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Answer **all** the questions.

1 The condition known as AIDS is widespread in some parts of the world.

(a) (i) Identify the infective agent that causes AIDS.

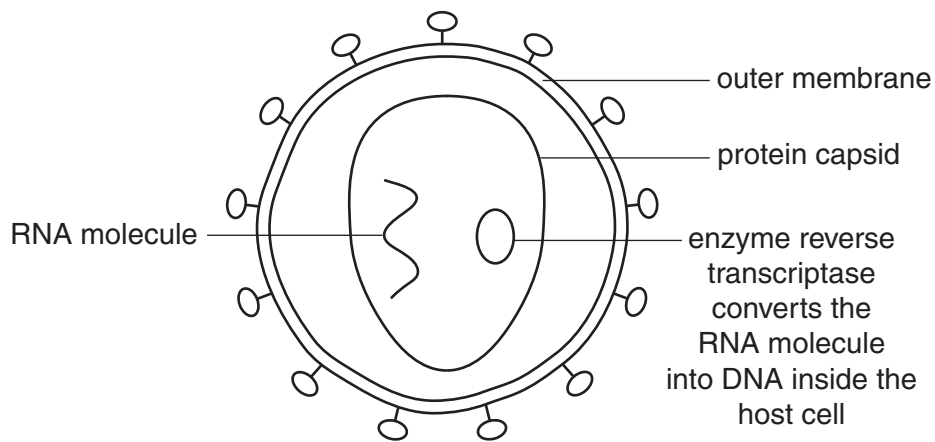
..... [1]

(ii) The government has introduced needle exchange programmes for drug users.

Explain how this may help reduce the transmission of AIDS.

.....  
.....  
.....  
.....  
..... [2]

(b) Fig. 1.1 shows a simplified diagram of the structure of the infective agent that causes the condition known as AIDS.



**Fig. 1.1**

(i) The proteins in the capsid and the RNA molecules are polymers. Polymers are made up of smaller monomer subunits.

Name the monomers that make up:

proteins .....

RNA ..... [2]

(ii) The infective agent that causes AIDS takes control of the T lymphocytes of the host.

Using the information in Fig. 1.1, suggest why the infective agent is able to ‘take control’ once it has entered the T lymphocytes.

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..... [2]

(c) People with AIDS frequently become ill following infection with opportunistic diseases such as tuberculosis (TB).

(i) State **three** factors that increase the chance of infection with TB.

1 .....

2 .....

3 ..... [3]

(ii) When an infection occurs, some T lymphocytes produce cell signalling molecules called cytokines. These cytokines stimulate specific groups of B lymphocytes to divide.

Describe how cytokine molecules can stimulate specific groups of B lymphocytes to divide.

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..... [3]

[Total: 13]

Turn over

- 2 Fig. 2.1 shows part of an **amylose** molecule. This is an unbranched form of starch.

When iodine solution is added to starch, iodine fits into the helix of the amylose molecule, producing a colour change.

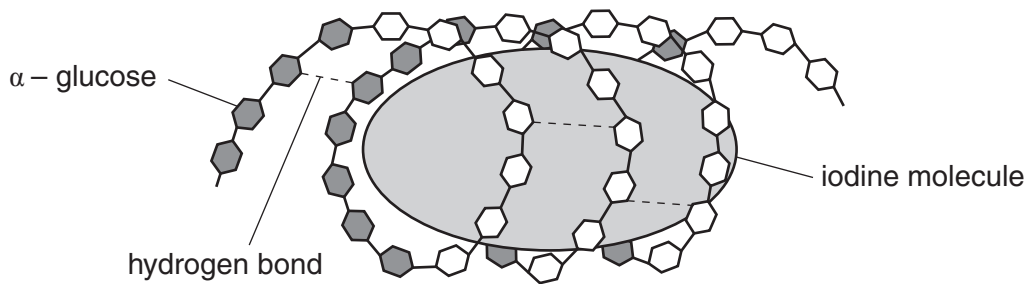


Fig. 2.1

- (a) (i) State the colour of iodine solution in the presence of starch.

..... [1]

- (ii) Hydrogen bonds hold the amylose molecule in its helical shape.

Describe how a hydrogen bond is formed.

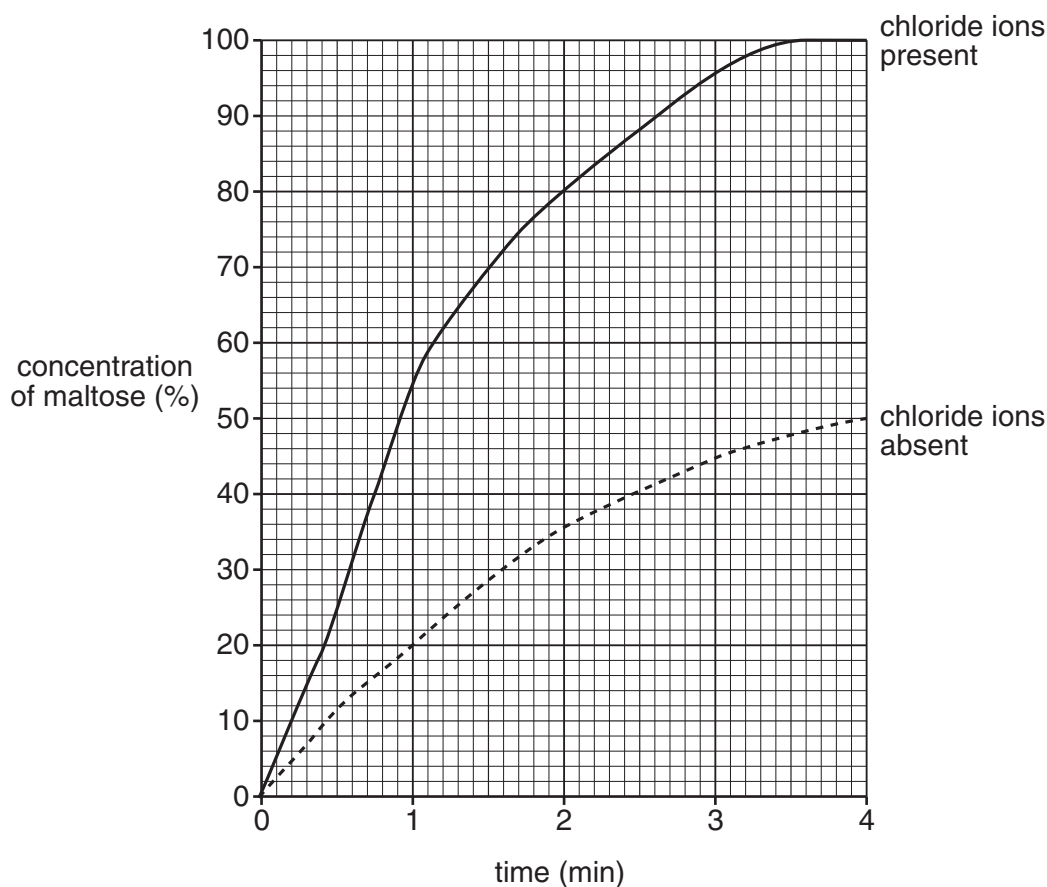
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..... [2]

- (iii) Using the information in Fig. 2.1, suggest what would happen to the iodine-amylose complex if the solution was heated to  $60^{\circ}\text{C}$ .

.....  
.....  
.....  
.....  
..... [2]



- (c) Fig. 2.2 shows the results that the student obtained from a practical procedure in which the rate of formation of maltose was measured in the presence and absence of chloride ions.



**Fig. 2.2**

- (i) Describe the effect of chloride ions on the rate of reaction.

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..... [2]

- (ii) Suggest how chloride ions have this effect on the rate of reaction.

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..... [2]

- (iii) State **three** variables that need to be controlled in this practical procedure in order to produce valid results.

1 .....

2 .....

3 ..... [3]

[Total: 19]

QUESTION 3 STARTS ON PAGE 8

Turn over

- 3 Part of the Cairngorms National Park in the Scottish Highlands is at an altitude of approximately 1000 metres. It presently supports a range of plants and animals including some that are normally found in sub-arctic conditions.

Table 3.1 shows the breeding success of a number of bird species between 1970 and 2000. Specialist sub-arctic species are marked with an asterisk \*.

**Table 3.1**

species	number of young raised per year			
	1970	1980	1990	2000
snow bunting *	78	69	36	2
Lapland bunting *	7	3	0	0
ptarmigan *	1280	1134	960	876
red grouse	890	920	933	962
wheatear	209	240	190	231
meadow pipit	23	45	48	82
ring ouzel	23	21	29	26
dotterel *	45	43	39	35

\* = specialist sub-arctic species

- (a) (i) Using the data in Table 3.1, compare the breeding success of the sub-arctic species and the non sub-arctic species between 1970 and 2000.

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..... [3]



- (ii) Suggest **two** reasons for the trends described.

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..... [2]

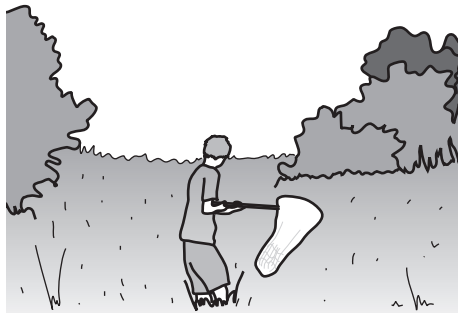
- (b) A study of insects was carried out in the same area of the Cairngorms National Park to determine species richness.

- (i) What is meant by species richness?

.....

..... [1]

- (ii) The insects were sampled using a sweep net method. Fig. 3.1 shows a sweep net being used. With this method, a net is swept through the vegetation. Insects are removed, identified and counted.



**Fig. 3.1**

Describe **three** ways in which the sampling procedure could be designed to try to make sure that a representative sample was obtained.

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..... [3]

Turn over

(iii) Species evenness also contributes to the measurement of biodiversity.

Explain the importance of species evenness in determining the biodiversity in a habitat.

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..... [3]

[Total: 12]

**PLEASE DO NOT WRITE ON THIS PAGE**

**QUESTION 4 STARTS ON PAGE 12**

**Turn over**

- 4 (a) The World Health Organisation has promoted the concept of health.

What is meant by the term *health*?

.....

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..... [2]

- (b) The body has adaptations that provide it with a primary defence against the entry of pathogens and parasites.

State **two** features of the body that form part of the primary defence.

For each feature, explain how it **helps to prevent the entry** of pathogens and parasites into the body.

feature 1 .....

explanation .....

.....

.....

feature 2 .....

explanation .....

.....

..... [4]

(c) Fig. 4.1 shows the life cycle of the threadworm. This is a common parasite in young children.

