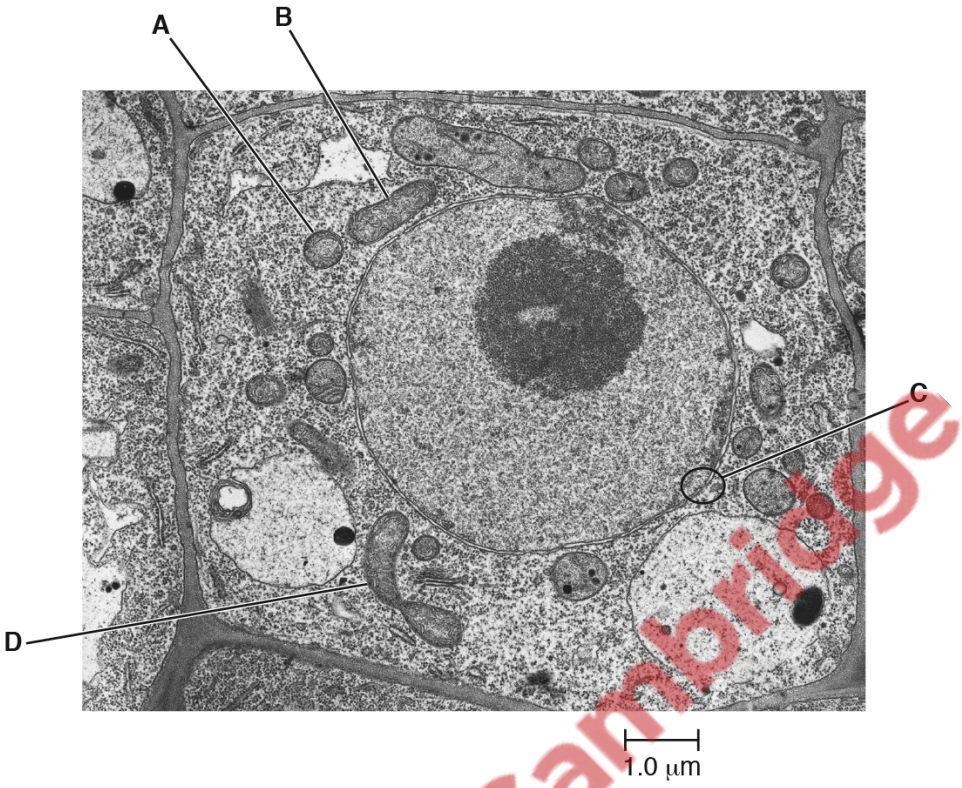

Fig. 1.1

(a) (i) The structures labelled **A** and **B** on Fig. 1.1 are sections of two mitochondria.

Suggest why **A** and **B** are different shapes.

.....

.....

.....[1]

(ii) The structure labelled **D** on Fig. 1.1 is a mitochondrion about to divide.

Explain the importance of the division of mitochondria for the cell shown in Fig. 1.1 **and** for cells in the root tips of thale cress.

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.....[2]

(b) Within a cell, substances move between the nucleus and the cytoplasm. The area labelled **C** in Fig. 1.1 shows an area where this communication occurs.

Make a large, labelled drawing of area **C** to show where this communication occurs.

[2]

(c) Outline the functions of the nucleus in non-dividing cells, such as the cell in Fig. 1.1.

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.....[4]

[Total: 9]

58. 9700_s18_qp_22 Q: 4

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

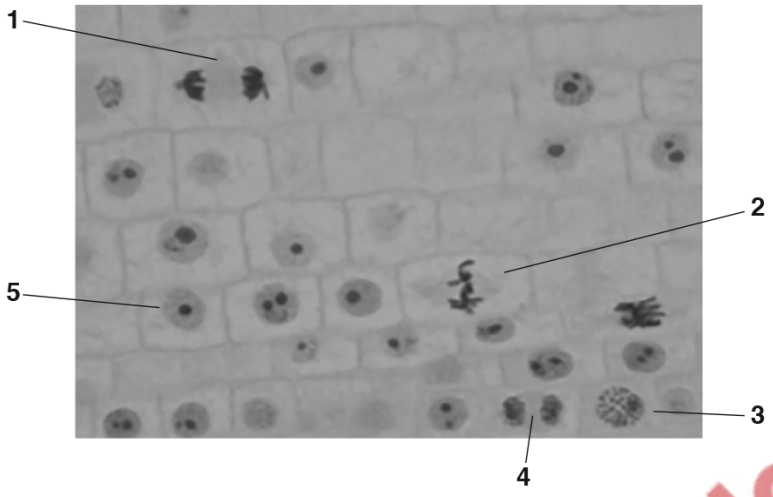

Fig. 4.1

(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]

(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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.....

