UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CANDIDATE NAME	
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0784806915

BIOLOGY **9700/21**

Paper 2 Structured Questions AS **May/June 2013**

1 hour 15 minutes

Candidates answer on the Question Paper.

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[Turn over

Answer **all** the questions.

For Examiner's Use

1 Capillaries are known as exchange vessels. Substances are exchanged between blood and tissue fluid as the blood flows through the capillaries.

Fig. 1.1 is an electron micrograph of a section through a capillary with two red blood cells.

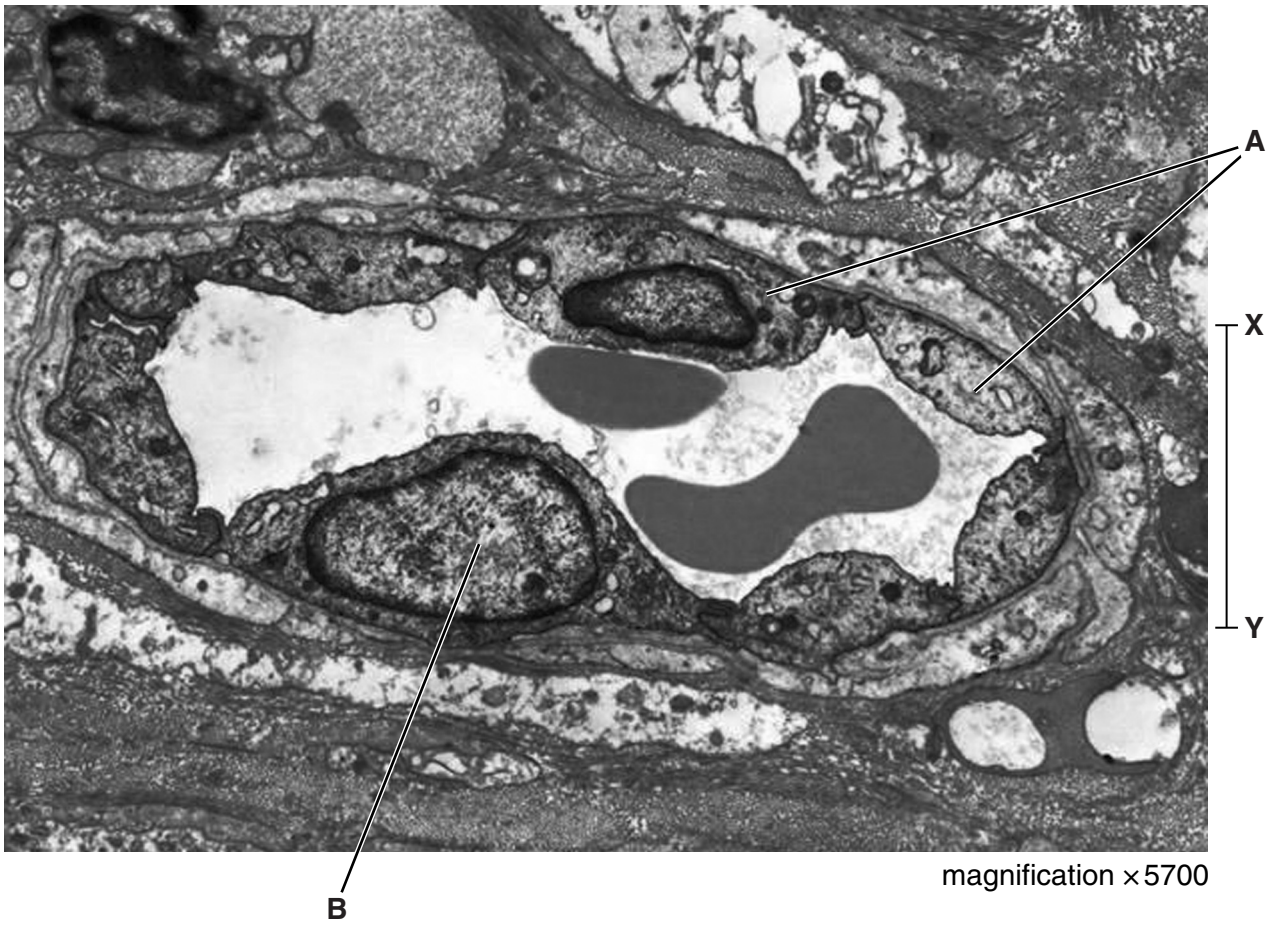


Fig. 1.1

(a) (i) Name the cells labelled **A** and the structure labelled **B**.

A .....

B ..... [2]

(ii) Calculate the actual distance **X** – **Y** on Fig. 1.1.

Show your working and give your answer to the nearest micrometre (μm).

answer ..... μm [2]

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(iii) Explain how capillaries are adapted for their function as exchange vessels.

For Examiner's Use

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..... [2]

(b) Table 1.1 shows the composition of blood, tissue fluid and lymph.

Table 1.1

component	blood	tissue fluid	lymph
red blood cells / cells $mm^{-3} \times 10^6$	5.1	0.0	0.0
white blood cells / cells mm^{-3}	9 000	75	1 000 000
glucose / g dm^{-3}	800	800	775
protein / g dm^{-3}	71	1	26

Explain the differences between the composition of blood, tissue fluid and lymph as shown in Table 1.1, for white blood cells, glucose and protein.

white blood cells .....

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glucose .....

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protein .....

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(c) Outline how **red blood cells** are involved in the transport of carbon dioxide.

For Examiner's Use

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[Total: 14]

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For Examiner's Use

2 **(a)** Explain how the virus that causes measles is transmitted.

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..... [2]

(b) Antibodies against measles are produced by plasma cells during an immune response.

Fig. 2.1 shows a diagram of an antibody molecule.