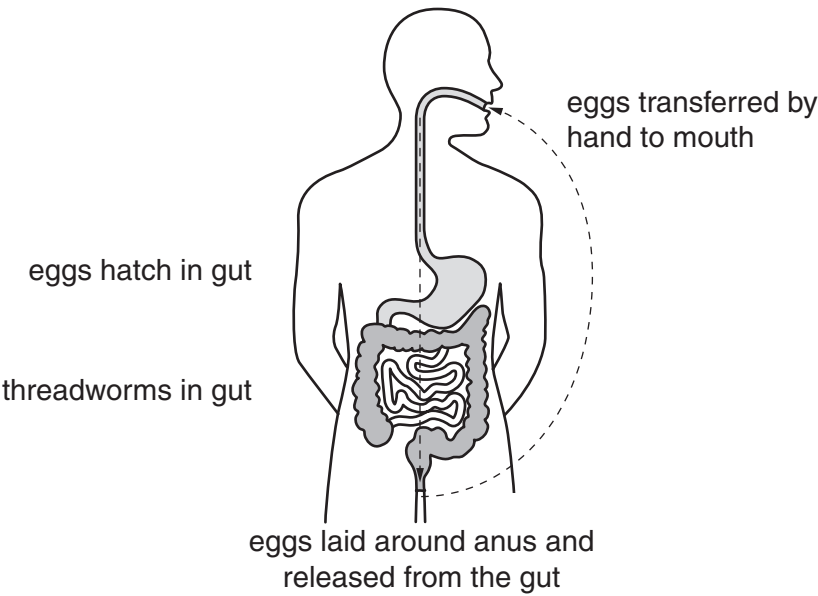


Fig. 4.1

(i) Define the term *parasite* **and** suggest how the threadworm benefits from this relationship.

..... [4]

(ii) Using the information in Fig. 4.1, suggest **two** ways in which the cycle of infection could be broken.

..... [2]

[Total: 12]

Turn over

**5** DNA and RNA are nucleic acids.

**(a)** The table below contains a number of statements relating to nucleic acids.

Complete the table, using a letter **D**, **R** or **B**, to show whether each statement applies to:

- DNA only (**D**)
- RNA only (**R**)
- both DNA and RNA (**B**).

The first one has been done for you.

statement	DNA only ( <b>D</b> ) or RNA only ( <b>R</b> ) or both DNA and RNA ( <b>B</b> )
contains thymine	<b>D</b>
contains ribose	
consists of two chains connected to each other with hydrogen bonds	
has a sugar-phosphate backbone	
has four different nitrogenous bases	
contains a pentose sugar	
is found in the nucleus and cytoplasm	

[6]

**(b)** It has been found that 98.4% of chimpanzee DNA is identical to that of a human.

**(i)** Suggest how the information obtained by DNA analysis can be useful to taxonomists.

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.....

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..... [2]

- (ii) State **two** types of evidence, other than biochemical evidence, that are used by taxonomists when classifying organisms.

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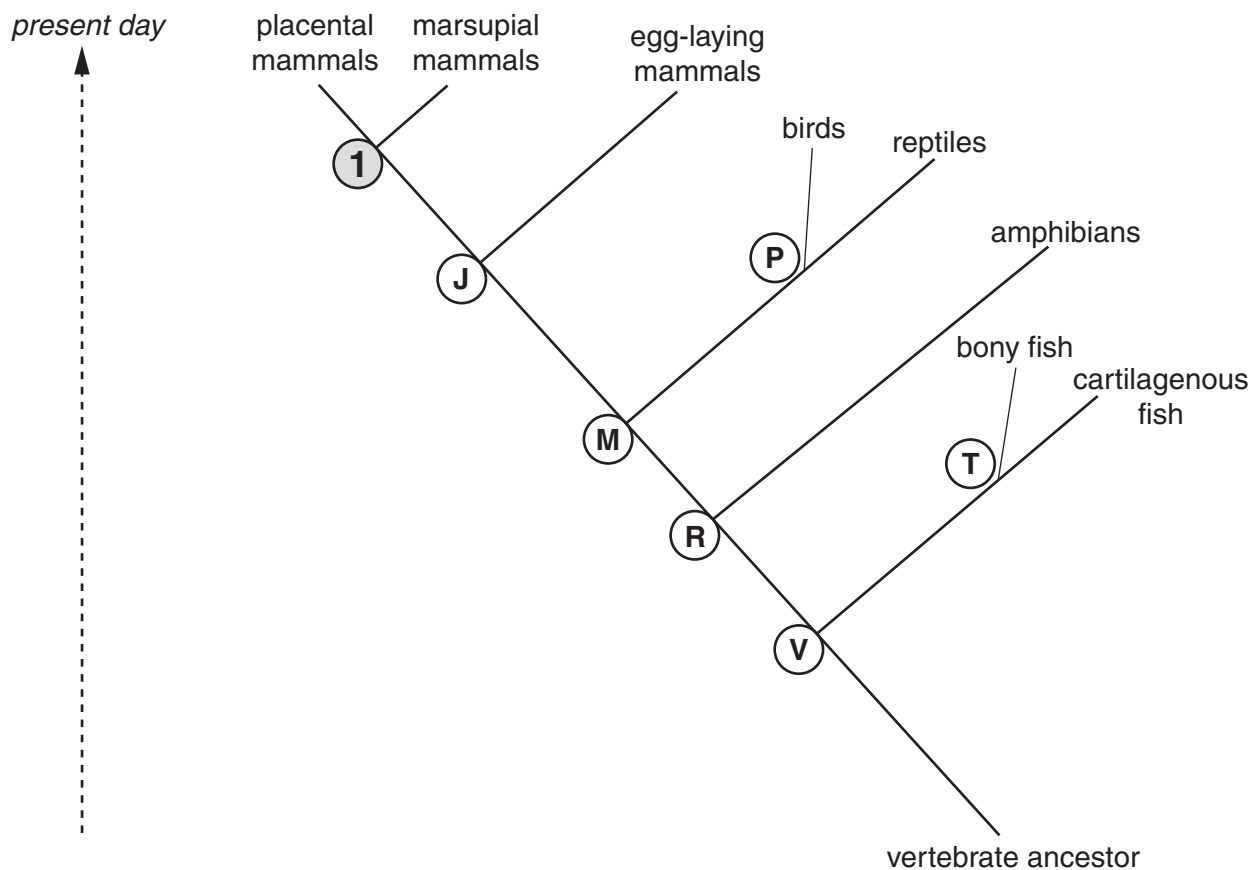
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..... [2]

- (c) Cytochrome C is a protein found in living organisms. The structure of cytochrome C varies between different organisms. However, closely related organisms have similar cytochrome C.

Fig. 5.1 shows a possible evolutionary tree for vertebrates.  
Common ancestors are indicated by the number 1 and various letters.



**Fig. 5.1**

State the **letter** of the common ancestor that has cytochrome C which will be:

**most** similar in structure to common ancestor 1 .....

**least** similar in structure to common ancestor 1 ..... [2]

Turn over

- (d) The pine marten is a small mammal that is rare in the United Kingdom. Its numbers are particularly low in Wales and there have been few confirmed sightings of this animal in the past 50 years. There have been plans to introduce pine martens from other areas of the United Kingdom into Wales to increase the size of the population.

The DNA of museum specimens of Welsh pine martens in the National Museum of Wales was tested, the most recent specimens dating from 1948. The DNA analysis suggests that Welsh pine martens are genetically distinct from those found elsewhere in the United Kingdom.

- (i) The relevance of this analysis has been questioned by some scientists.

Suggest why the findings from the museum specimens may not relate closely to the current pine marten population of the United Kingdom.

.....

.....

..... [1]

- (ii) Suggest why some people are concerned about the plan to introduce pine martens from other areas into Wales.

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..... [1]

[Total: 14]



**PLEASE DO NOT WRITE ON THIS PAGE**

**QUESTION 6 STARTS ON PAGE 18**

**Turn over**

- 6 An important aspect of food production is maximising productivity. Maximum productivity can be achieved in a number of different ways.
- (a) In selective breeding, humans look for variation between members of the same species and use this variation to improve productivity.
- (i) State the **two** different causes of variation.

- 1 .....
- 2 ..... [2]

Fig. 6.1 is a scattergraph that shows the growth rate and egg productivity in a flock of chickens.

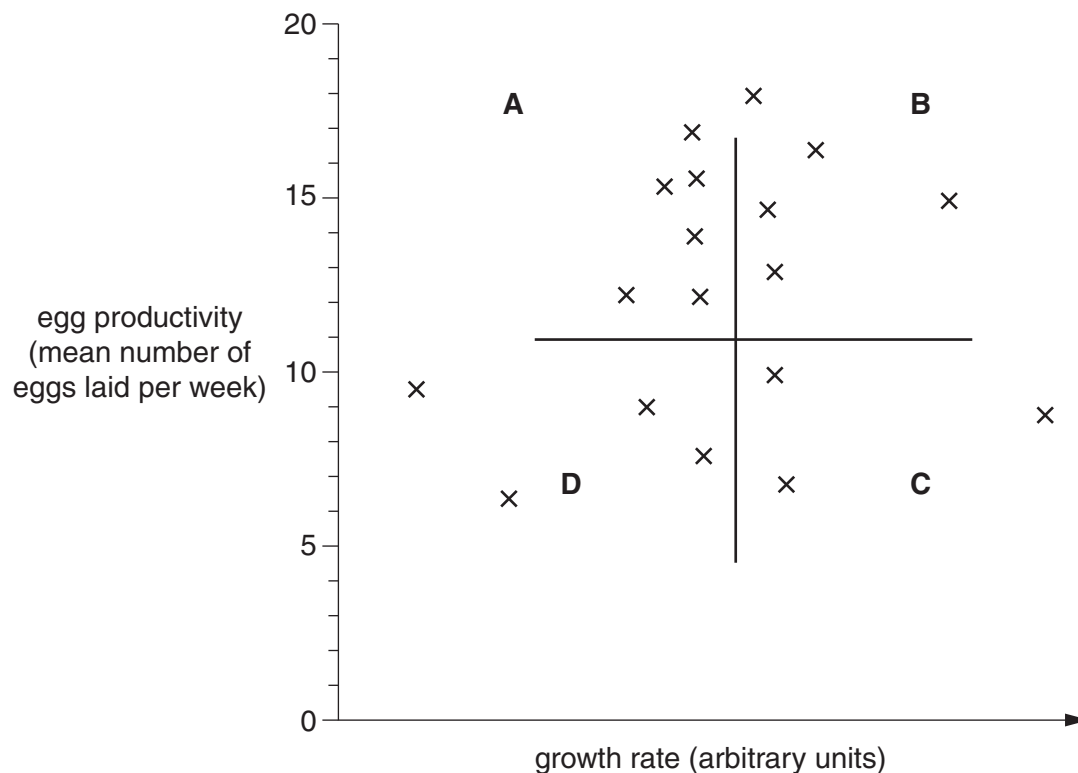


Fig. 6.1

- (ii) The growth rate of the chickens in Fig. 6.1 shows **continuous** variation.

Describe **three** characteristics of this type of variation.

..... [3]

- (iii) A chicken breeder divides the flock into four groups, **A**, **B**, **C** and **D**, as shown in Fig. 6.1.

State which group of chickens, **A**, **B**, **C** or **D**, he should use to breed from in order to improve the growth and productivity of the flock.

..... [1]

- (iv)** Suggest **two undesirable** consequences of selective breeding in chickens.

[2]

- (v) The wild ancestor of the domestic chicken is the red jungle fowl found in the rainforests of South East Asia.

Explain why it is important to preserve the population of the red jungle fowl.

[2]

**Turn over**

- (b) In the past, domestic chickens were given antibiotics as a growth promoter.
- (i) When antibiotic growth promoters were used, it was claimed that the meat was of better quality, with less fat and increased protein content.

Suggest **two further** benefits of using antibiotics.

- 1 .....  
.....
- 2 .....  
..... [2]

- (ii) The use of antibiotics as growth promoters in animal production was banned in the European Union in 2006.

Suggest a concern that led to this ban.

