Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

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3829449140

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **May/June 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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Answer **all** the questions.

1 **(a)** Each of the statements **A** to **D** describes a structure found in eukaryotic cells.

Identify the structure that is described in each statement.

A An organelle that contains 70S ribosomes.

.....

B A thread-like structure composed of DNA and histone proteins.

.....

C The organelle that modifies and packages proteins for secretion.

.....

D The structure that synthesises rRNA and combines it with proteins.

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[4]

(b) Prokaryotes and plant cells have cell walls.

Outline the composition of the cell wall of a prokaryote **and** the composition of the cell wall of a plant cell to show how they differ.

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.....[2]

[Total: 6]

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2 Phosphatases are enzymes that catalyse the removal of phosphate groups from organic compounds.

Some students investigated the effect of substrate concentration on the rate of the reaction catalysed by an acid phosphatase (enzyme **A**). The results are shown in Fig. 2.1.

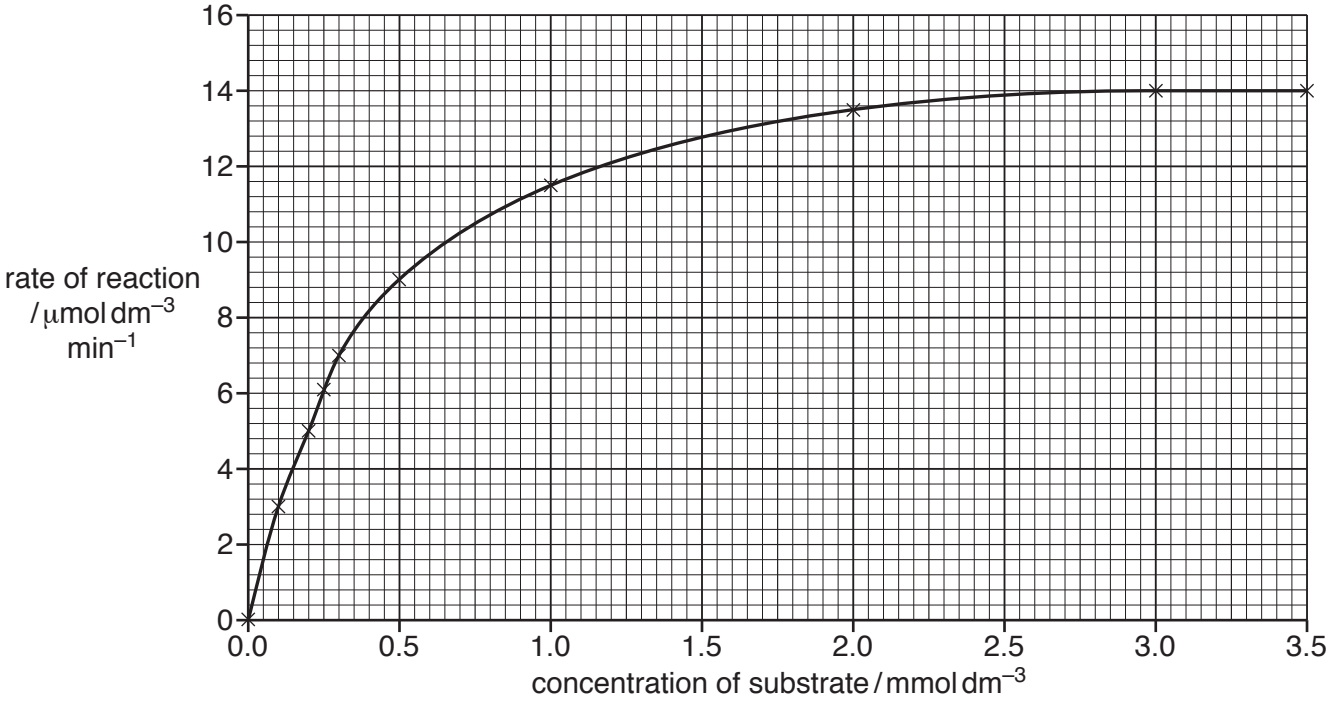


Fig. 2.1

(a) The students used Fig. 2.1 to derive the Michaelis-Menten constant (K_m) for enzyme **A** as 0.3 mmol dm^{-3}.

Explain how they derived K_m.

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.....[2]

(b) The students investigated a different phosphatase enzyme (enzyme **B**) and found the value of K_m to be higher than 0.3 mmol dm^{-3}.

Explain the difference between the values of K_m for these two phosphatase enzymes.

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.....[2]

(c) The students repeated their investigation on enzyme **A** with a competitive inhibitor.

They used the same concentrations of substrate as before, but added a competitive inhibitor to each reaction mixture.

They used the same concentration of the inhibitor in each reaction mixture.

The students found that V_{max} was the same as before, but K_m was higher than 0.3 mmol dm^{-3}.

Explain how the addition of the competitive inhibitor results in the same value for V_{max} but a higher value for K_m.

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[Total: 8]

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3 Fig. 3.1 is a diagram that shows the structure of an antibody molecule.