.....

.....[2]

(c) Suggest why some cells in Fig. 4.1 appear empty, with no nucleus or chromosomes.

.....

.....

.....[1]

[Total: 6]

59. 9700_m17_qp_22 Q: 1

A diagram of a chromosome from a dividing cell is shown in Fig. 1.1.

Fig. 1.1

(a) A dividing cell is at risk of losing genetic material each time DNA replication occurs.

On Fig. 1.1, add a label line and the letter **G** to show the location on the chromosome of an area that helps to prevent the loss of genes. [1]

(b) The chromosome shown in Fig. 1.1 consists of one long DNA molecule associated with histone proteins.

Name **one** stage of mitosis in which a chromosome would have the same general structure as the chromosome shown in Fig. 1.1.

..... [1]

(c) Name the stage in the mitotic cell cycle during which the cytoplasm and the cell divide to produce two genetically identical daughter cells.

..... [1]

(d) The control of the cell cycle can be affected by extracellular chemical messengers that bind to proteins and glycoproteins in the cell surface membrane. The overall mechanism is known as cell signalling.

State the term used to describe the proteins and glycoproteins that function in this way.

..... [1]

[Total: 4]

60. 9700_w17_qp_22 Q: 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.

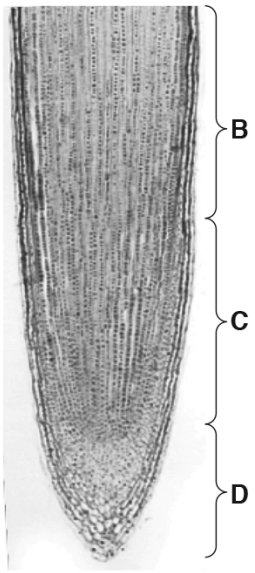

Fig. 1.1

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

.....[1]

(b) **(i)** Draw a labelled diagram to show the structure of a chromosome at late prophase of mitosis.

[3]

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

.....

.....

.....

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.....[2]

[Total: 6]

61. 9700_w17_qp_23 Q: 6

Extracellular growth factors are involved in the control of cell cycles in some mammalian cells. One of these growth factors is epidermal growth factor (EGF).

Fig. 6.1 shows the events that occur when EGF is present at the surfaces of two cells, **A** and **B**.