- .....  
.....  
..... [1]

[Total: 13]

**PLEASE DO NOT WRITE ON THIS PAGE**

**QUESTION 7 STARTS ON PAGE 22**

**Turn over**



(b) Describe the ways in which the structure of collagen is **similar** to the structure of haemoglobin.

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..... [4]

[Total: 11]

QUESTION 8 STARTS ON PAGE 24

Turn over

- 8 Complete the following passage by selecting the most suitable term from the list below.

Each term may be used once, more than once or not at all.

**antibiotics**

**natural**

**antibodies**

**non-specific**

**antibody**

**specific**

**antigen**

**vaccination**

**artificial**

**vaccines**

The body can acquire immunity in a number of different ways.

In passive immunity, .....are introduced directly into the body. This may occur via breast milk or the placenta, in which case it is described as ..... immunity. This immunity provides the growing child with valuable protection until its immune system has developed fully. It is sometimes important to provide immediate protection, such as when a person has a wound that could be contaminated with tetanus bacteria. In this case, suitable blood serum from another individual is injected into the bloodstream to provide ..... immunity.

Edward Jenner pioneered the technique of stimulating the immune system into action so that the body develops immunity without developing the symptoms of the disease. Jenner's technique mimics the way in which the body would develop ..... immunity from direct contact with the pathogen and the stimulation of the primary response. Nowadays, a harmless form of the ..... is injected so that the body develops antibodies and memory cells for future defence. This technique is known as .....

[6]

[Total: 6]

**END OF QUESTION PAPER**



**ADDITIONAL PAGE**

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**ADDITIONAL PAGE**

[illegible]

**ADDITIONAL PAGE**

[illegible]

Answer **all** the questions.

- 1 Organisms require energy in order to carry out essential metabolism. Organisms are able to release energy by carrying out both aerobic and anaerobic respiration.

(a) Complete the table to compare **anaerobic** respiration in mammals and yeast.

	mammal	yeast
name of hydrogen acceptor after glycolysis		
is CO <sub>2</sub> produced?		
name of final product		

[3]

(b) Suggest **one** benefit of anaerobic respiration to an organism.

.....

..... [1]

[Total: 4]

Turn over

- 2 (a) Fig. 2.1 represents the end region of a neurone at a cholinergic synapse.

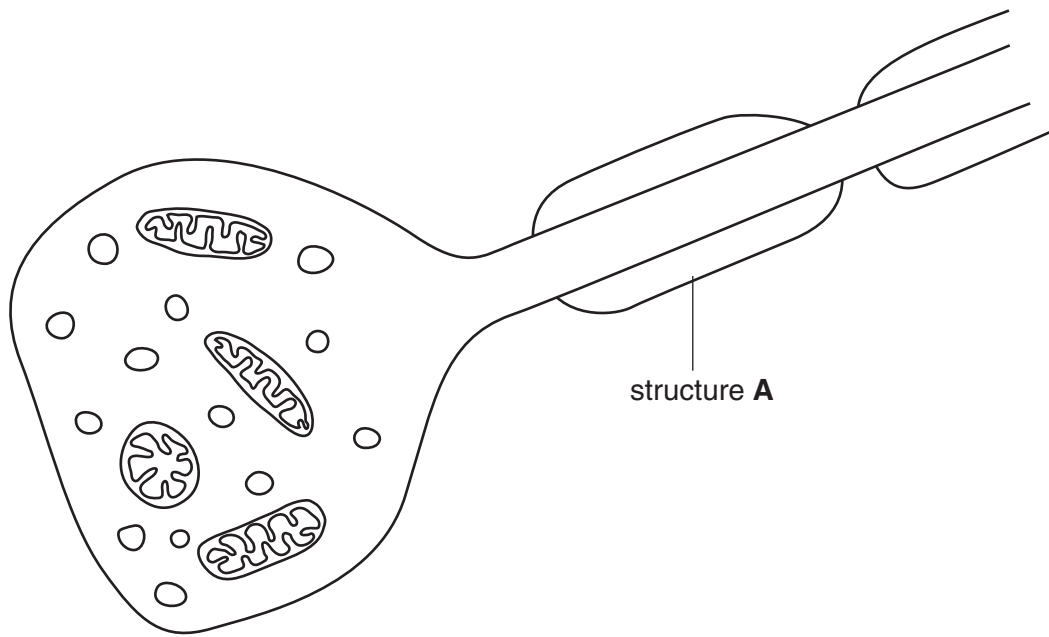


Fig. 2.1

- (i) Describe the function of **structure A**.



*In your answer, you should use the appropriate technical terms, spelt correctly.*

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..... [4]

- (ii) Name the process by which acetylcholine leaves the neurone shown in Fig. 2.1.

..... [1]

- (iii) Name the process by which acetylcholine travels across the synaptic cleft.

..... [1]

(iv) A feature of synapses is that they allow transmission in only one direction.

State how this is achieved.

.....  
.....  
..... [1]

(b) The chemical nature of synaptic transmission makes it susceptible to disruption by toxins.

(i) Atropine is a toxin produced by the deadly nightshade plant, *Atropa belladonna*.

Atropine is a similar shape to acetylcholine. The presence of atropine prevents the initiation of an action potential in the post-synaptic neurone.

Explain how the presence of atropine in the synapse will prevent the initiation of an action potential.

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.....  
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.....  
..... [3]

(ii) Nerve gases have been used as chemical weapons. Some nerve gases act by inhibiting acetylcholinesterase, prolonging the effect of acetylcholine.

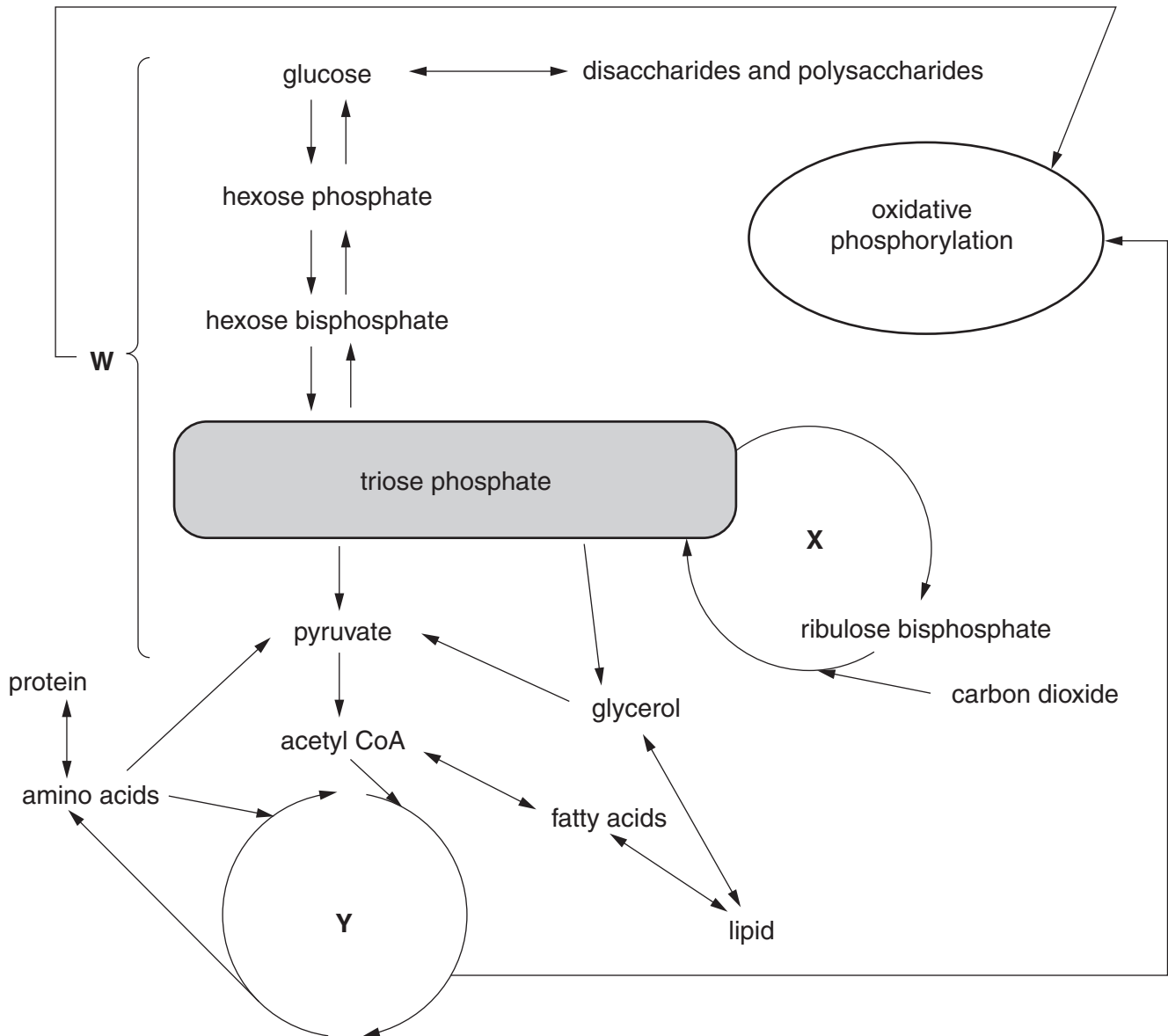
Suggest how atropine could act as an antidote to nerve gas.

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.....  
.....  
..... [2]

[Total: 12]

Turn over

3 Fig. 3.1 represents some of the reactions that take place in a leaf cell of a flowering plant.



**Fig. 3.1**

(a) (i) Name the reaction pathways indicated by the letters **W**, **X** and **Y**.

**W** .....

**X** .....

**Y** ..... [3]

(ii) Triose phosphate is a compound that is central to the metabolism of this cell.

Explain how **the three** reaction pathways (**W**, **X** and **Y**) are able to work independently of each other in the same leaf cell.

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..... [3]

(iii) Identify which of **these three** reaction pathways (**W**, **X** and **Y**) are associated with:

photosynthesis .....

aerobic respiration..... [2]

(iv) Fig. 3.1 shows that compounds from two of the three pathways are used in oxidative phosphorylation.

State the products of oxidative phosphorylation.

.....

..... [2]

(b) Explain the role of coenzymes in this leaf cell, with respect to the metabolic reactions outlined in Fig. 3.1.

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..... [3]

[Total: 13]

Turn over



- 4 Osmoregulation is a key feature of homeostasis and maintains the water potential of the blood within certain limits. This is achieved by the action of anti-diuretic hormone (ADH).

(a) Explain the likely effect on the blood cells if the water potential of the plasma was allowed to increase significantly.

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..... [2]

Fig. 4.1 is a simplified diagram of the structure of ADH.