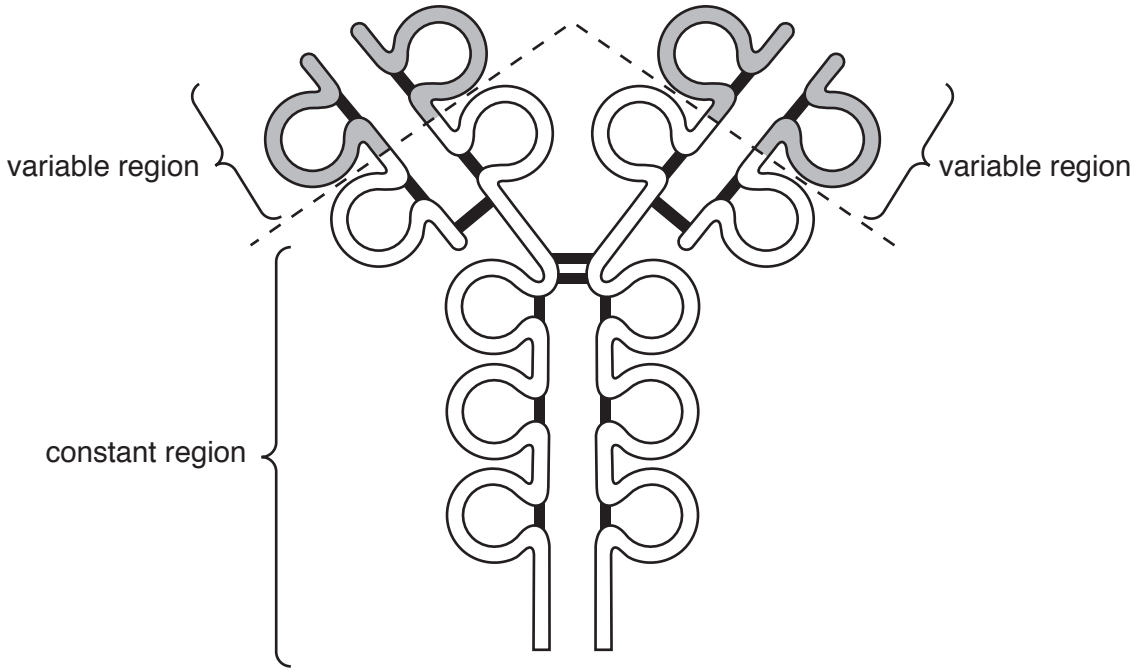


Fig. 3.1

(a) State why the antibody molecule shown in Fig. 3.1 has quaternary structure.

.....

.....[1]

(b) **(i)** Use Fig. 3.1 to explain how the structure of the variable region of an antibody molecule is related to its function.

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.....[3]

(ii) State the role of the constant region of an antibody.

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.....[1]

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(c) Monoclonal antibodies are used both in diagnosis and in treatment of disease.

(i) Outline how monoclonal antibodies are produced.

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.....[4]

(ii) Suggest the advantages of using monoclonal antibodies in diagnosis of disease.

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[Total: 11]

4 **(a)** Fig. 4.1 shows part of a DNA molecule.

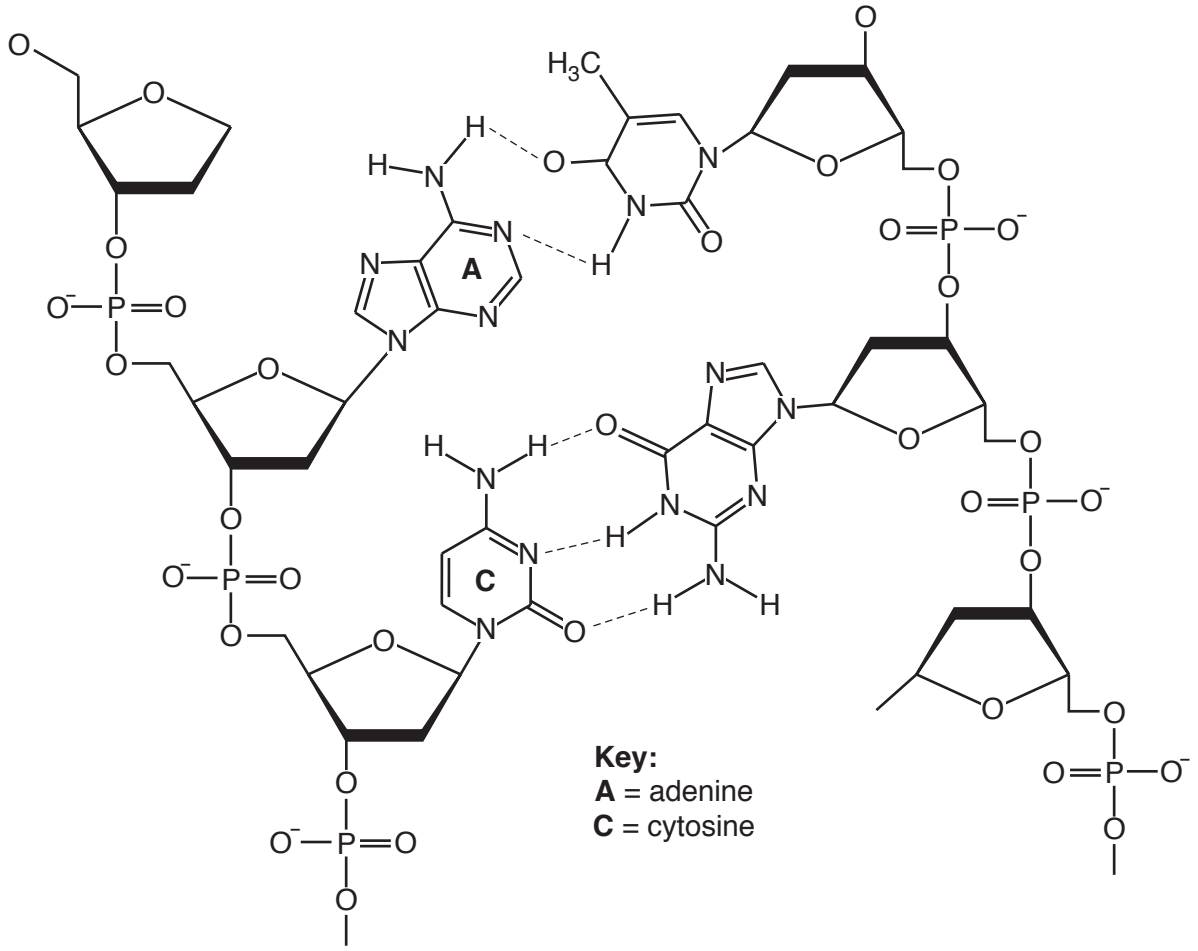


Fig. 4.1

Use Fig. 4.1 to explain how the structure of mRNA differs from the structure of DNA.