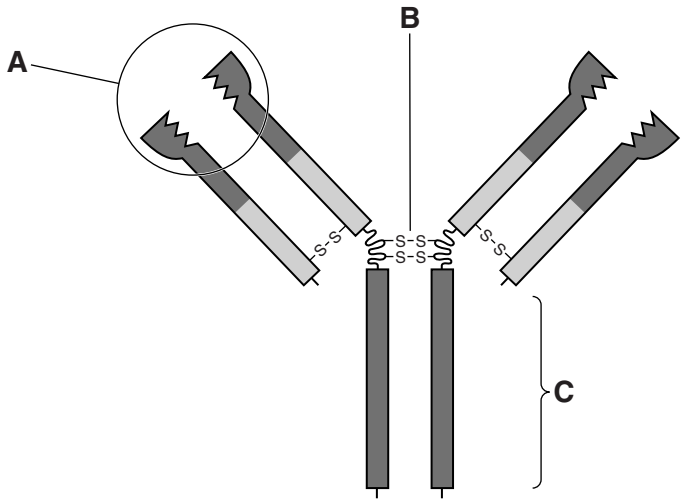


Fig. 2.1

Explain the functions of the parts labelled **A**, **B** and **C**.

(i) **A** .....

.....

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..... [2]

(ii) **B** .....

.....

..... [1]

(iii) **C** .....

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..... [1]

[Total: 6]

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[Turn over

3 **(a)** Transpiration is often described as an 'inevitable consequence of gas exchange in plants'.

For Examiner's Use

Explain what is meant by this statement.

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.....[3]

The buttonwood tree, *Conocarpus erectus*, grows in coastal areas of the Americas. A study was carried out on its ability to survive on Socorro Island off the Pacific coast of Mexico. The island is exposed to high winds, which can lead to high rates of transpiration.

The transpiration rates of trees at sheltered and exposed locations at the same altitude on Socorro Island were compared. The results are shown in Fig. 3.1.

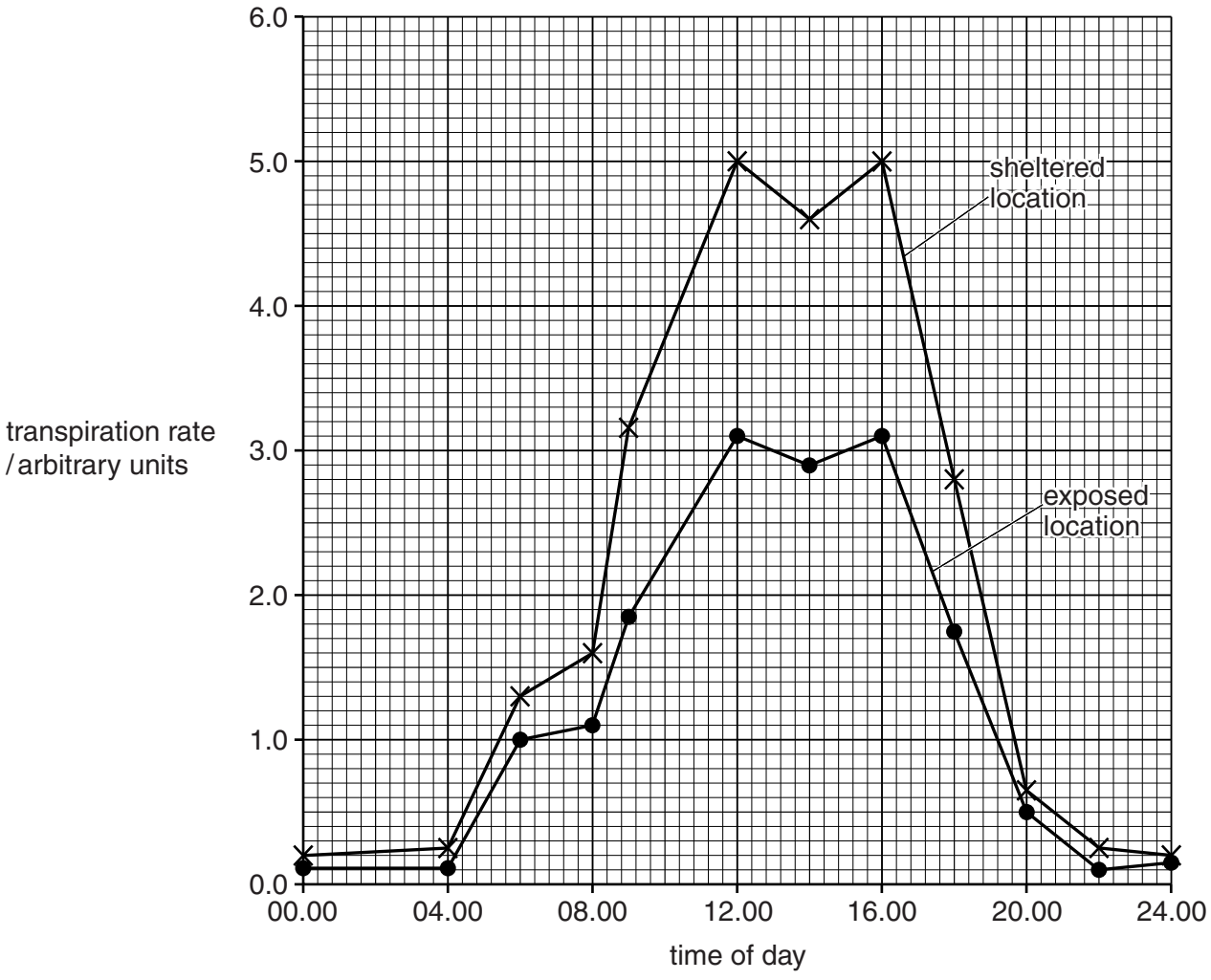


Fig. 3.1

(b) Describe the results shown in Fig. 3.1.

For Examiner's Use

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(c) The leaves of the buttonwood trees at the exposed site were significantly smaller than those at the sheltered site.

Describe three ways, **other than small size**, in which leaves are adapted to reduce the rate of transpiration.

1. .....

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2. .....

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3. .....