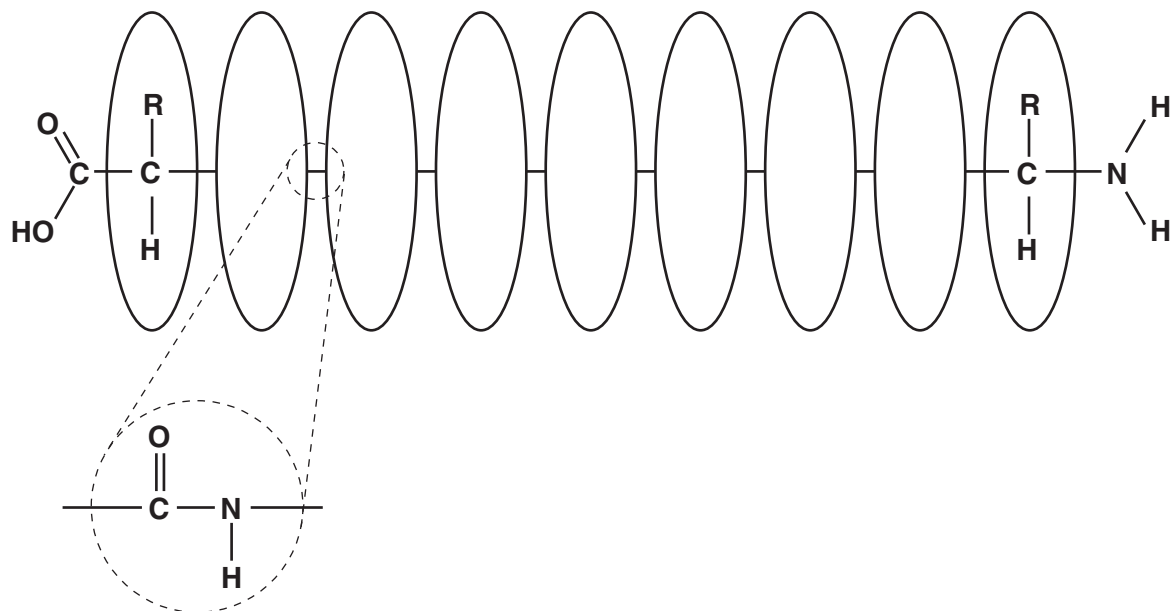


Fig. 4.1

(b) Name the type of monomer that makes up a molecule of ADH and the bond that joins the monomers together.

type of monomer.....

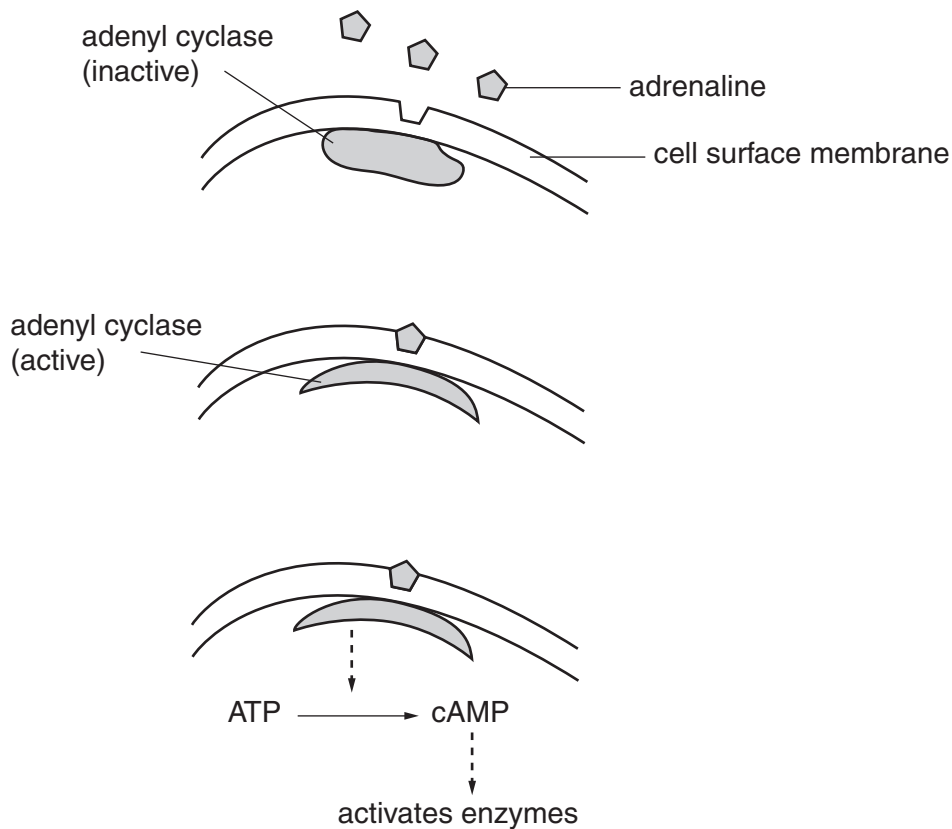
name of bond..... [2]

**[8]**

**[3]**

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- 5 (a) Fig. 5.1 represents the sequence of events that takes place when adrenaline reaches a liver cell.



**Fig. 5.1**

- (i) In terms of cell signalling, name the compound in Fig. 5.1 that is acting as:
- the second messenger.....
- the first messenger..... [2]
- (ii) Suggest what happens to polysaccharides in the liver cell as a result of the events shown in Fig. 5.1.
- .....
- .....
- ..... [1]

(iii) Adrenaline affects a range of target tissues in the body.

Suggest how the adrenaline molecule can cause different effects in different target tissues.

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..... [2]

(b) Outline the **hormonal** and **nervous** mechanisms involved in the control of heart rate.



*In your answer, you should use the appropriate technical terms, spelt correctly.*

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..... [5]

[Total: 10]

Turn over

- 6 The leaves of flowering plants have the ability to develop differently, depending on environmental conditions such as the amount of sun or shade a leaf receives.

A student carried out an investigation into sun and shade leaves from different parts of the same plant. Her observations and results are shown in Table 6.1.

Table 6.1

type of leaf	number of leaves studied	mean no. of stomata per mm <sup>2</sup> on lower surface	mean thickness of leaf (µm)	cuticle
sun	55	170	208	thick
shade	8	92	93	thin

- (a) Calculate the percentage difference in the **mean thickness** of the sun leaves compared to the shade leaves.

Show your working.

Answer = ..... [2]

- (b) Suggest **and** explain one benefit of the greater **mean number** of stomata per mm<sup>2</sup> on the lower surfaces of the sun leaves.

.....  
.....  
.....  
.....  
..... [2]

- (c) Describe **two** ways in which the student could improve her investigation.

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.....  
..... [2]

[Total: 6]

END OF QUESTION PAPER

## ADDITIONAL PAGES

**If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.**

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[illegible]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



Answer **all** the questions.

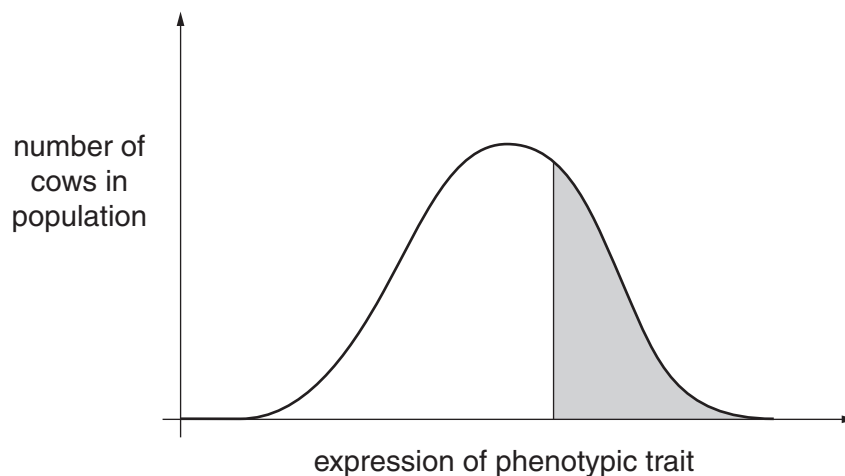
- 1 (a) Human populations have herded cattle for milk for around 9 000 years. Artificial selection over this time has resulted in the modern dairy cow.

(i) State **three** phenotypic traits (characteristics) that have been selected for in dairy cows.

- 1 .....  
2 .....  
3 ..... [3]

- (ii) Fig. 1.1 shows the pattern of variation of a phenotypic trait in a herd of dairy cows. The shaded part of the graph indicates those cows that are chosen to breed.

Draw, **on Fig. 1.1**, a second curve to show the pattern of variation in the next generation.



**Fig. 1.1**

[2]

- (iii) In recent years, artificial selection of dairy cows has been helped by modern reproductive technology.

Name **two** modern techniques or procedures that can be used in the selective breeding of dairy cows.

- 1 .....  
2 ..... [2]

(b) Lactase is an enzyme that is necessary to digest lactose sugar in milk.

In some parts of the world, animals are not farmed for milk and no dairy products are eaten. Adult humans that are native to these parts of the world do not produce lactase.

In areas where animals are farmed for milk, native adult humans do produce lactase. In these populations, a new allele has arisen by gene mutation.

(i) State what is meant by gene mutation.

.....  
..... [1]

(ii) Over time, the frequency of this new allele increased in the gene pool of the human populations whose diet included milk.

Name the process by which this increase occurred.  
..... [1]

(c) (i) All human babies produce the enzyme lactase. The genetic change that allows adults to produce this enzyme is thought to involve a mutation in a regulatory gene. This mutation causes the structural gene to be expressed in adults.

Distinguish between the terms 'regulatory gene' and 'structural gene'.  
.....  
.....  
.....  
.....  
..... [2]

(ii) Adult humans who cannot produce the enzyme lactase are described as lactose-intolerant and cannot drink milk without experiencing health problems. However, lactose-intolerant people can safely eat yogurt.

Yogurt is produced from milk that is fermented by bacteria. These bacteria perform anaerobic respiration, using carbohydrate as their respiratory substrate.

Suggest why yogurt is a suitable food for lactose-intolerant people.  
.....  
.....  
.....  
.....  
..... [2]

Turn over

- (d) The control of the expression of the *lac* operon genes, which allow uptake and digestion of lactose in the bacterium *Escherichia coli*, is well known.

Fig. 1.2 shows the arrangement of the elements of the *lac* operon.

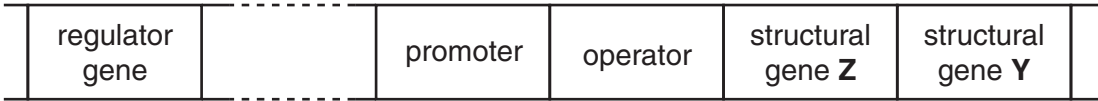


Fig. 1.2

Describe how genes **Z** and **Y** are switched on in bacteria that are moved to a nutrient medium that contains lactose.

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..... [3]

[Total: 16]

2 This question is about types of muscle and how the nervous system and hormones control their activity.

(a) There are three types of muscle within the human body. These differ in their cellular structure and in their function.

Complete Table 2.1 to show how each type of muscle **differs from the other two** types.

**Table 2.1**

	voluntary (skeletal) muscle	involuntary (smooth) muscle	cardiac muscle
cellular structure			
function			

[6]

(b) The human thorax is the area between the base of the neck and the base of the rib cage. All three types of muscle can be found within this area.

For each type of muscle, identify where **in the thorax** this type of muscle may be found.