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(b) Fig. 4.2 shows:

- the first seven amino acids of the β chain of haemoglobin
- the first amino acid in the sequence is valine (Val)
- the 21 base pairs in the sequence of DNA that code for these seven amino acids.

amino acid sequence	Val	His	Leu	Thr	Pro	Glu	Glu
base sequence in DNA	CAC	GTG	GAC	TGA	GGA	CTC	CTC
	GTG	CAC	CTG	ACT	CCT	GAG	GAG

Fig. 4.2

Table 4.1 shows the triplets of bases that code for seven amino acids.

Using Fig. 4.2 and Table 4.1, state what will happen to the sequence of amino acids in the first part of the β chain of haemoglobin:

(i) if the base pair at position 6 is deleted

.....

.....[1]

(ii) if the three base pairs at positions 7, 8 and 9 are deleted.

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.....[1]

Table 4.1

amino acid		DNA triplets
cysteine	(Cys)	TGT TGC
glutamic acid	(Glu)	GAA GAG
histidine	(His)	CAT CAC
leucine	(Leu)	CTT CTC CTA CTG
proline	(Pro)	CCT CCC CCA CCG
threonine	(Thr)	ACT ACC ACA ACG
valine	(Val)	GTT GTC GTA GTG
no amino acid	STOP	TAA TAG TGA

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(c) DNA is involved in the processes of replication and transcription.

Complete Table 4.2 by using a tick (✓) to indicate which features apply to each of the processes. Use a cross (✗) for features that do **not** apply.

The first row has been completed for you.

Table 4.2

feature	replication	transcription
a single-stranded molecule is produced	✗	✓
hydrogen bonds are broken		
both strands of DNA act as templates		
phosphodiester bonds are formed		
DNA polymerase is used		

[4]

(d) Telomeres are parts of chromosomes. Describe the function of telomeres.

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.....[2]

(e) Describe the function of ribosomes in protein synthesis.

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[Total: 16]

5 Sugar molecules enter cells through transport proteins.

(a) Explain why transport proteins are required for the movement of sugar molecules, such as glucose and fructose, into cells.

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.....[2]

Some plant cells convert fructose and glucose into sucrose for transport from sources to sinks. Sucrose is moved into phloem sieve tubes as shown in Fig. 5.1.