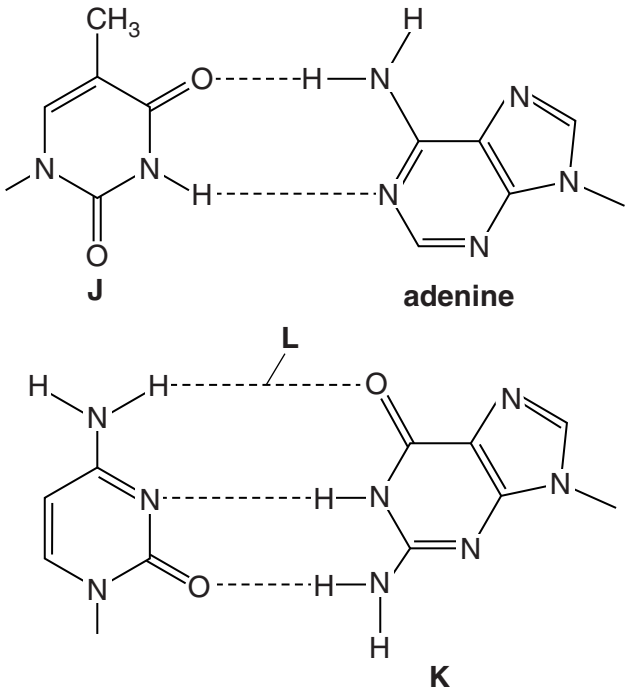
.....

..... [3]

[Total: 11]

4 Fig. 4.1 shows the two base pairs in a DNA molecule.

For Examiner's Use



K

Fig. 4.1

(a) Name the bases labelled **J** and **K** and the bond labelled **L**.

J .....

K .....

L ..... [3]

HIV enters T-lymphocytes by a form of endocytosis. Two of the enzymes in HIV are:

- reverse transcriptase, which uses viral RNA as a template to make DNA to incorporate into the chromosomes of the host's cells
- protease, which is used to break a polypeptide into smaller molecules. These molecules are used to make the protein coat of new viral particles, which will infect other cells.

Various drugs have been developed to treat HIV infections. Table 4.1 gives information about some of these drugs.

Table 4.1

drug	**enzyme inhibited**	**mode of action**
zidovudine	reverse transcriptase	occupies active site
tenofovir	reverse transcriptase	occupies active site
efavirenz	reverse transcriptase	occupies sites other than the active site
atazanavir	protease	occupies active site

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(b) Explain the difference between the mode of action of zidovudine and efavirenz.

For Examiner's Use

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..... [4]

(c) People who receive drug treatment for HIV take a mixture of drugs that act in different ways.

Suggest the advantage of taking a mix of the drugs shown in Table 4.1.

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(d) Antibiotics are prescribed to people who have HIV/AIDS for the treatment of secondary infections, but not to treat the HIV infection.

Explain why this is so.

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[Total: 11]

5 Fig. 5.1 shows a section of a cell surface membrane.

For Examiner's Use

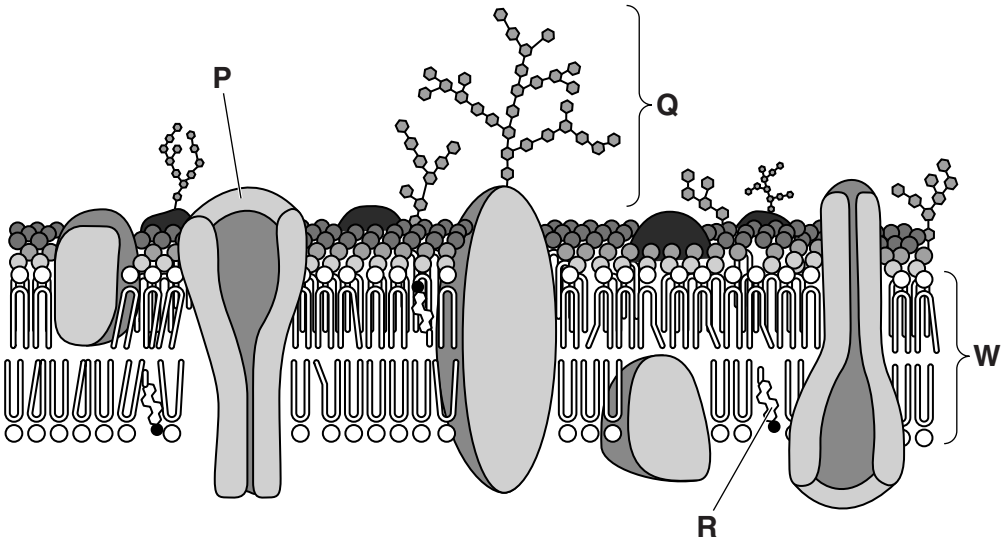


Fig. 5.1

(a) State the functions of structures **P**, **Q** and **R**.

P .....

.....

Q .....

.....

R .....

..... [3]

(b) Circle the width of the membrane shown as **W** in Fig. 5.1.

17.0 μm 1.7 μm 0.7 μm 70.0 nm 17.0 nm 7.0 nm 0.7 nm [1]

(c) Membranes, such as the cell surface membrane, are described as having a fluid mosaic structure.

Explain what is meant by the term *fluid mosaic*.

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..... [2]

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(d) Aquaporins are membrane channel proteins in plant and animal cells. They permit the movement of water across membranes. Explain why they are necessary.

For Examiner's Use

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..... [3]

[Total: 9]

6 **(a)** Explain how uncontrolled cell division can result in cancer.

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(b) Describe the experimental evidence that shows that smoking causes lung cancer.

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..... [3]

(c) Fig. 6.1 shows the changes in mortality rates for lung cancer in five countries between 1950 and 2006 for males.