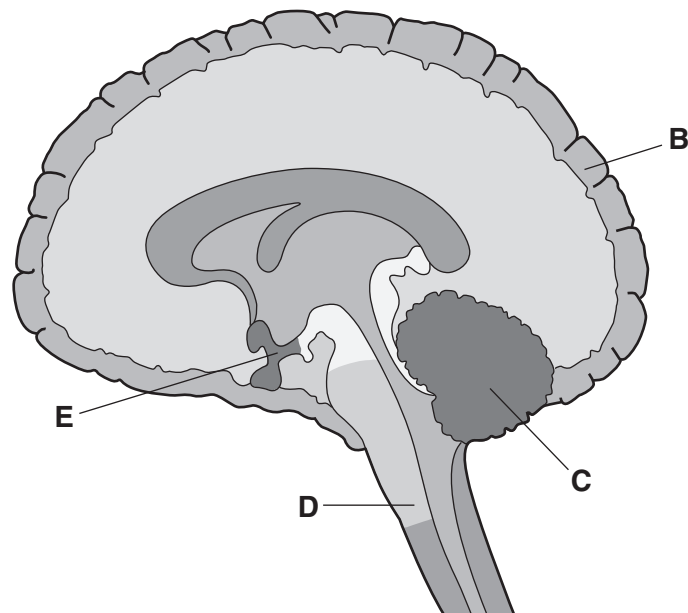
voluntary .....

involuntary .....

cardiac ..... [3]

Turn over

(c) Fig. 2.1 shows a vertical section through the human brain.



**Fig. 2.1**

Use Fig. 2.1 to state the letter (**B** to **E**) of the part of the brain that would be involved in the following:

adjusting the rate of contraction of cardiac muscle .....

clapping the hands together .....

automatically correcting balance when riding a bicycle .....

**[3]**

(d) Movement disorders are conditions in which people lose the ability to control their body movements.

Scientists have discovered that inserting electrodes to stimulate parts of the brain can help to cure some movement disorders. This discovery has resulted from experimental work with monkeys, which has made the research controversial.

Suggest why monkeys rather than other laboratory animals, such as rats, were used for this work **and** comment on whether their use in this way is justified or not.

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..... [3]

**QUESTION 2(e) STARTS ON PAGE 8**

**Turn over**

- (e)** The 'fight or flight' response to threatening environmental stimuli is coordinated by the nervous and endocrine systems.

Describe and explain how the activation of the 'fight or flight' response affects voluntary, involuntary and cardiac muscle.



*In your answer, for each type of muscle, you should give a named structure in which it is found and explain how the nervous and endocrine systems affect its response.*

[9]

**[Total: 24]**

- 3 Total plant growth within an ecosystem depends on the light intensity, temperature and the supply of water and inorganic minerals to the ecosystem.

Table 3.1 shows the net primary production by plants in four different ecosystems.

**Table 3.1**

ecosystem	net primary production (kJ m <sup>-2</sup> year <sup>-1</sup> )
temperate grassland	9 240
temperate woodland	11 340
tropical grassland	13 440
tropical rainforest	36 160

- (a) Discuss possible reasons for the differences in net primary production in these ecosystems.

.....

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.....

.....

.....

.....

.....

..... [4]

**QUESTION 3(b) STARTS ON PAGE 10**

**Turn over**



- (b) To calculate the net primary production figures in Table 3.1 in  $\text{kJ m}^{-2} \text{ year}^{-1}$ , it is necessary to measure the energy content of the primary producers.

Outline how the energy content, in kJ, of a primary producer such as grass can be measured in the laboratory.

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.....

.....

..... [2]

- (c) The efficiency with which consumers convert the food they eat into their own biomass is generally low.

Table 3.2 compares the energy egested, absorbed and respired in four types of animal.

**Table 3.2**

animal	percentage of energy consumed that is:			
	egested	absorbed	respired	converted to biomass
grasshopper, a herbivorous insect	63	37	24	13
perch, a carnivorous fish	17	83	61	
cow, a herbivorous mammal	60	40	39	
bobcat, a carnivorous mammal	17	83	77	6

- (i) **Complete Table 3.2** to show the percentage of energy consumed that is converted into biomass in the perch and the cow.

You may use the space below for your working.

[2]

(ii) Describe **and** explain, using the data from Table 3.2, how the trophic level of a **mammal** affects the percentage of its food energy that it is able to convert to biomass.

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..... [3]

(iii) Using the data from Table 3.2 and your knowledge of energy flow through food chains, suggest which of these four animals could be farmed to provide the maximum amount of food energy in  $\text{kJ m}^{-2} \text{ year}^{-1}$  for humans.

Explain the reasons for your choice.

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..... [3]

[Total: 14]

Turn over

- 4 The antibiotic penicillin is produced by batch culture of the fungus *Penicillium chrysogenum*.

(a) Fig. 4.1 shows the concentration of penicillin, lactose and ammonia as well as the fungal biomass over time when penicillin is being produced by batch culture.

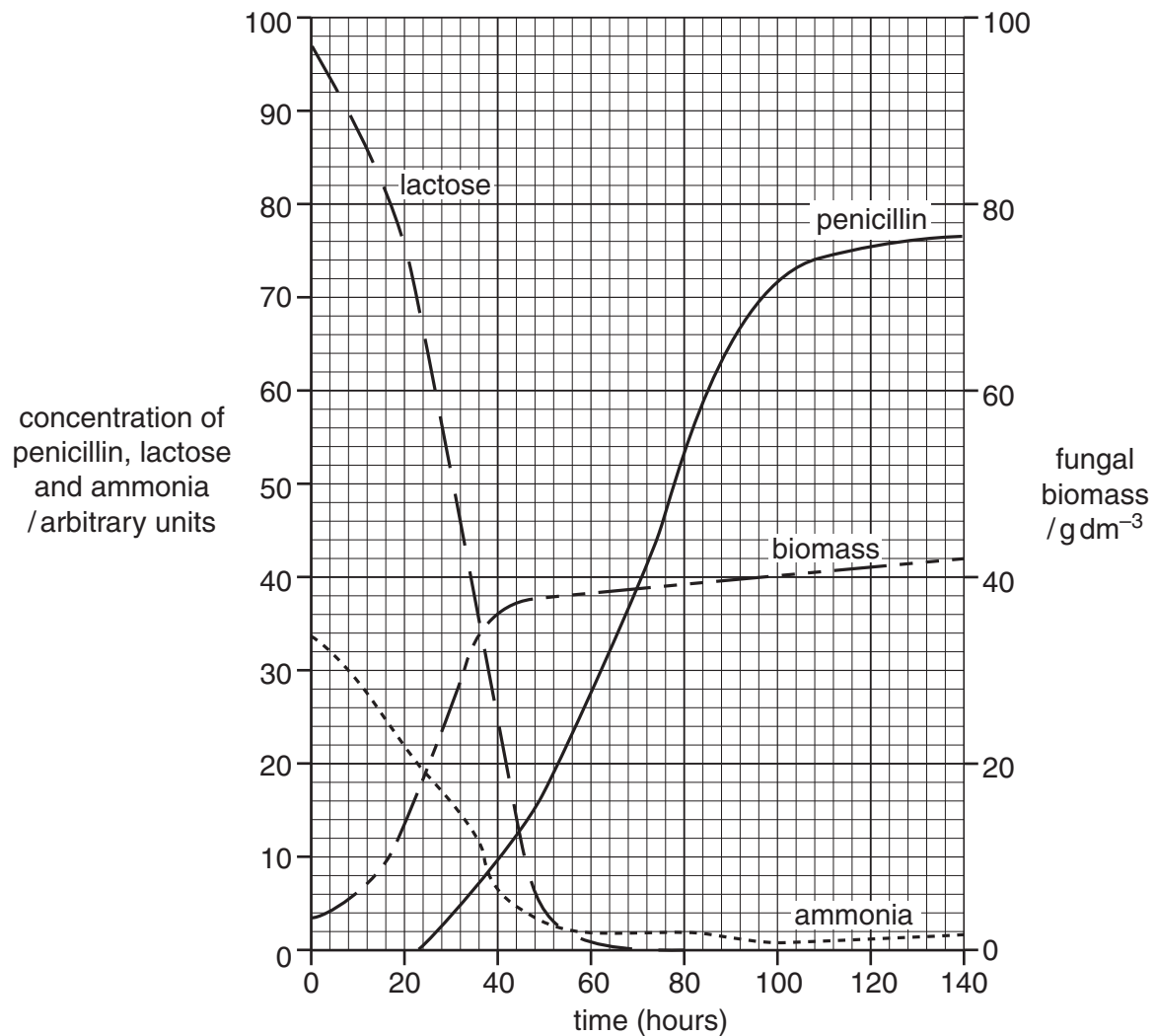


Fig. 4.1

- (i) With reference to Fig. 4.1, describe and explain the changes in concentration of lactose **and** ammonia.

description .....

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explanation .....

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..... [4]

- (ii) A student incorrectly suggested that penicillin might be produced by continuous culture fermentation instead of by batch culture.

Suggest how the curves for lactose, ammonia and biomass on Fig. 4.1 might differ in continuous culture.

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..... [2]

- (iii) A second student said that continuous culture would not be suitable, as penicillin is a secondary metabolite.

What evidence is there in Fig. 4.1 that penicillin is a secondary metabolite?

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Turn over

- (b) (i) Explain the importance of maintaining aseptic conditions in manufacturing penicillin by fermentation.

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- (ii) State **three** physical or chemical factors within the fermenter, other than nutrient levels, that need to be monitored and controlled.

For each factor, explain **why** it must be controlled.

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[Total: 14]

- 5 This question is about genetic engineering and the techniques used for making multiple copies of genes (gene cloning).

(a) Genetic engineering uses the following:

- A** an enzyme that synthesises new DNA
- B** an enzyme that cuts DNA at specific sequences
- C** an enzyme that reseals cut ends of DNA
- D** small circular pieces of DNA found in bacteria; these pieces of DNA have antibiotic resistance genes
- E** an enzyme found in some viruses with an RNA genome; this enzyme converts RNA into DNA.

Name **A** to **E**.

- A** .....
- B** .....
- C** .....
- D** .....
- E** ..... [5]

(b) Genes are cloned for a number of reasons. For example,

- one group of research scientists at a hospital wanted to sequence a disease-causing mutation to learn more about a human disease; these scientists started their research using white blood cells;
- another group of scientists at a biotechnology company wanted to clone the insulin gene in order to manufacture its protein product to treat diabetes; these scientists started their research using cells from the pancreas.

Suggest **and** explain the biological reasons why the two groups each started with a different cell.

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..... [4]

Turn over

- (c) A gene can be cloned *in vitro* (in a test-tube) by the polymerase chain reaction (PCR). Alternatively, a gene can be cloned *in vivo* (in living cells) by introducing the gene into bacterial host cells.

Table 5.1 identifies some of the key steps in each process.

**Table 5.1**

<i>in vitro</i> gene cloning (PCR)	<i>in vivo</i> gene cloning
At 95°C, DNA extracted from a cell separates into two strands.	A library of gene fragments is produced and introduced into host bacteria.
At 50°C, specially-made primer sequences attach to the ends of the desired gene only.	Bacteria are screened for antibiotic resistance to identify those with recombinant DNA.
At 72°C complementary copies of both DNA strands are made.	A gene probe is used to select the bacterial colony containing the desired gene.
The cycle of temperature changes is repeated and more copies of the gene are made.	This colony is grown on in nutrient broth and the DNA is then purified.

Compare the two processes of gene cloning by explaining the advantages of each.



*In your answer you should ensure that clear comparisons between the two processes are made and explained.*

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**[Total: 17]**

**Turn over**



6 (a) State the term used to describe:

(i) a directional growth response of a plant

..... [1]

(ii) a signalling molecule that enables **plants** to respond to environmental change

..... [1]

(iii) plants that lose their leaves seasonally

..... [1]

(iv) the process of managing an ecosystem sustainably to protect biodiversity

..... [1]

(v) organisms that return inorganic minerals from the bodies of dead organisms to the abiotic environment

..... [1]

(vi) the conversion of nitrogen gas to ammonium compounds in the soil.