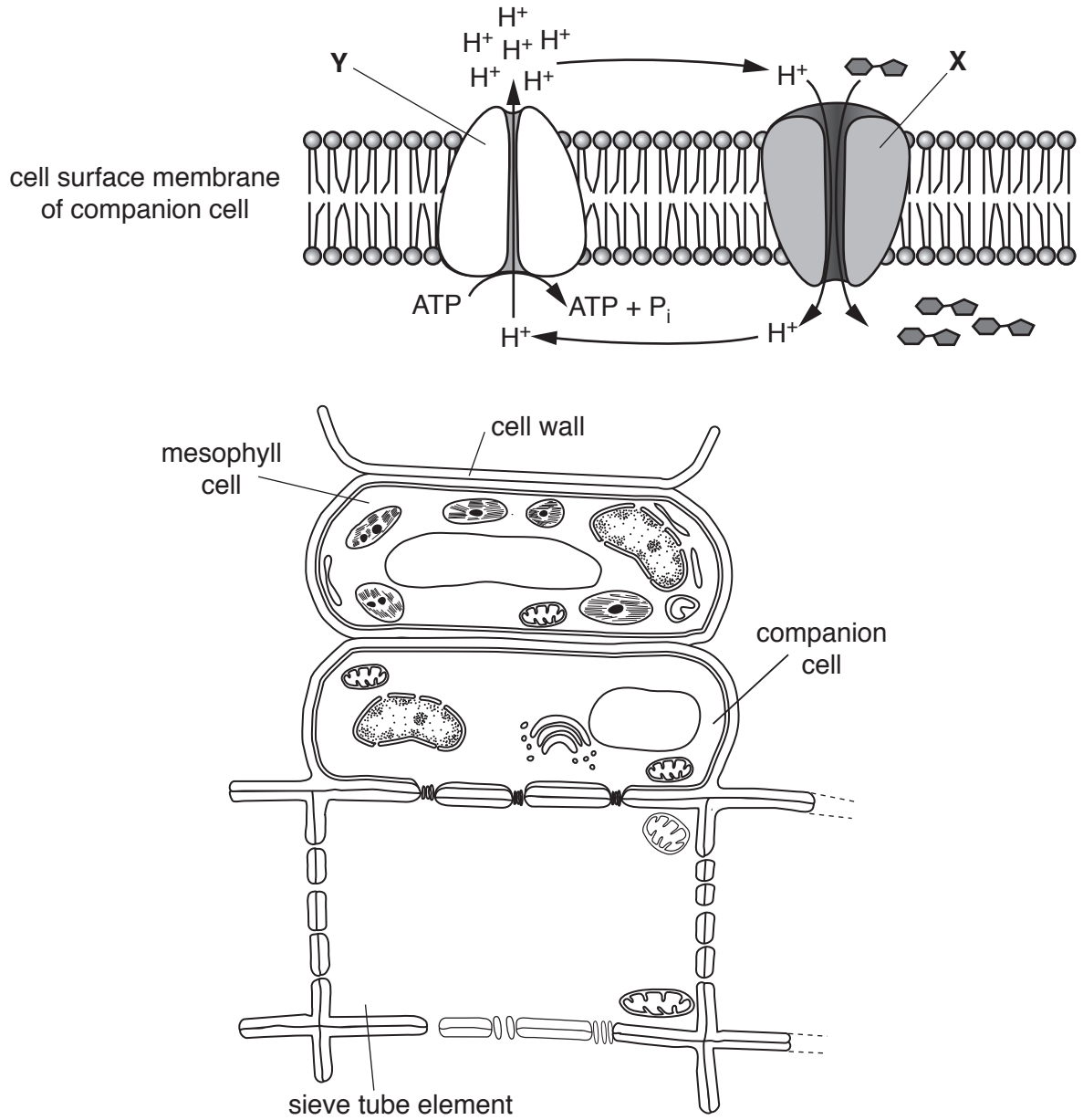


Fig. 5.1 not to scale

(b) Use the information in Fig. 5.1 to explain how sucrose:

- moves into the companion cell
- moves from the companion cell into the sieve tube element.

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(c) Sucrose travels in phloem sieve tubes to sinks.

State two examples of sinks.

1 .....

2 .....[1]

[Total: 8]

6 Cholera bacteria release the toxin, choleragen, when they are in the intestine.

(a) (i) Name the bacterium that is the pathogen of cholera.

.....[1]

(ii) Describe the way in which cholera is transmitted from an infected person to an uninfected person.

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.....[2]

Gangliosides are glycolipids that bind choleragen. These glycolipids are found on many cell surface membranes.

When choleragen is released from the bacteria in the intestine, it binds to gangliosides on epithelial cells and enters these cells as shown in Fig. 6.1.

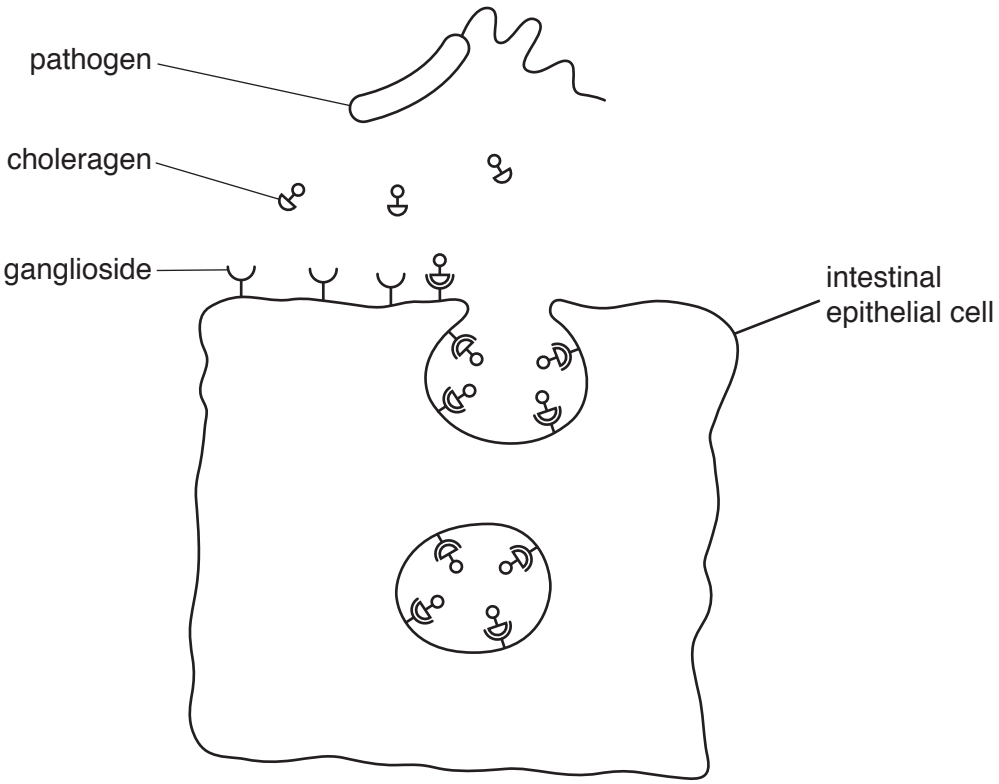


Fig. 6.1 not drawn to scale

(b) Suggest how choleragen interacts with gangliosides on intestinal epithelial cells.

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.....[2]

(c) Name the process by which choleragen enters the intestinal epithelial cell as shown in Fig. 6.1.

.....[1]

Once inside the cells choleragen is activated. One effect is to increase the movement of chloride ions through channel proteins out of cells.

(d) Suggest **and** explain the likely consequences on the intestinal epithelial cells of the loss of chloride ions through the channel proteins.

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.....[2]

(e) Health authorities recommend that antibiotics, such as tetracycline, are **only** to be used for treating people with severe cases of cholera.

Explain why it is recommended that antibiotics should **not** be given to people with mild cases of cholera or to protect people from cholera.

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.....[3]

[Total: 11]

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CANDIDATE NUMBER | | | | |

9074709121

BIOLOGY **9700/22**

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1 hour 15 minutes

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Answer **all** the questions.

1 (a) In multicellular organisms, the structure of different cell types is adapted to their function. Within these cells there are a number of different organelles, each with a particular function.

Table 1.1 contains information about the structure and function of five different types of cell. The table also includes, for each type of cell, one example of a cell organelle that is essential for the function to be carried out.

Complete Table 1.1.

Table 1.1

type of cell	function of cell	example of organelle required to carry out function
palisade mesophyll		chloroplast
Leydig	synthesis of steroid hormones	
	production of secretory vesicles for release of antibody	Golgi body
root hair cell	active uptake of mineral ions from the soil	
pancreas acinar	synthesis of enzymes	

[5]

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(b) A tissue is a collection of one or more types of cell, specialised to carry out a particular function.