For Examiner's Use

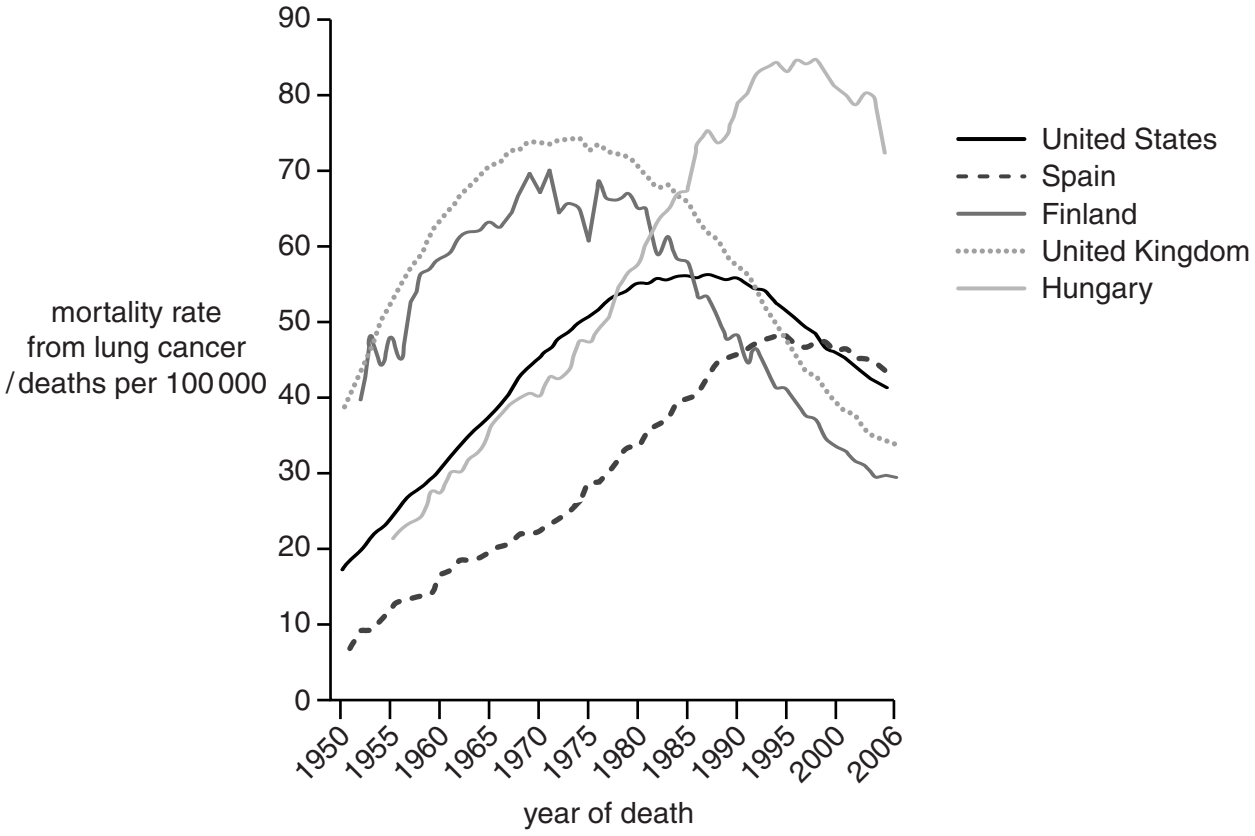


Fig. 6.1

With reference to Fig. 6.1, describe the similarities **and** differences in the trends in mortality rates in the countries shown.

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..... [3]

[Total: 9]

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BIOLOGY **9700/22**

Paper 2 Structured Questions AS **May/June 2013**

1 hour 15 minutes

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Answer **all** the questions.

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1 **(a)** The cells in Fig. 1.1 are from the same organism and look the same. The cells in Fig. 1.1(a) have been produced by mitosis and the cells in Fig. 1.1(b) have been produced by meiosis**.**

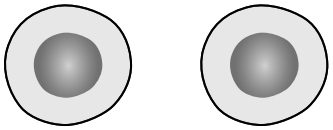


Fig. 1.1(a)

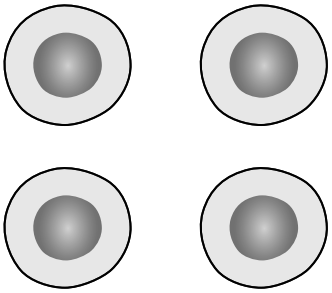


Fig. 1.1(b)

(i) Complete the table to show two differences between cells that have been produced by mitosis compared to cells that have been produced by meiosis.

mitosis	**meiosis**

[2]

(ii) Explain why the organism produces cells by meiosis.

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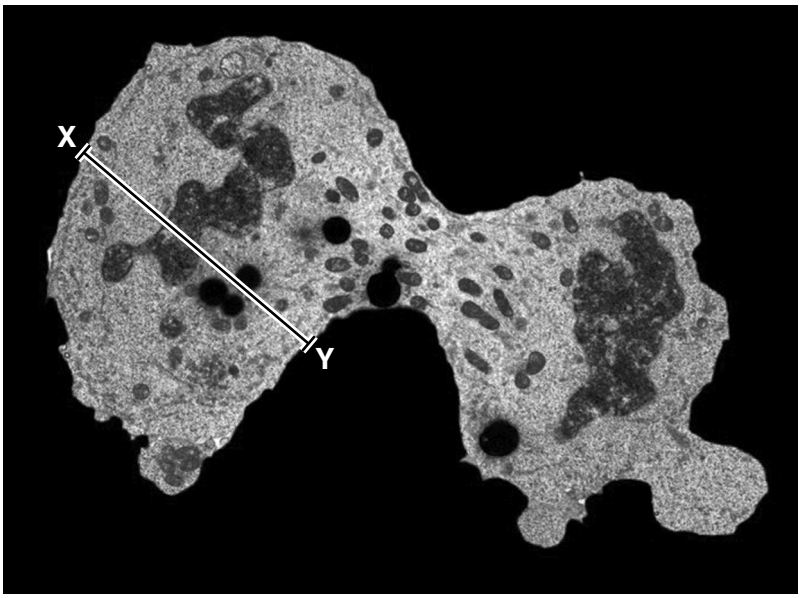
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..... [2]

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(b) Fig. 1.2 is a transmission electron micrograph of a dividing cancer cell.

For Examiner's Use



magnification x 3000

Fig. 1.2

(i) Calculate the actual width of the cell shown in Fig. 1.2 at **X**-**Y**.