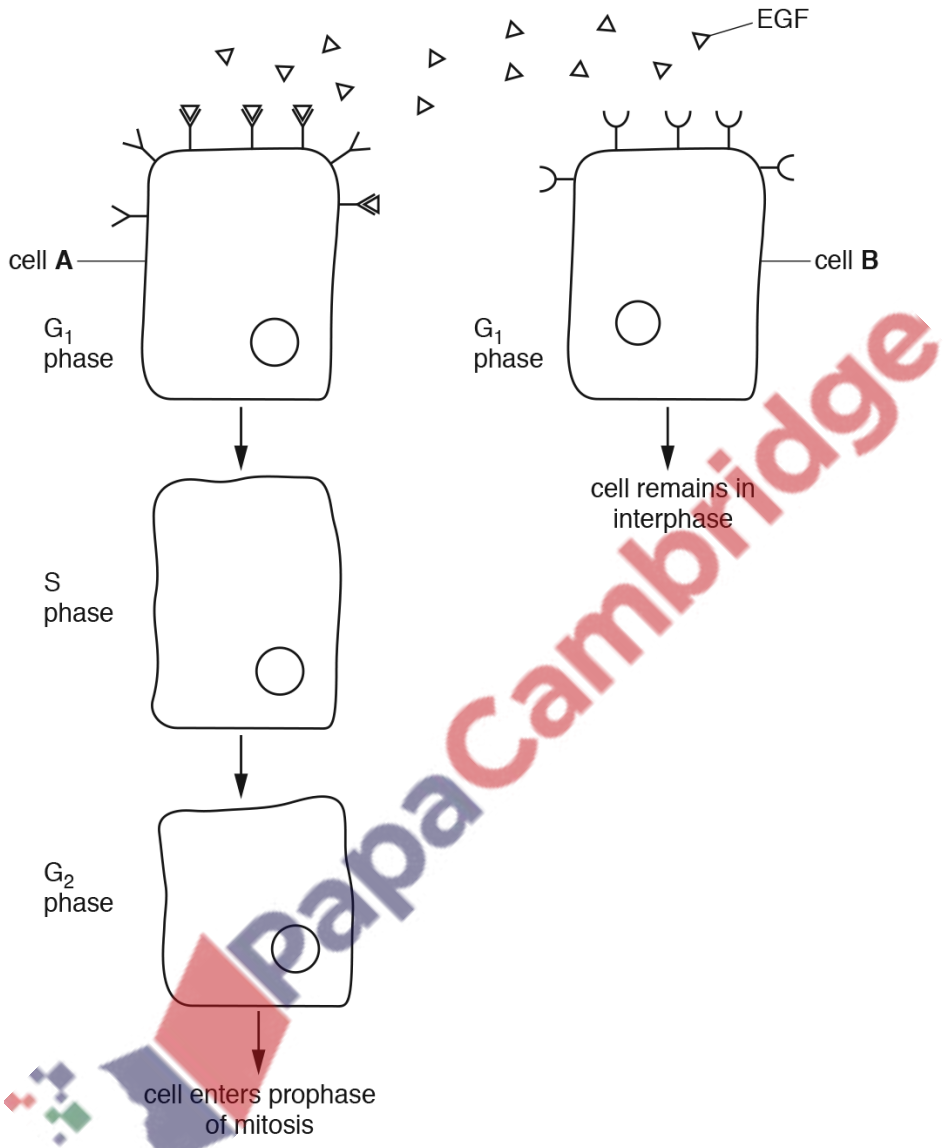

Fig. 6.1

(a) Explain why cell **A** in Fig. 6.1 responds to EGF, but cell **B** does not.

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.....

.....[2]

(b) In the cell cycle, more mRNA is produced in the G_1 phase than during mitosis.

Suggest why this is so.

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.....[1]

(c) DNA is replicated during the S phase of the cell cycle. EGF is one of many factors that stimulate the change from the G_1 phase to the S phase.

State the substances used to synthesise DNA during the S phase.

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.....[3]

(d) Fig. 6.2 is a drawing of chromosome 1 from rice, *Oryza sativa*, during metaphase of mitosis.

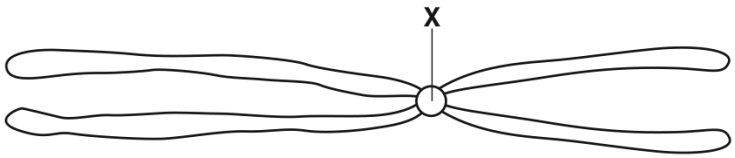

Fig. 6.2

(i) State the name and function of the region of the chromosome labelled **X**.

name .....

function .....

.....

.....[2]

(ii) In the outline of the cell below, draw the chromosome from Fig. 6.2 as it would appear in anaphase of mitosis.

[2]

[Total: 10]

62. 9700_s16_qp_22 Q: 5

Fig. 5.1 shows plant cells in stages of mitosis.

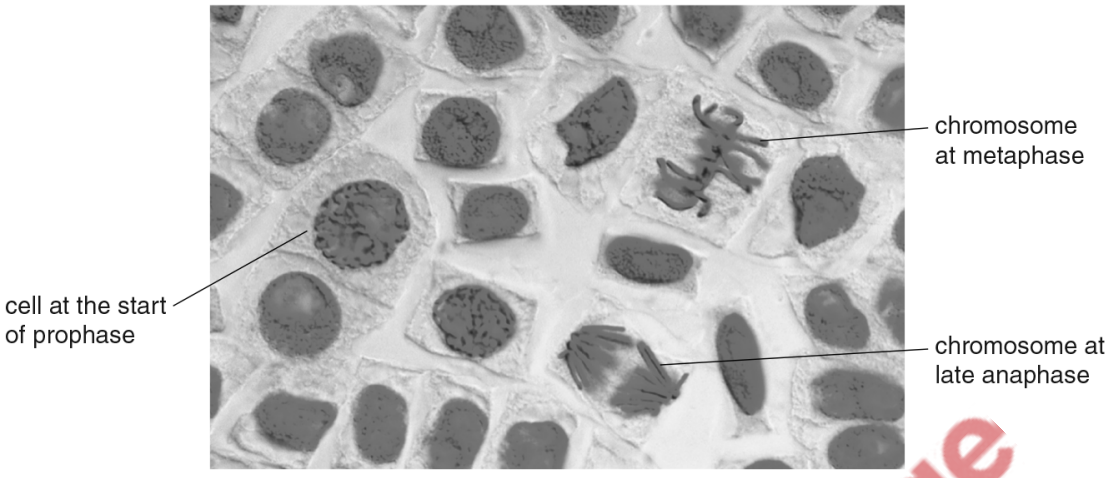

Fig. 5.1

(a) Individual chromosomes cannot be seen in the cell at the start of prophase. Changes to the chromatin occur so that by late prophase chromosomes are clearly visible.