An organ can be considered a structural unit within an organism that:
- consists of more than one type of tissue
- performs a particular function.

The aorta is the main artery of the body.

Explain, with reference to its structure and function, whether the aorta may be described as a tissue or an organ.

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.....[4]

[Total: 9]

2 Lipase is an enzyme with many commercial uses. Some species of bacteria are of great interest as they produce large quantities of lipase.

(a) Complete Fig. 2.1 to show the hydrolysis of triglyceride by lipase.

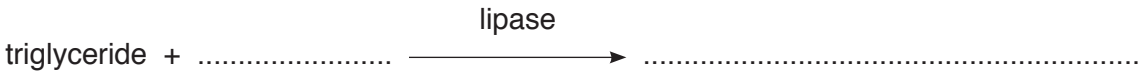


Fig. 2.1

[2]

Researchers carried out investigations into lipase extracted from a bacterium found in hot springs.

(b) To measure the activity of the bacterial lipase during their investigations, the researchers used a method based on the biological test for triglycerides.

Outline a biological test that could be carried out to show the presence of triglyceride in a liquid mixture **and** describe the positive result for this test.

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.....[3]

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(c) The researchers investigated the effect of pH values between pH 2.0 and pH 10.5 on the activity of bacterial lipase in hydrolysing triglyceride at a temperature of 37 °C.

The results are shown in Fig. 2.2.

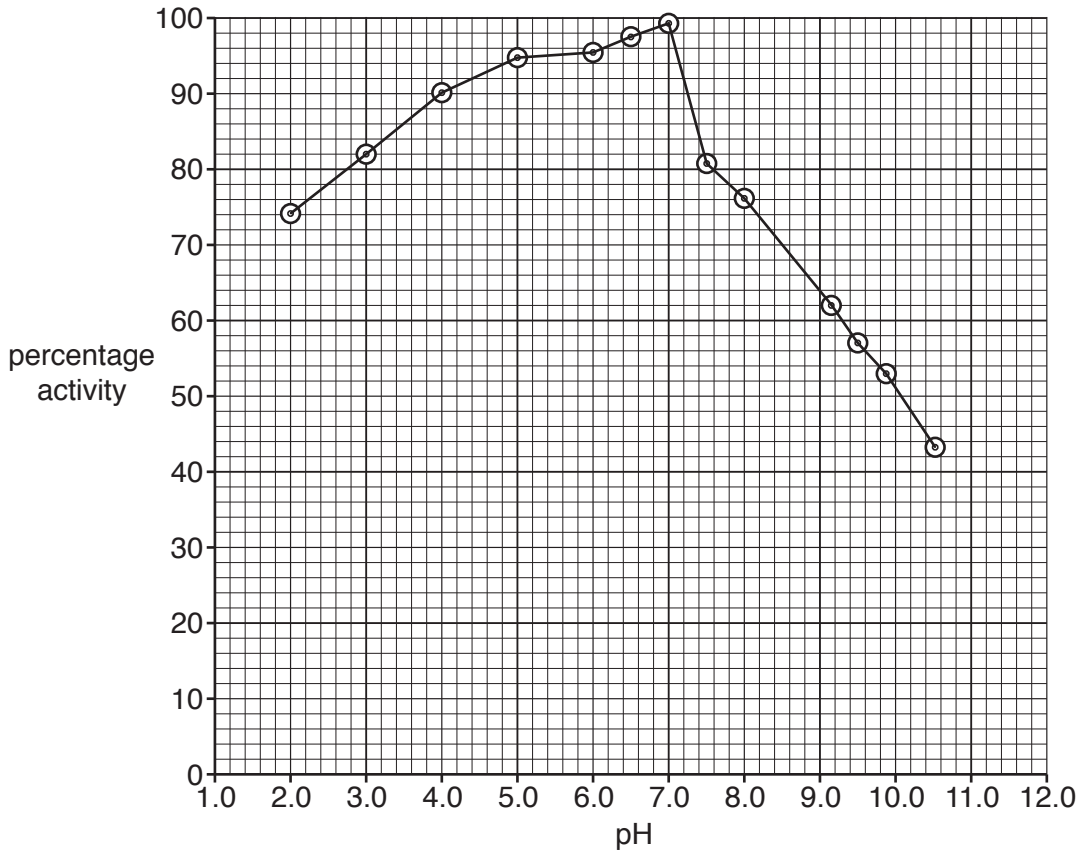


Fig. 2.2

With reference to Fig. 2.2, describe the effect of pH on the activity of bacterial lipase.

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(d) A separate investigation into the effect of pH on the same bacterial lipase compared the enzyme free in solution with the enzyme immobilised by physical attachment to a stable polymer.

At a temperature of 37 °C, the optimum pH of the enzyme free in solution was the same as that shown in Fig. 2.2. The optimum pH of the immobilised enzyme was measured as pH 4.

(i) Suggest **one** reason to explain why the enzyme free in solution has a different optimum pH compared to the immobilised enzyme.

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.....[1]

(ii) Suggest **one** advantage of immobilising the extracted lipase for commercial use.

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.....[1]

[Total: 11]

3 Malaria is a disease caused by the protoctist, *Plasmodium*. The organism has a very complex life cycle as it has two hosts, a human and a mosquito.

(a) Name **one** of the four species of *Plasmodium* that infects humans.

.....[1]

(b) State the name of the mosquito that is host to *Plasmodium*.

.....[1]

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Fig. 3.1 is a transmission electron micrograph showing the developing *Plasmodium* cells inside a protective structure known as an oocyst. In this stage of the life cycle the oocysts are found in the mosquito gut. When mature, the *Plasmodium* cells are released and travel to the salivary glands of the mosquito.