Show your working and give your answer to the nearest micrometre (μm).

answer ..... μm [2]

(ii) The cancer cell shown in Fig. 1.2 has more mitochondria and rough endoplasmic reticula (RER) compared to the non-cancerous cell from which it originated.

Suggest why this is so.

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..... [2]

[Total: 8]

2 Fig. 2.1 shows xylem tissue in a longitudinal section through the stem of a dicotyledonous plant.

For Examiner's Use

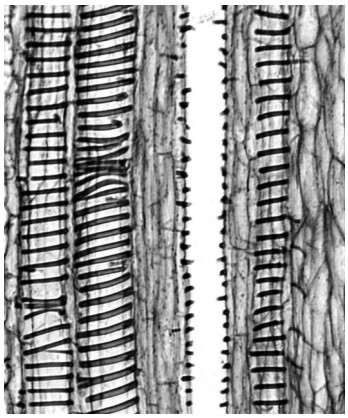


Fig. 2.1

(a) Describe and explain how the structure of xylem vessels is suited to their function.

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..... [5]

(b) It is possible to obtain images, such as Fig. 2.1, at the same magnification with both the light microscope and the electron microscope.

For Examiner's Use

State the advantages of using the light microscope, rather than using the electron microscope, in studies of tissues.

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..... [2]

[Total: 7]

3 **(a)** Explain why tuberculosis (TB) is known as an **infectious** disease.

For Examiner's Use

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..... [3]

(b) Outline the role of antibiotics in the treatment of infectious diseases, such as TB.

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..... [4]

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Tobacco smoking is a risk factor for a number of diseases. This means that it increases the risk of developing disease. In 2009, the World Health Organization (WHO) published a factsheet stating that tobacco smoking:

- may be responsible for more than 20% of the new cases of TB globally
- increases the risk of becoming infected and having active TB
- increases the risk of dying from TB
- is a risk factor for TB in all socioeconomic groups.

Projects have been set up in a number of different countries to tackle this health problem. One project involves health workers encouraging TB patients to give up smoking.

(c) Suggest what epidemiological evidence would lead to the conclusion that tobacco smoking is a risk factor for TB.

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..... [2]

(d) Suggest **and** explain how the effects of smoking can increase the risk of becoming infected with TB.

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..... [3]

(e) Many smokers know that tobacco smoking is a risk factor for coronary heart disease, but continue to smoke. Some of these smokers have stated that they expect medical practitioners to cure them if they develop coronary heart disease.

List two treatments used by medical practitioners to treat coronary heart disease.

1. .....

2. ..... [2]

[Total: 14]

For Examiner's Use

4 Polysaccharides are synthesised by condensation reactions between monosaccharide or disaccharide subunits (monomers).

(a) Name the type of bond formed when polysaccharides are synthesised.

..... [1]

(b) Disaccharides are formed following synthesis from monosaccharides or as a result of polysaccharide hydrolysis.

Cellobiose, maltose, sucrose and trehalose are four different disaccharides found in nature. Fig. 4.1 shows the molecular structure of these disaccharides.

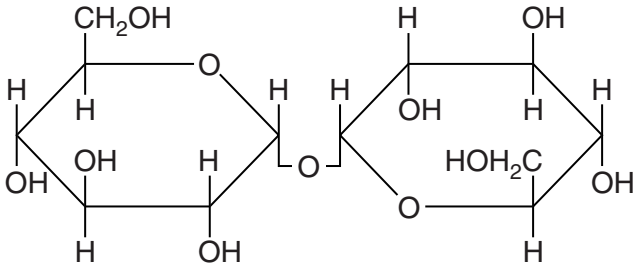
Identify the disaccharides, labelled **A** to **D**, using the information below.

- The disaccharide cellobiose is formed from the hydrolysis of the polysaccharide cellulose.
- When cellobiose is hydrolysed, two **β-glucose** molecules are produced.
- One of the disaccharides is sucrose.
- Trehalose is a disaccharide that is synthesised from two **α-glucose** molecules.
- The disaccharide maltose is formed from the hydrolysis of amylose, a component of starch.

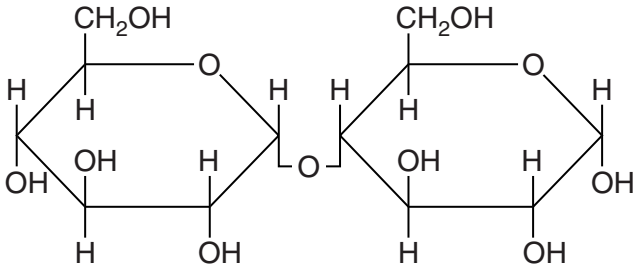
Write the name of the disaccharides in the spaces provided on Fig. 4.1.

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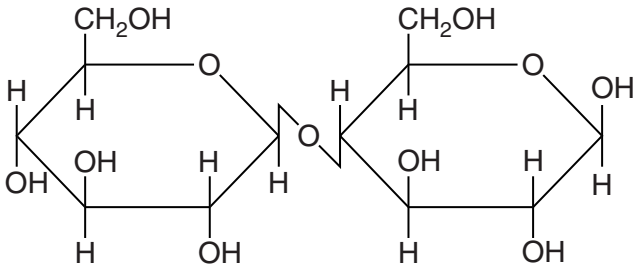
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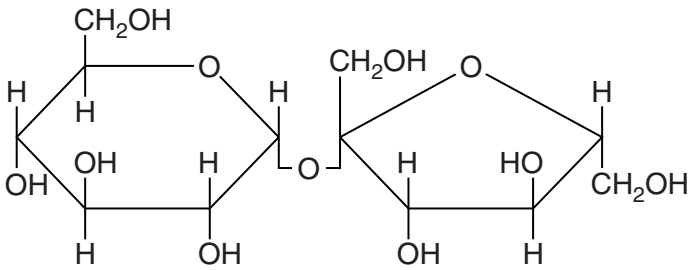
A .....



B .....



C .....



D .....