(i) Outline what occurs during early prophase so that chromosomes become visible in late prophase.

.....

.....

.....[1]

(ii) Describe the structure of the chromosome in late prophase.

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.....[3]

(b) State **two** differences between the chromosome at metaphase and the chromosome at late anaphase.

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.....[2]

(c) One of the functions of a plant hormone known as cytokinin is to act as a cell signalling molecule and promote cytokinesis.

Suggest how cytokinin acts as a cell signalling molecule.

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.....[3]

[Total: 9]

63. 9700_w16_qp_22 Q: 1

Match the description for each of statements **A** to **E** to a correct cell structure.

A Double membrane-bound organelle, absent in animal cells, that produces ATP.

.....

B Partially permeable membrane surrounding the large permanent vacuole of plant cells.

.....

C Formed from microtubules during mitosis.

.....

D Has peptidoglycan as one of its major components.

.....

E Site of assembly of 80S ribosomes.

.....

[5]

[Total: 5]

64. 9700_s15_qp_21 Q: 1

A student investigated growth in the roots of broad bean, *Vicia faba*. The student cut sections of the root tip of this plant and viewed them with a light microscope.

Fig. 1.1 is a photomicrograph of one of the sections. The cell labelled **D** is in interphase.

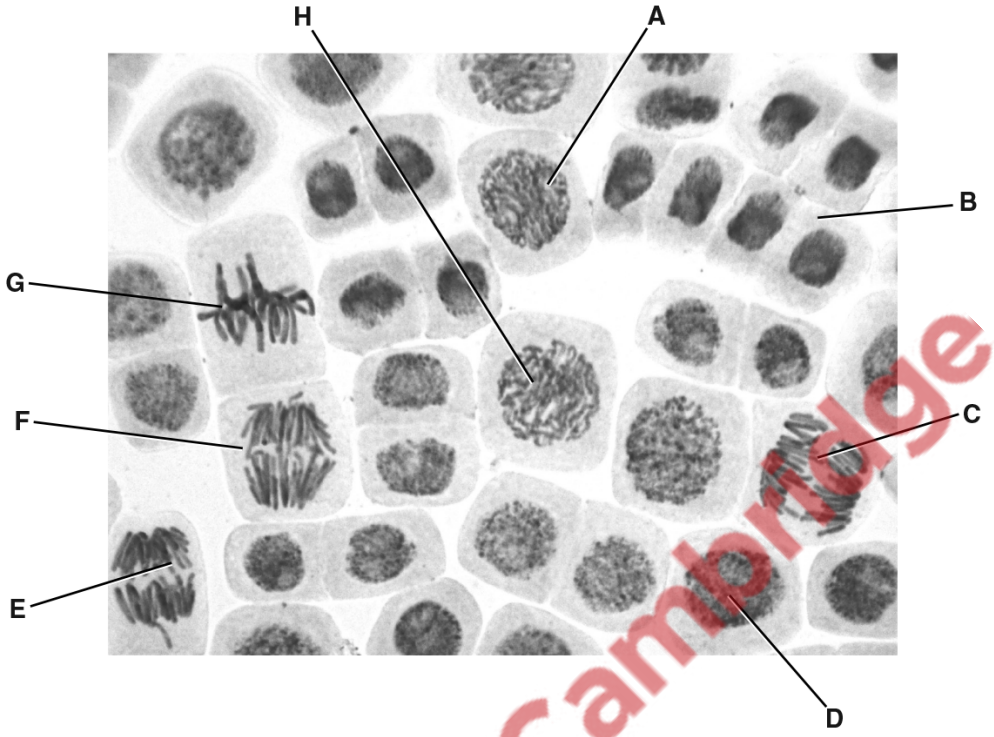

Fig. 1.1

(a) Complete the table below by:

- naming the stages of mitosis in the correct sequence following interphase
- identifying **one** example from the cells labelled **A** to **H** that is in each stage of mitosis that you have named.

stage of mitosis	label from Fig. 1.1

[5]

(b) In animal cells, centrioles are responsible for assembling microtubules to make the spindle at the beginning of mitosis.

Describe the role of the spindle during mitosis.

.....

.....

.....

.....

.....

.....[2]

(c) State two roles of mitosis in plants and animals **other than growth**.

1 .....

2 .....[2]

(d) *V. faba* is a legume. Roots of legumes often have swellings at intervals known as nodules. Cells within the nodules contain nitrogen-fixing bacteria.