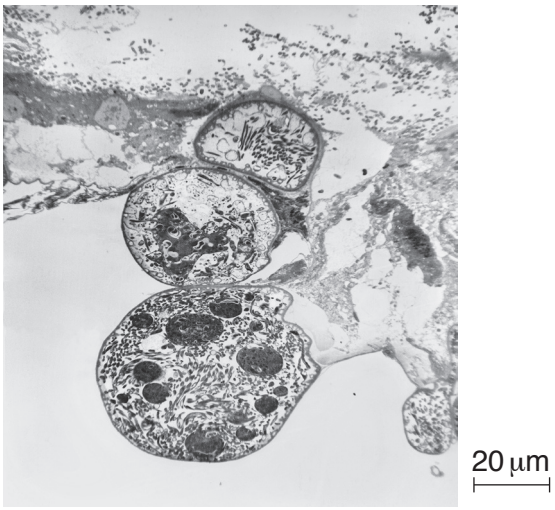


Fig. 3.1

(c) The magnification used in Fig. 3.1 can also be obtained using a light microscope.

Suggest why an electron microscope was used to obtain this image instead of a light microscope.

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.....[2]

(d) Use the scale bar to calculate the magnification of the image shown in Fig. 3.1.

Write down the formula and use it to make your calculation. Show your working.

formula

magnification × .....[3]

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(e) Outline the role of the mosquito in the transmission of malaria.

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.....[2]

[Total: 9]

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

(a) Fig. 4.1 summarises a cell cycle for a meristematic cell in the root tip. The two phases of this cell cycle are shown:

- interphase, which is divided into the G_1, S and G_2 stages
- cell division, which is divided into stages 1–5.

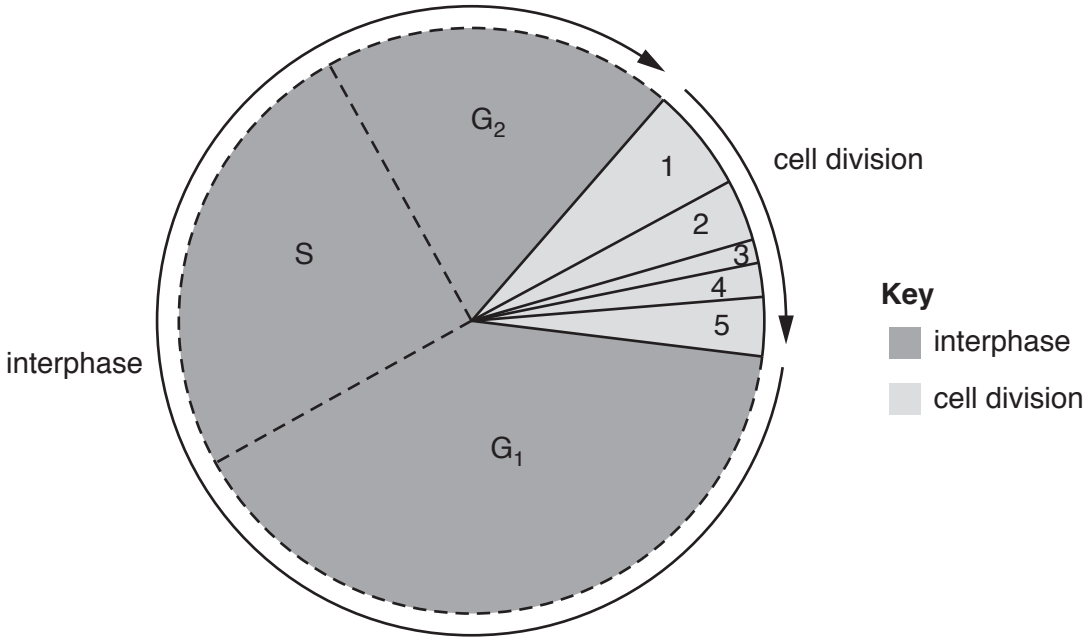


Fig. 4.1

(i) In Fig. 4.1, stage 2 is metaphase.

The stages shown in Fig. 4.1 are listed below. Draw a circle around the stage in the cell cycle that is cytokinesis **and** describe what happens in this stage in the root tip meristematic cell.

1 2 3 4 5 G_1 S G_2

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.....[3]

(ii) The stages shown in Fig. 4.1 are listed below. Draw a circle around the stage in the cell cycle in which the semi-conservative replication of DNA occurs **and** state what is meant by semi-conservative replication.

1 2 3 4 5 G_1 S G_2

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.....[3]

(b) Meristematic cells have a similar role to stem cells found in animals.

Suggest the role of a meristematic cell **and** explain the features that help it to carry out its role.

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(c) Meristematic regions in the plant can sometimes be described as strong sinks.

(i) State what is meant by a *sink*.

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.....[1]

(ii) Suggest what is meant by a **strong** sink.

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.....[1]

(d) Describe **and** explain how sucrose is loaded into phloem sieve tubes.

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.....[4]

[Total: 15]

5 Some pathogens can enter the human body through the gas exchange system.

(a) The epithelial lining of the gas exchange system is adapted for defence against pathogens.

(i) List the structures in the gas exchange system that have a ciliated epithelial lining.

.....

.....[1]

(ii) Name the cells in the ciliated epithelium that synthesise and secrete mucus.

.....[1]

Alveolar macrophages are cells of the immune system. They have an important role in defence against respiratory infections.

(b) The infectious lung disease, pneumonia, can be caused by *Streptococcus pneumoniae*.

Most healthy people inhaling air containing these bacteria do **not** become ill because of the action of the alveolar macrophages.

Outline the mode of action of an alveolar macrophage in response to the presence of *S. pneumoniae*.