..... [1]

(b) Describe briefly **one** example of each of the following types of **animal** behaviour:

(i) habituation

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..... [3]

(ii) operant conditioning

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(iii) social behaviour in primates and its importance.

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..... [3]

[Total: 15]

END OF QUESTION PAPER

Answer **all** questions in the spaces provided.

- 1 (a)** Some seeds contain lipids. Describe how you could use the emulsion test to show that a seed contains lipids.

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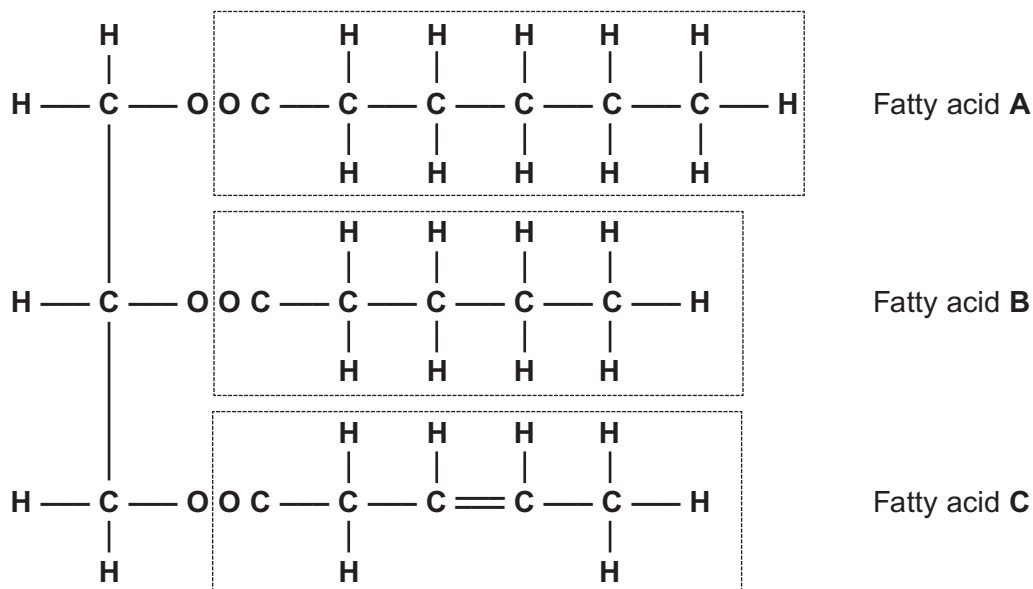
(3 marks)

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- 1 (b)** A triglyceride is one type of lipid. The diagram shows the structure of a triglyceride molecule.



- 1 (b) (i) A triglyceride molecule is formed by condensation. From how many molecules is this triglyceride formed?

(1 mark)

- 1 (b) (ii) The structure of a phospholipid molecule is different from that of a triglyceride. Describe how a phospholipid is different.

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(2 marks)

- 1 (b) (iii) Use the diagram to explain what is meant by an unsaturated fatty acid.

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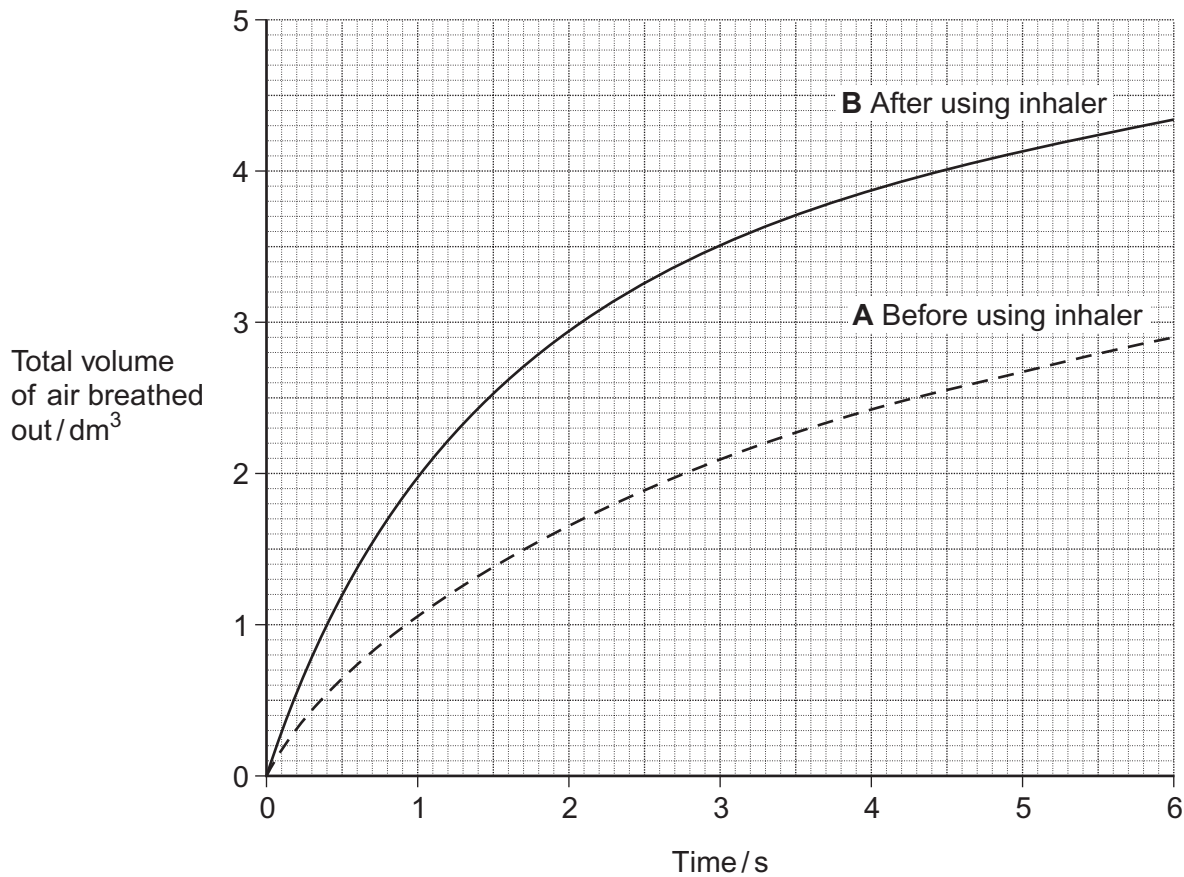
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(2 marks)

Turn over for the next question

Turn over ►

- 2** A person with asthma breathed out as hard as he could. The graph shows the volume of air he breathed out in the first 6 seconds of a breath. Curve **A** shows the volume before he used an inhaler. Curve **B** shows the volume after he used an inhaler.



- 2 (a)** The diaphragm helps to bring about the changes shown by the curve **A**. Explain how.

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(3 marks)

(Extra space) .....

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- 2 (b)** You could use curve **A** to find the total volume of air that this person could breathe out in one complete breath. Describe how.

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(2 marks)

- 2 (c)** The inhaler which the person used contained a substance that dilates bronchioles. Use this information to explain why curve **A** is different from curve **B**.

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(2 marks)

7
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Turn over for the next question

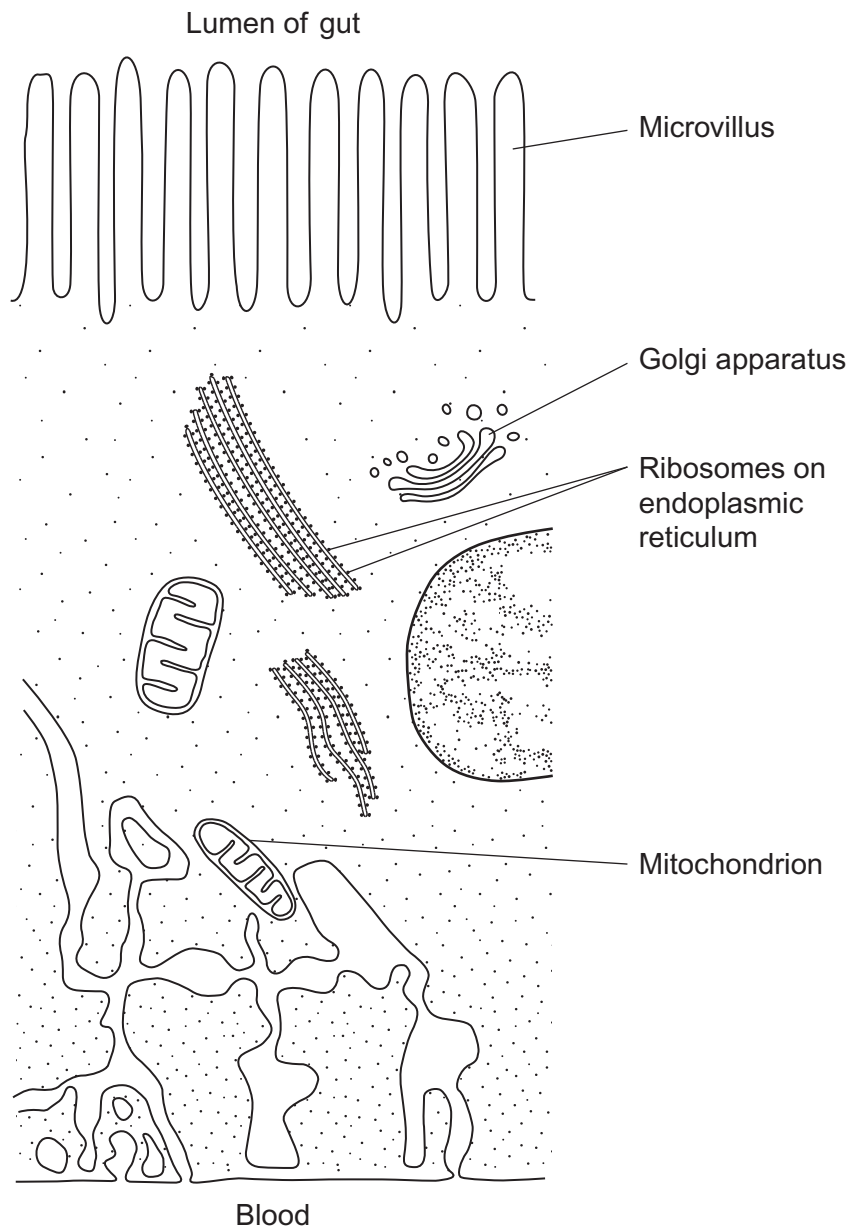
Turn over ►

- 3 (a)** The table shows some features of cells. Complete the table by putting a tick in the box if the feature is present in the cell.

Feature	Cell		
	Cholera bacterium	Epithelial cell from intestine	Epithelial cell from alveolus of lung
Cell-surface membrane			
Flagellum			
Nucleus			

(3 marks)

- 3 (b)** The diagram shows part of an epithelial cell from an insect's gut.



This cell is adapted for the three functions listed below. Use the diagram to explain how this cell is adapted for each of these functions.

Use a **different** feature in the diagram for each of your answers.