[3]

Fig. 4.1

In some organisms, trehalose is used as an energy store and gives protection against the harmful effects of very low temperatures. Trehalose is sometimes referred to as a cryoprotectant, allowing organisms to survive in freezing conditions.

For Examiner's Use

Freezing temperatures can damage the cell surface membrane and membranes within the cell.

(c) Explain the importance of the cell surface membrane to cells.

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..... [3]

(d) Freezing temperatures can also completely stop enzyme activity by causing the molecules to undergo 'cold denaturation'. Enzyme activity is not recovered when temperatures are increased to a normal working temperature range.

(i) Explain the mode of action of enzymes.

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..... [3]

(ii) Suggest how the molecular structure of the enzyme changes during 'cold denaturation'.

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..... [2]

(e) Cryoprotectants, such as trehalose, are of particular interest in their application to preserving cells, tissues or organisms for future use.

For Examiner's Use

An investigation was carried out to find the protective effect given by different concentrations of two cryoprotectants, trehalose and glycerol, on a respiratory enzyme.

The enzyme was subjected to a freezing temperature and then returned to its optimum temperature. The activity of the enzyme was measured at its optimum temperature.

Fig. 4.2 is a graph showing the results of the investigation.

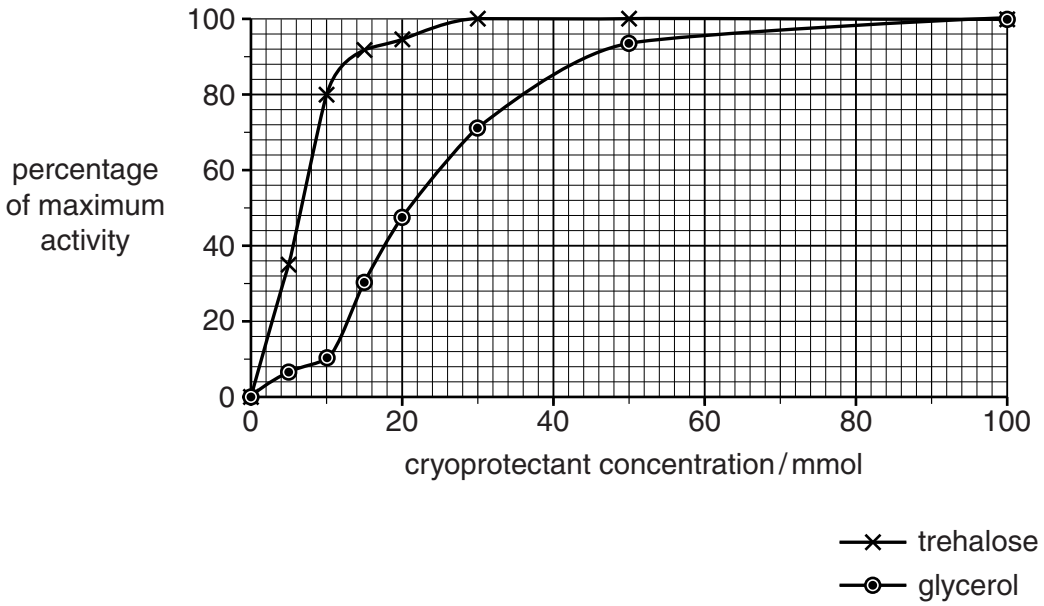


Fig. 4.2

With reference to Fig. 4.2, **describe** the results of the investigation.

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[Total: 16]

For Examiner's Use

5 **(a)** Complete the table to **describe** three differences between DNA replication and DNA transcription.

DNA replication	DNA transcription

[3]

(b) Errors during replication may lead to gene mutations.

Define the term *gene mutation*.

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..... [2]

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For Examiner's Use

(c) Some disease-causing organisms undergo frequent mutation, changing their surface antigens and making the disease much more difficult to control with a vaccination programme.

(i) Explain why existing vaccines may no longer be effective when the surface antigens of a disease-causing organism change.

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..... [2]

(ii) State precisely the type of immunity gained by a person who has been vaccinated.

..... [1]

(d) The virus causing measles is said to be antigenically stable as it rarely mutates. Measles vaccination programmes have been successful in preventing epidemics in many areas.

Outline **two** reasons why measles is still common in many parts of the world, even though the vaccine is available.

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..... [2]

[Total: 10]

For Examiner's Use

6 **(a)** The statements below are some of the events that occur in the initiation and control of heart action during one cardiac cycle.

Place the events in the correct sequence, using **1** as the first event in the sequence.

event	correct sequence
Purkyne tissue conducts the wave of excitation	
atrioventricular node sends out a wave of excitation	
atria contract	
ventricles contract	
sinoatrial node sends out a wave of excitation	

[3]

(b) The wall of the left ventricle contains more cardiac muscle than the wall of the right ventricle.

Explain the difference in the thickness of the walls of the left and right ventricles of the heart, in terms of their functions.

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..... [2]

[Total: 5]