You may use diagrams with notes to help your answer.

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.....[3]

Irritants in tobacco smoke can contribute to emphysema, one of the chronic obstructive pulmonary disorders (COPD). In emphysema, the alveoli lose their ability to recoil on expiration and can burst.

(c) Suggest how the structure of the alveolar wall changes so that an alveolus bursts.

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.....[2]

(d) Some alveolar cells produce a surfactant that helps to prevent the collapse of alveoli on exhalation. Too much surfactant decreases the efficiency of gas exchange in the alveoli.

A glycoprotein known as GM-CSF is released by some cells of the immune system when there is too much surfactant in the alveoli. Excess surfactant is then broken down by alveolar macrophages.

Receptors for GM-CSF are on the cell surface membranes of alveolar macrophages.

Explain how maintaining the correct quantity of surfactant in the alveoli is the result of a cell signalling mechanism.

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.....[4]

[Total: 11]

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[Turn over

6 As a result of transcription and translation, a polypeptide chain is produced. Proteins with quaternary structure contain two or more polypeptide chains.

An antibody molecule and a haemoglobin molecule both show quaternary structure.

(a) Table 6.1 shows some features of an antibody molecule and a haemoglobin molecule.

Complete Table 6.1 to produce a summary of the features of the two molecules.

Table 6.1

feature	antibody	haemoglobin
fibrous or globular		
number and names of polypeptide chains	two heavy and two light chains	
type of bond holding polypeptide chains together		ionic

[3]

(b) The base sequence shown in Fig. 6.1 is a short section of a longer length of DNA that is transcribed to produce mRNA. When translated, this short section produces the amino acid sequence threonine (Thr), proline (Pro), cysteine (Cys).

Fill in the two **unshaded** boxes in Fig. 6.1 to show:

- the mRNA codon for Cys
- the tRNA anticodon for Thr.

You do **not** need to give the codon and anticodon sequences in the shaded boxes.

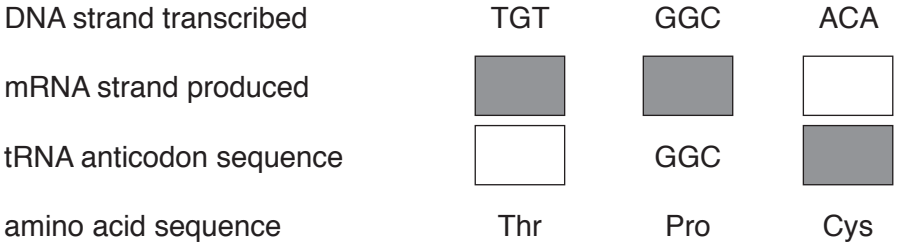


Fig. 6.1

[2]

[Total: 5]

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BIOLOGY **9700/23**

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Answer **all** the questions.

1 Mammals have a closed double circulation system.

(a) Explain what is meant by a *closed double circulation*.

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.....[2]

(b) Table 1.1 shows some structures in the mammalian circulatory system.

Complete Table 1.1 to show the sequence of structures through which blood flows, starting with the pulmonary vein.

Use the numbers 2 to 5 to indicate the correct sequence.

Table 1.1

structure	sequence of blood flow
left ventricle	
vena cava	
pulmonary vein	**1**
aorta	
right atrium	

[2]

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(c) (i) Explain why arteries have thicker walls than veins.

.....

.....

.....

.....

.....[2]

(ii) Smoking causes carbon monoxide and nicotine to enter the blood.

Describe the short-term effects of each of these substances on the cardiovascular system.

carbon monoxide

.....

.....

.....

nicotine

.....

.....

.....[4]

[Total: 10]

2 Fig. 2.1 is a transmission electron micrograph of a cell from a leaf.



Fig. 2.1

(a) Use the scale bar to calculate the magnification of the image in Fig. 2.1.

Write down the formula that you will use and show your working.

formula

magnification × .....[3]

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(b) Name structure **X** and state **one** function of this structure.

name .....

function .....

.....[2]

(c) Name two structures, **visible** in the cell in Fig. 2.1, that contain DNA.

1 .....

2 .....[2]

(d) Plant cells can be infected with viruses.

Fig. 2.2 shows the key features of a plant virus.

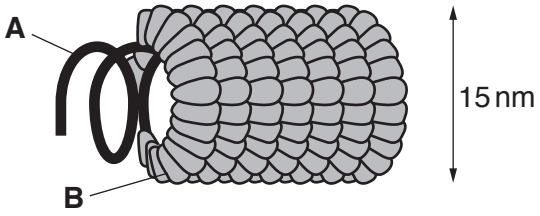


Fig. 2.2

Identify the structures labelled **A** and **B** in Fig. 2.2.

A .....

B .....[2]

(e) Some plant cells produce a polypeptide called systemin.

(i) Describe the role of DNA in the production of systemin.

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.....[2]

(ii) Systemin stimulates plant cells to produce enzyme inhibitors known as serpins.

One of these serpins is a competitive inhibitor of some protease enzymes. It inhibits the protease enzymes found in herbivores, but does **not** inhibit the proteases in plants.

Suggest how this serpin inhibits **only** the protease enzymes in herbivores but **not** those in plants.

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.....[3]

(iii) The presence of competitive inhibitors, such as serpins, increases the Michaelis-Menten constant (K_m) for the enzymes they inhibit.

Explain why the K_m value increases.

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.....[1]

[Total: 15]

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3 **(a)** Name the causative organism of tuberculosis (TB).

.....[1]

(b) Fig. 3.1 shows the number of deaths from TB and the number of new cases of TB from 1925 to 2010 in Canada.