**3 (b) (i)** the active transport of substances from the cell into the blood

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(2 marks)

**3 (b) (ii)** the synthesis of enzymes

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(2 marks)

**3 (b) (iii)** rapid diffusion of substances from the lumen of the gut into the cytoplasm

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(1 mark)



**4 (a)** Scientists who investigate disease may look at risk factors. What is a risk factor?

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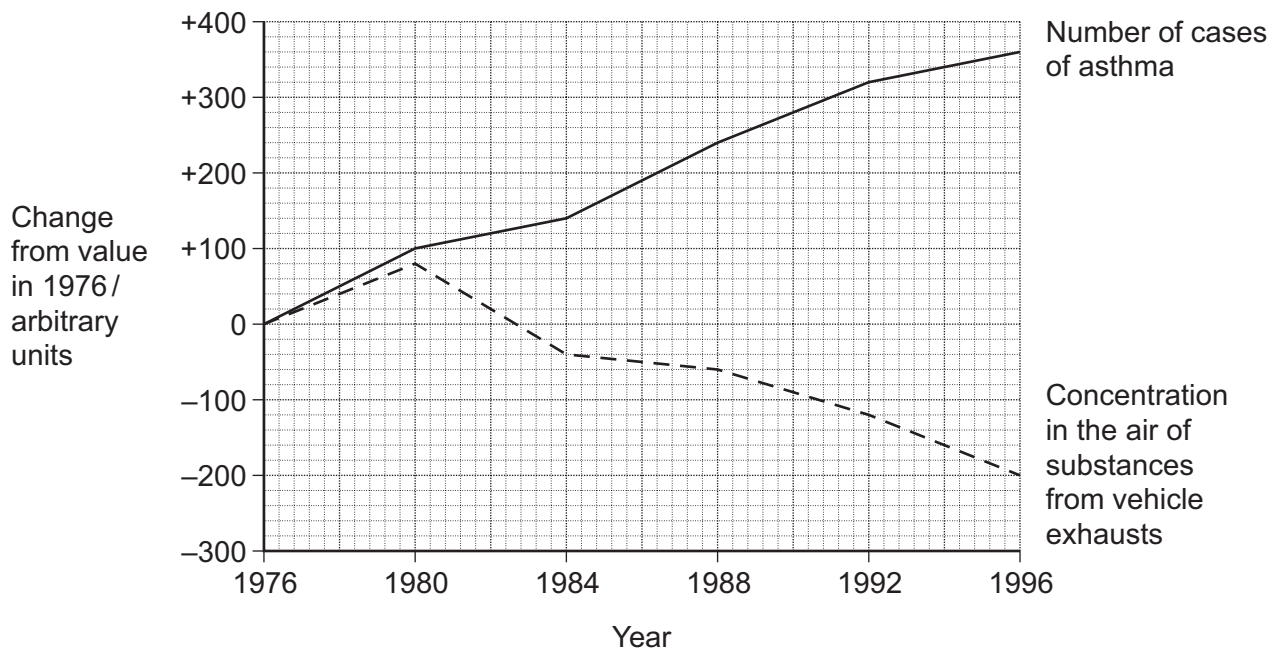
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(1 mark)

Scientists investigated the link between pollution from vehicle exhausts and the number of cases of asthma. Between 1976 and 1996, the scientists recorded changes in the following

- the concentration in the air of substances from vehicle exhausts
- the number of cases of asthma.

The graph shows their results



4 (b) Between which years on the graph was there

4 (b) (i) a positive correlation between the number of cases of asthma and the concentration in the air of substances from vehicle exhausts

.....  
(1 mark)

4 (b) (ii) a negative correlation between the number of cases of asthma and the concentration in the air of substances from vehicle exhausts?

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(1 mark)

4 (c) The scientists concluded that substances in the air from vehicle exhausts did **not** cause the increase in asthma between 1976 and 1980. Explain why.

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(3 marks)

(Extra space) .....

6

Turn over ►

- 5 (a) (i)** The human heart has four chambers.  
In which **one** of the four chambers of the human heart does pressure reach the highest value?

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(1 mark)

- 5 (a) (ii)** Explain how the structure of this chamber causes this high pressure.

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(1 mark)

**Figure 1** shows the volume of blood in a man's right ventricle at different times during one cardiac cycle.

**Figure 1**

Time / s	Volume of blood / cm <sup>3</sup>
0.0	125
0.1	148
0.2	103
0.3	70
0.4	56
0.5	55
0.6	98
0.7	125

- 5 (b) (i)** Use the data in the **Figure 1** to calculate the man's heart rate.

Heart rate = ..... beats per minute

- 5 (b) (ii)** Use the data in **Figure 1** and your answer to part **5 (b) (i)** to calculate the man's cardiac output. Show your working.

Cardiac output = ..... cm<sup>3</sup> per minute  
(3 marks)

- 5 (c)** Use information from **Figure 1** to complete the table below to show whether the valves are **open** or **closed** at each of the times shown. Write open or closed in the appropriate boxes.

Time / s	Valve between right atrium and right ventricle	Valve between right ventricle and pulmonary artery
0.2		
0.6		

(2 marks)

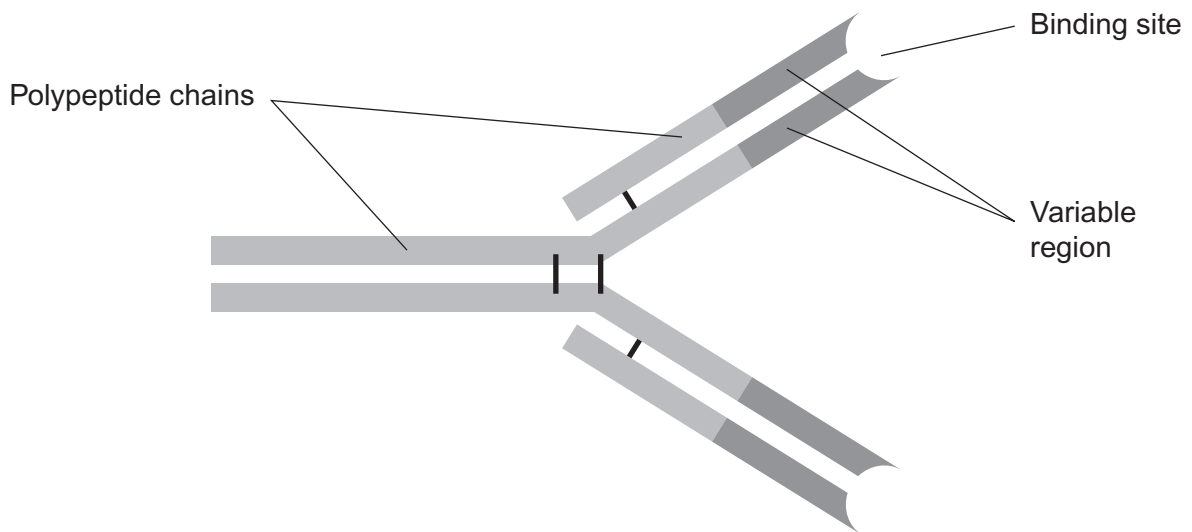
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Turn over ►

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ANSWER IN THE SPACES PROVIDED**

- 6** The diagram shows an antibody molecule.



- 6 (a)** What is the evidence from the diagram that this antibody has a quaternary structure?

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 .....  
 (1 mark)

- 6 (b)** Scientists use this antibody to detect an antigen on the bacterium that causes stomach ulcers. Explain why the antibody will only detect this antigen.

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 (3 marks)

(Extra space) .....  
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4

Turn over ►

7 Read the following passage.

Aspirin is a very useful drug. One of its uses is to reduce fever and inflammation. Aspirin does this by preventing cells from producing substances called prostaglandins. Prostaglandins are produced by an enzyme-controlled pathway. Aspirin works by inhibiting one of the enzymes in this pathway. Aspirin attaches permanently to a chemical group on one of the monomers that make up the active site of this enzyme.

5

The enzyme that is involved in the pathway leading to the production of prostaglandins is also involved in the pathway leading to the production of thromboxane. This is a substance that promotes blood clotting. A small daily dose of aspirin may reduce the risk of myocardial infarction (heart attack).

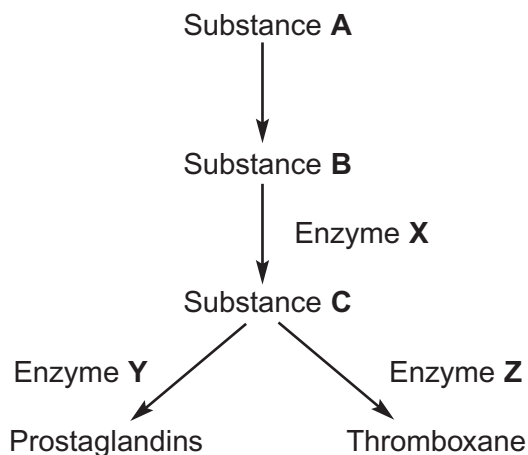
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Use information from the passage and your own knowledge to answer the following questions.

7 (a) Name the monomers that make up the active site of the enzyme (lines 6 – 7).

.....  
(1 mark)

7 (b) The diagram shows the pathways by which prostaglandins and thromboxane are formed.



7 (b) (i) Aspirin only affects one of the enzymes in this pathway. Use information in lines 5 – 7 to explain why aspirin does **not** affect the other enzymes.

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(2 marks)

**7 (b) (ii)** Which enzyme, **X**, **Y** or **Z**, is inhibited by aspirin? Explain the evidence from the passage that supports your answer.

Enzyme .....

Explanation .....

.....  
.....

(2 marks)

**7 (c)** Aspirin is an enzyme inhibitor. Explain how aspirin prevents substrate molecules being converted to product molecules.

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(2 marks)

**7 (d)** Aspirin may reduce the risk of myocardial infarction (lines 8 – 12). Explain how.

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(3 marks)

(Extra space) .....

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Turn over ►



**8 (a)** Vaccines protect people against disease. Explain how.

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(5 marks)

(Extra space) .....

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- 8 (b)** Oral rehydration solutions (ORS) are used to treat diarrhoeal disease. What does an ORS consist of and how does it work?

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(Extra space) ..... (5 marks)

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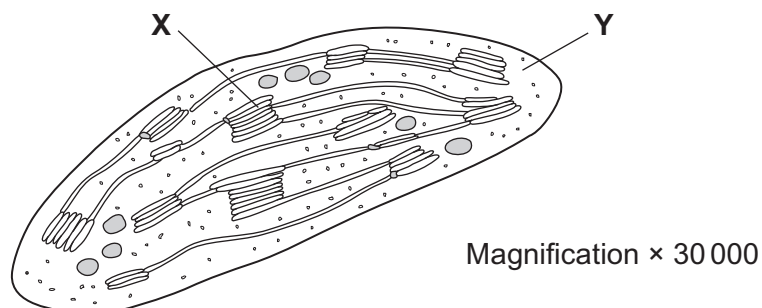
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**END OF QUESTIONS**

10

Answer **all** questions in the space provided.

- 1 The diagram shows a chloroplast as seen with an electron microscope.



- 1 (a) Name X and Y.

X .....

Y ..... (2 marks)

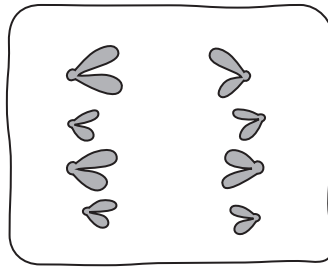
- 1 (b) Describe the function of a chloroplast.

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..... (2 marks)

- 1 (c) Calculate the maximum length of this chloroplast in micrometres ( $\mu\text{m}$ ). Show your working.