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BIOLOGY **9700/23**

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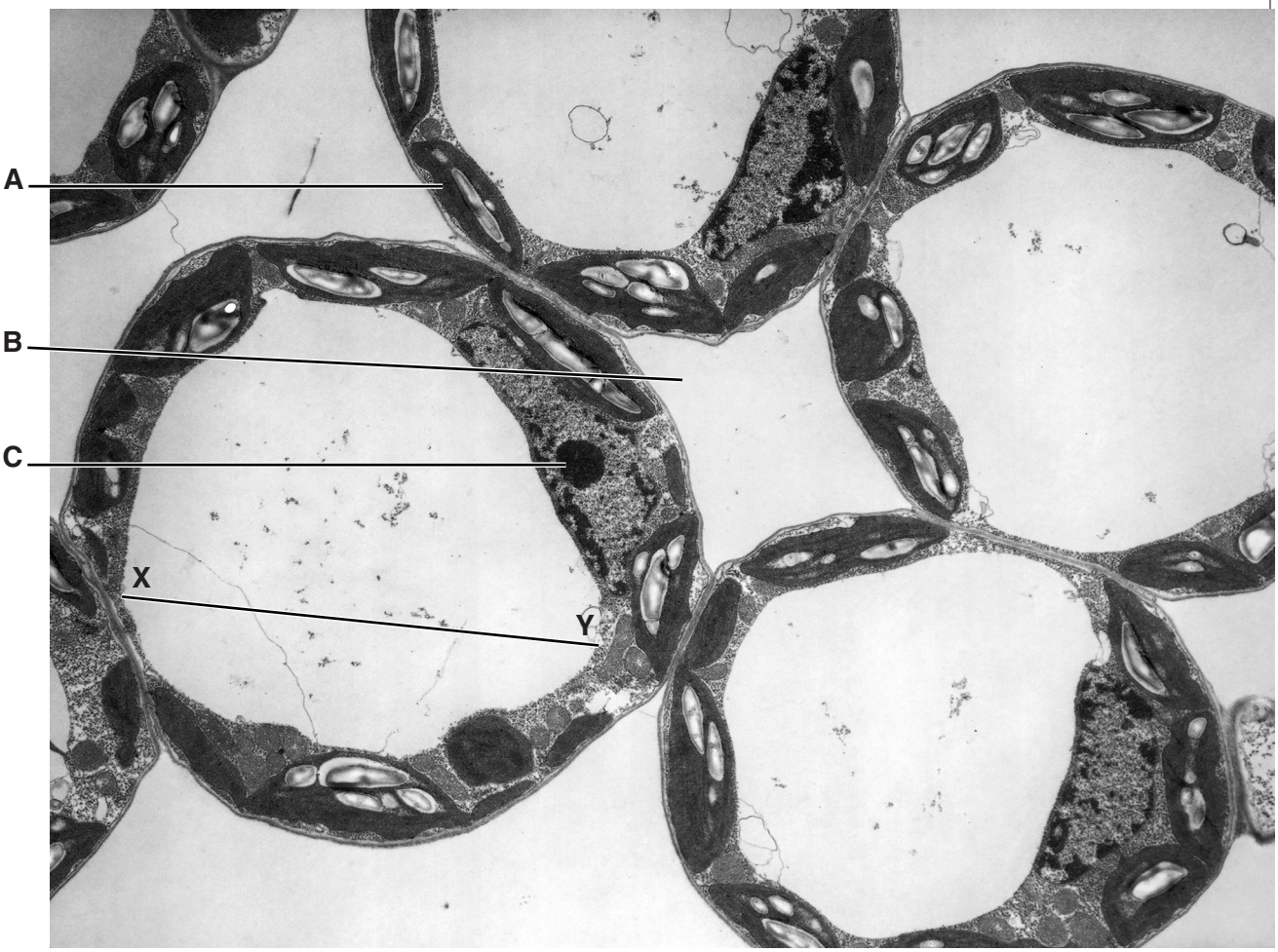
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Answer **all** the questions.

For Examiner's Use

1 Fig. 1.1 is an electron micrograph of a transverse section of palisade mesophyll tissue in the leaf of the flowering plant, *Zinnia elegans*.



magnification ×7000

Fig. 1.1

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

A .....

B .....

C .....

[3]

(b) Calculate the width of the vacuole across the line **X**-**Y**.

Show your working and give your answer to the nearest micrometre (μm).

answer ..... μm [2]

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(c) The membrane surrounding the vacuole, called the tonoplast, has a fluid mosaic structure.

For Examiner's Use

Describe the structure of this membrane.

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..... [4]

(d) Palisade mesophyll cells have very large vacuoles.

Explain how water moves from the xylem in the leaf into these vacuoles.

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..... [3]

[Total: 12]

2 Read the following passage.

For Examiner's Use

> A method called *in vitro* translation is often used by scientists to produce proteins in the laboratory. The method uses extracts from animal cells, plant cells or bacteria. These are chosen because they have high levels of protein synthesis. The cells are treated so that the cell walls, if present, and cell membranes are broken down and then treated so that any of the cell's own DNA and mRNA are destroyed. When mRNA from any source is added to these extracts, it will be translated into the corresponding protein.

(a) Explain why:

(i) the cells are chosen on the basis of their high level of protein synthesis

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..... [2]

(ii) the cell walls (if present) and cell membranes need to be broken down

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..... [1]

(iii) the cell's own mRNA needs to be destroyed

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..... [1]

(iv) mRNA from any source can be translated in any type of extract.

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.....

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..... [2]

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(b) State **two** differences between the cell structures used in translation in prokaryotes and eukaryotes.

For Examiner's Use

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..... [2]

(c) Scientists usually find that the method of *in vitro* translation is less efficient than *in vivo* translation, which occurs in cells.

Suggest a reason for this.

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..... [1]

[Total: 9]