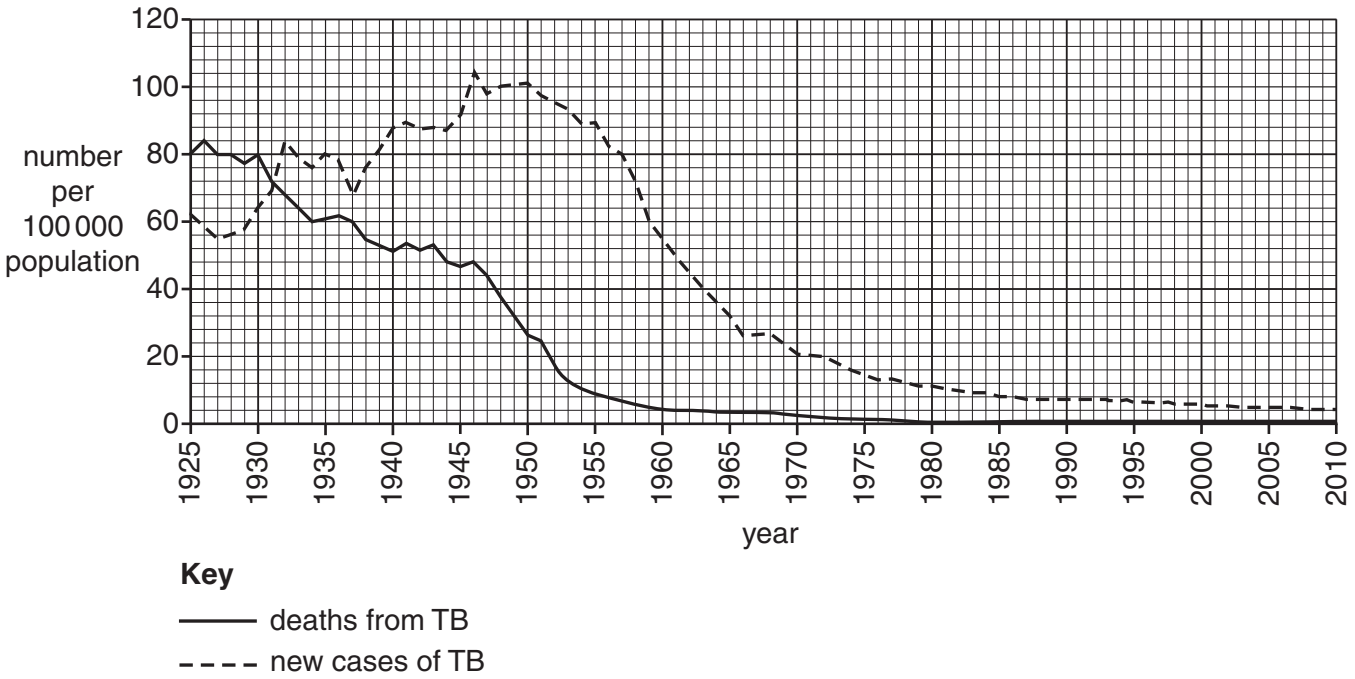


Fig. 3.1

The vaccine for TB was introduced in Canada for widespread use from 1948.

Antibiotics, such as streptomycin, were introduced in Canada from 1940.

Use the information in Fig. 3.1 to comment on the effect of the introduction of the vaccine and antibiotics on the number of new cases and deaths from TB.

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.....[5]

(c) In 2010, Swaziland had one of the highest death rates from TB in the world.

Swaziland also had a high number of new cases of HIV infection in its population in 2010.

People who are infected with HIV are described as HIV+ and people who are **not** infected with HIV are described as HIV–.

Table 3.1 shows the number of deaths from TB in Swaziland in 2010.

Table 3.1

HIV status	**number of deaths from TB per 100 000 population**
HIV+	400
HIV–	91

Using the information in Table 3.1, suggest why the number of deaths per 100 000 population of people who are HIV+ is much higher than that in people who are HIV–.

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.....[3]

[Total: 9]

4 **(a)** Complete Table 4.1 by using a tick (✓) to indicate which statements apply to each of the molecules. Use a cross (✗) for statements that do **not** apply.

Some of the boxes have been completed for you.

Table 4.1

statement	ATP	cellulose	haemoglobin	phospholipid
contains phosphorus	✓		✗	
found in plants				
contains iron				✗
has a structural role				

[4]

(b) Fig. 4.1 shows two amino acids.

Complete Fig. 4.1 to show how a peptide bond forms between these two amino acids.



Fig. 4.1

[3]

(c) Some glycoproteins in cell surface membranes function as transport proteins.

State two **other** functions of glycoproteins in cell surface membranes.

1 .....

.....

2 .....

.....[2]

[Total: 9]

5 **(a)** Describe the process of DNA replication.

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.....[5]

(b) State the name of the part of the chromosome that prevents the loss of genes during DNA replication.

.....[1]

(c) During DNA replication, the use of an incorrect base in the newly synthesised strand can lead to a mutation.

(i) A transversion event is where a pyrimidine is used in the newly synthesised strand instead of a purine, or the other way round.

Name the **two** possible bases that could be used instead of cytosine in a transversion event.

.....[1]

(ii) A transition event is where an incorrect purine is used or an incorrect pyrimidine is used.

Suggest why transversion events are **less** likely to occur than transition events.

.....

.....

.....[2]

(d) Outline how mutations can cause healthy cells to become tumour cells.

.....

.....

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.....[3]

[Total: 12]

6 **(a)** In the space below, draw a diagram to show a hydrogen bond between two water molecules.

[3]

(b) **(i)** Movement of water in xylem depends on the force of attraction between water molecules as a result of hydrogen bonding.

State the name given to this force of attraction.

.....[1]

(ii) State the property of water that results in a cooling effect as water evaporates from the surface of organisms.

.....

.....[1]

[Total: 5]

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