(i) Explain the role of nitrogen fixation in the nitrogen cycle.

.....

.....

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.....

.....

.....[2]

(ii) Farmers in some parts of the world grow legume crops together with cereal crops in the same field. This is known as intercropping.

Explain how intercropping results in an increase in the yield of the cereals when the legumes die.

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.....[3]

[Total: 14]

65. 9700_w15_qp_22 Q: 3

The photomicrographs in Fig. 3.1 show stages of the mitotic cell cycle occurring in the root tip of the onion, *Allium sp.* They are all of the same magnification. Stages **A** to **C** are in the correct sequence and stages **K** to **N** are **not** in the correct sequence.

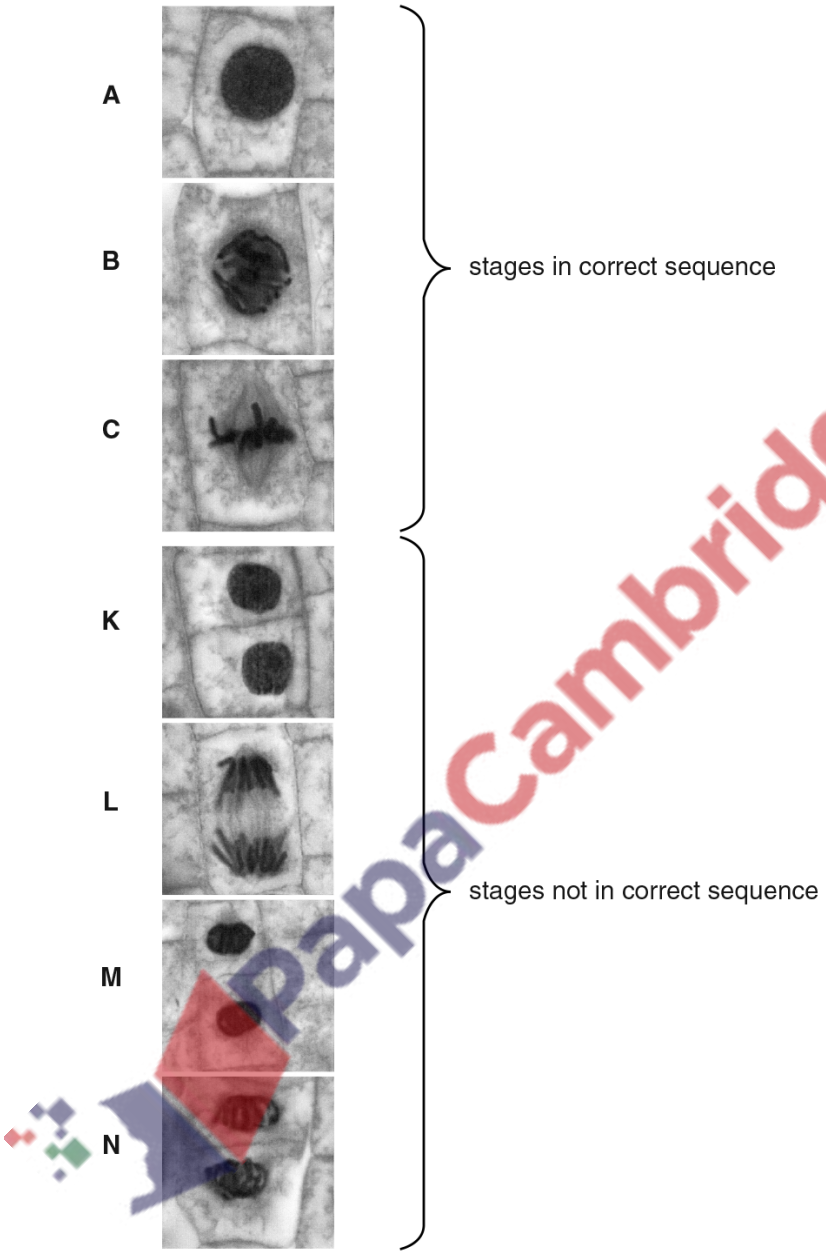

Fig. 3.1

(a) Name stages **A** and **C**.

A .....

C ..... [1]

(b) Put stages **K** to **N** in the correct sequence, starting with the stage that immediately follows stage **C**.

C ⟶ ..... ⟶ ..... ⟶ ..... ⟶ ..... [1]

(c) Explain how the behaviour of the chromosomes and spindle during stage **L** in Fig. 3.1 ensures that the two daughter cells will be genetically identical.

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.....

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..... [3]

[Total: 5]