3 Fig. 3.1 shows part of the nitrogen cycle.

For Examiner's Use

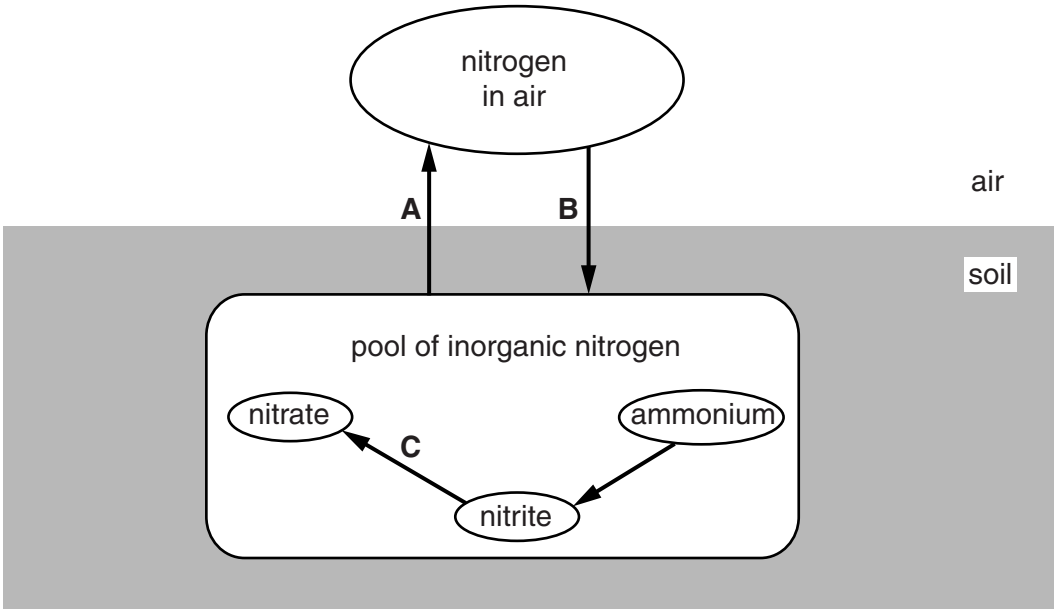


Fig. 3.1

(a) (i) Name processes **A**, **B** and **C**.

A .....

B .....

C .....

[3]

(ii) Dead animal and plant material can also contribute to the pool of inorganic nitrogen in soil.

Describe how this happens.

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..... [3]

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(b) Other inorganic substances, such as phosphate, are cycled entirely within the soil.

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(i) State **one** use for phosphate and **one** use for nitrate in organisms.

phosphate .....

nitrate .....
[2]

(ii) Nitrogen and phosphate are both cycled more rapidly in ecosystems where there are high rates of growth within trophic levels and high rates of energy flow between trophic levels.

With reference to the use of **both** nitrogen and phosphate in organisms, explain this statement.

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..... [3]

[Total: 11]

For Examiner's Use

4 The enzyme, catechol oxidase, causes a brown colour to develop when slices of many fruits, such as apples, are exposed to air.

The enzyme catalyses the following reaction:

$$\text{catechol} + \text{oxygen} \xrightarrow{\text{catechol oxidase}} \text{quinone} + \text{water}$$

Quinone is then immediately further oxidized in air to a brown-coloured substance. Catechol and quinone are colourless.

A student investigated the rate of this reaction under different conditions.

(a) State how the student could follow the progress of this reaction.

.....

..... [1]

In the first investigation, the student measured the initial rate of the reaction in varying concentrations of catechol. The results are shown in Fig. 4.1.

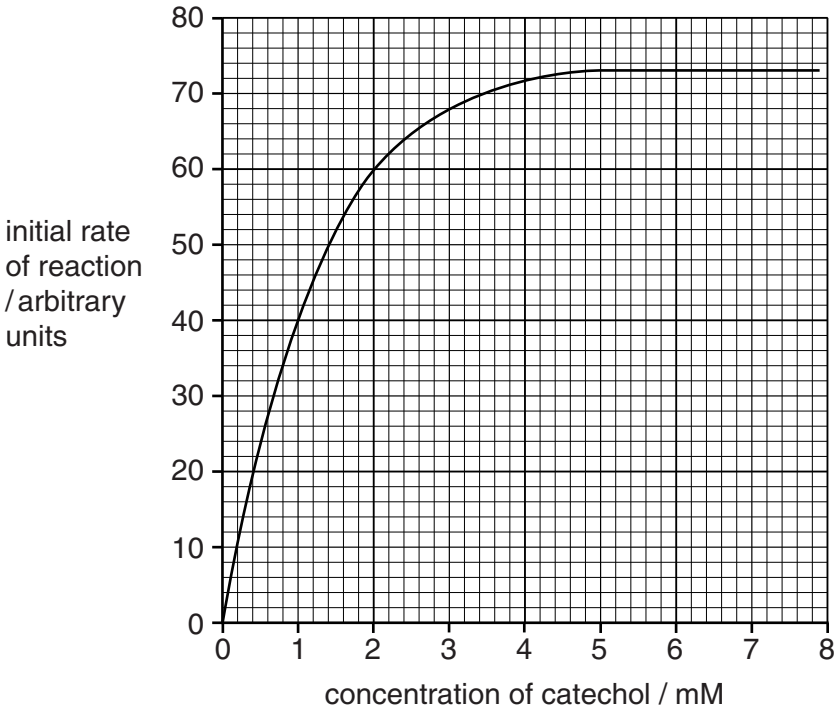


Fig. 4.1

(b) Explain the results shown in Fig. 4.1.

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..... [5]

(c) In a second investigation, the student repeated the experiment, but this time added a competitive inhibitor, para-hydroxybenzoic acid (PHBA), to each reaction mixture.

(i) Sketch **on Fig. 4.1** the results that would be obtained for this second investigation. [2]

(ii) Explain the effect that PHBA will have on the action of phenoloxidase.

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..... [2]

(d) Lemon juice contains citric acid. Adding even a small amount of diluted lemon juice to apple slices slows the appearance of the brown colour.

Suggest an explanation for this observation.

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..... [2]

[Total: 12]

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[Turn over

5 **(a)** Explain the importance of mitosis in multicellular organisms.

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..... [3]

A protein, mitosis-promoting factor (MPF), has been identified in cells. MPF is a globular protein made from two polypeptide chains.

(b) Place a tick (✓) in the box next to the type, or types, of protein structure shown by MPF.

primary	☐
secondary	☐
tertiary	☐
quaternary	☐

[1]

The presence of MPF is known to cause prophase to start.

(c) Describe the changes that occur during prophase in an animal cell.

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..... [4]

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(d) MPF normally begins to break down and stops functioning during anaphase.

Suggest the possible consequences of MPF **not** breaking down.

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..... [3]

[Total: 11]

For Examiner's Use

For Examiner's Use

6 Measles is an infectious disease, while lung cancer is not.

(a) Explain why lung cancer is sometimes referred to as a 'lifestyle disease'.

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..... [2]

(b) State the type of pathogen that causes measles and state its mode of transmission.

pathogen .....

transmission .....

.....

[2]

(c) Between January and April 2011, 118 measles cases were reported in the USA, where measles was previously thought to be virtually eradicated.

Suggest a reason for this rise in measles cases.

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..... [1]

[Total: 5]

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