Answer .....  $\mu\text{m}$   
(2 marks)

- 2 (a)** The diagram shows a stage of mitosis in an animal cell.



- 2 (a) (i)** Name this stage.

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(1 mark)

- 2 (a) (ii)** Describe what happens during this stage that results in the production of two genetically identical cells.

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(2 marks)

- 2 (b)** A sample of epithelial tissue from the small intestine of an animal was analysed. Some of the cells had 8.4 units of DNA, others had only 4.2 units.

- 2 (b) (i)** Use your knowledge of the cell cycle to explain why some cells had 8.4 units of DNA and others had only 4.2 units.

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(2 marks)

- 2 (b) (ii)** How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

(1 mark)

6
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**Turn over for the next question**

**Turn over ►**

Common ancestor

- Mochokus niloticus*
- Mochokiella paynei*
- Acanthocleithron chapini*
- Microsynodontis polli*
- Synodontis batesii*
- Synodontis schall*
- Synodontis membranacea*
- Synodontis batensoda*

(1 mark)

(1 mark)

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- 3 (c) (i)** A scientist carried out breeding experiments with catfish from different populations. Describe how the results could show that the catfish belong to the same species.

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(1 mark)

- 3 (c) (ii)** The variety of colours displayed by catfish is important in courtship. Give **two** ways in which courtship increases the probability of successful mating.

1 .....

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2 .....

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(2 marks)

6
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Turn over for the next question

Turn over ►

- 4** Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

- 4 (a) (i)** What is the maximum number of amino acids for which this base sequence could code?

(1 mark)

- 4 (a) (ii)** Explain how this mutation leads to the formation of non-functioning PAH.

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(3 marks)

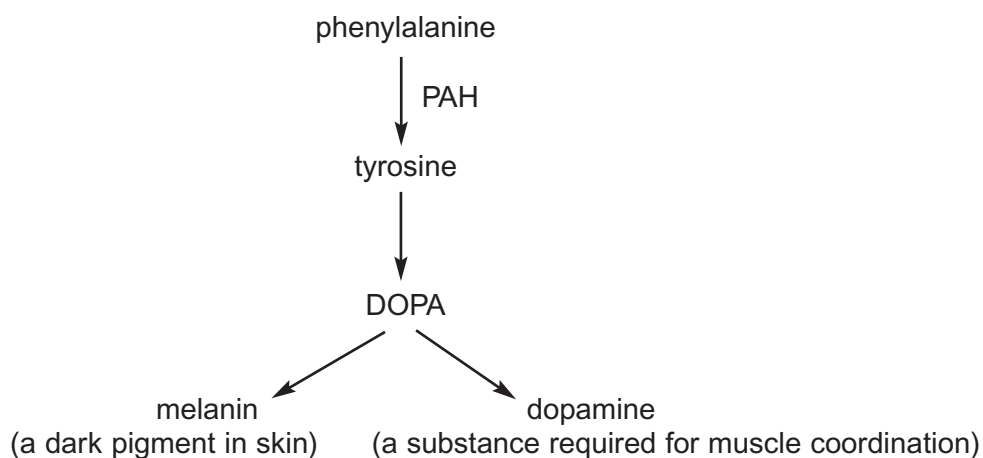
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PAH catalyses a reaction at the start of two enzyme-controlled pathways. The diagram shows these pathways.



- 4 (b) Use the information in the diagram to give **two** symptoms you might expect to be visible in a person who produces non-functioning PAH.

1 .....

2 ..... (2 marks)

- 4 (c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how the spread of this mutation may have occurred.

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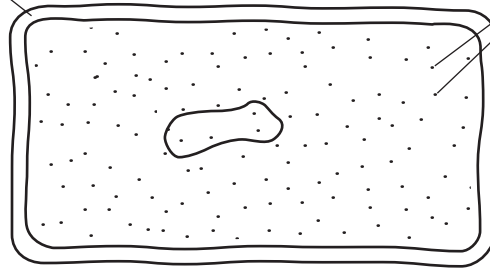
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..... (1 mark)

- 5 The diagram shows the structure of a bacterium and the sites of action of two antibiotics.

Vancomycin acts  
on the cell wall

Tetracycline acts  
on ribosomes



- 5 (a) (i) Use information in the diagram to explain why vancomycin does **not** affect human cells.

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(1 mark)

- 5 (a) (ii) Use information in the diagram to explain how tetracycline prevents bacterial growth.

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(1 mark)

- 5 (b)** Frequent treatment with vancomycin can result in resistant strains of bacteria. Explain how.

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(3 marks)

(Extra space) .....

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- 5 (c)** The gene for resistance to vancomycin is very common in the bacterium *Enterococcus faecalis*. The same gene has now been found in the bacterium *Staphylococcus aureus*.

Use your knowledge of gene transmission to explain how the gene was passed from one species of bacterium to another.

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(3 marks)

(Extra space) .....

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- 6 (a)** Scientists can use protein structure to investigate the evolutionary relationships between different species. Explain why.

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(2 marks)

- 6 (b)** Comparing the base sequence of genes provides more evolutionary information than comparing the structure of proteins. Explain why.

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(2 marks)

- 6 (c)** The proteins of different species can be compared using immunological techniques. The protein albumin obtained from a human was injected into a rabbit. The rabbit produced antibodies against the human albumin. These antibodies were extracted from the rabbit and then added to samples of albumin obtained from four different animal species. The amount of precipitate produced in each sample was then measured. The results are shown in the table.

Species from which albumin was obtained	Amount of precipitate / arbitrary units
Rat	23
Chimpanzee	96
Marmoset	65
Trout	11

What do the results suggest about the evolutionary relationship between humans and the other species?

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(2 marks)

6

Turn over for the next question

Turn over ►

**7 (a)** A student investigated the diversity of plants at several sites on a golf course. At each site she took a large number of random samples.

**7 (a) (i)** Explain the importance of taking a large number of samples at each site.

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(1 mark)

**7 (a) (ii)** Explain the importance of taking samples at random.

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(1 mark)

The student collected data from one part of the golf course and calculated an index of diversity.

The table shows her data.

Species	Number of plants per m <sup>2</sup>
Sheep's fescue	11
Creeping buttercup	6
Clover	5
Dandelion	2
Sheep's sorrel	1
Lady's bedstraw	7
Stemless thistle	4

The index of diversity can be calculated from the formula

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

where

$d$  = index of diversity

$N$  = total number of organisms of all species

$n$  = total number of organisms of each species

- 7 (b)** Use the formula to calculate the index of diversity for the plants on this part of the golf course. Show your working.

Answer .....

(2 marks)

- 7 (c)** The golf course was surrounded by undeveloped grassland from which it had been produced.  
The golf course had

- some areas of very short grass which was cut frequently
- some areas of longer grass which was cut less frequently
- some areas of long grass and shrubs which were never cut.

The index of diversity for the insects on the golf course was higher than that for the surrounding undeveloped grassland.

Explain the effect of developing this golf course on the index of diversity of insects.

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(3 marks)

(Extra space) .....

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7
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Turn over ►

- 8 (a)** Root pressure moves water through the xylem. Describe what causes root pressure.

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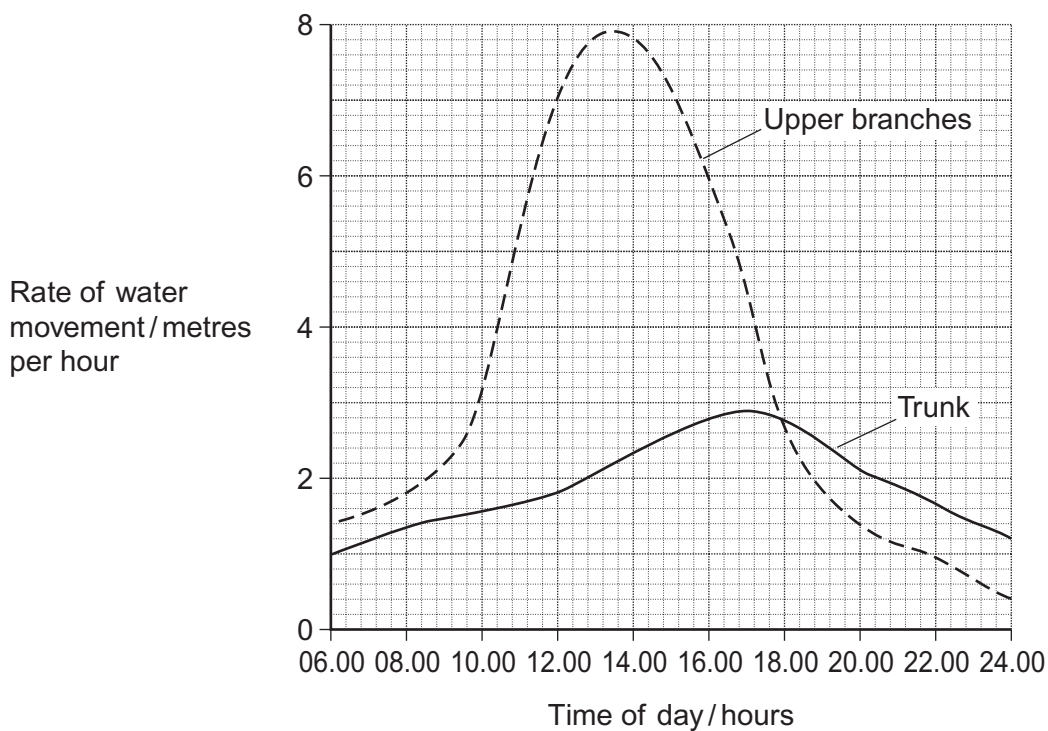
(3 marks)

(Extra space) .....

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- 8 (b)** A biologist investigated the rate of water movement during the day in different parts of a tree. The results are shown in the graph.





- 8 (b) (i)** Describe how the rate of water movement in the upper branches changed over the period shown in the graph.

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(2 marks)

- 8 (b) (ii)** The rate of water movement in the upper branches was different from the rate of water movement in the trunk. Describe how.

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(2 marks)

- 8 (b) (iii)** The results of this investigation support the cohesion tension theory. Explain how.

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(2 marks)

[illegible]

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Midges are very small insects. The early stages of the life cycle of midges are called larvae. Midge larvae live in water. A biologist investigated the uptake of oxygen by the larvae of two species of midge. He measured the rate of uptake of oxygen by the larvae in water containing different concentrations of oxygen. The table shows his results.

Concentration of oxygen in water / $\text{cm}^3 \text{dm}^{-3}$	Mean rate of oxygen uptake / $\text{cm}^3 \text{g}^{-1} \text{h}^{-1}$	
	<i>Chironomus longistylus</i>	<i>Tanytarsus brunnipes</i>
1	220	141
2	285	246
3	304	342
4	313	362
5	320	367
6	318	430
7	320	469

- 9 (b) The larvae in this investigation were kept at a temperature of  $17^\circ\text{C}$ . Why was it important that the larvae of both species were kept at the same temperature?

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(2 marks)

- 9 (c) Describe the effect of an increase in oxygen concentration on the mean rate of oxygen uptake in *Chironomus longistylus*.

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(2 marks)

Question 9 continues on the next page

Turn over ►

- 9 (d) *Chironomus longistylus* lives in still water whereas *Tanytarsus brunnipes* lives in fast running streams. The water in fast running streams has a higher concentration of oxygen than in still water. Use the table on page 19 to suggest how *Chironomus longistylus* is better adapted than *Tanytarsus brunnipes* to living in still water.

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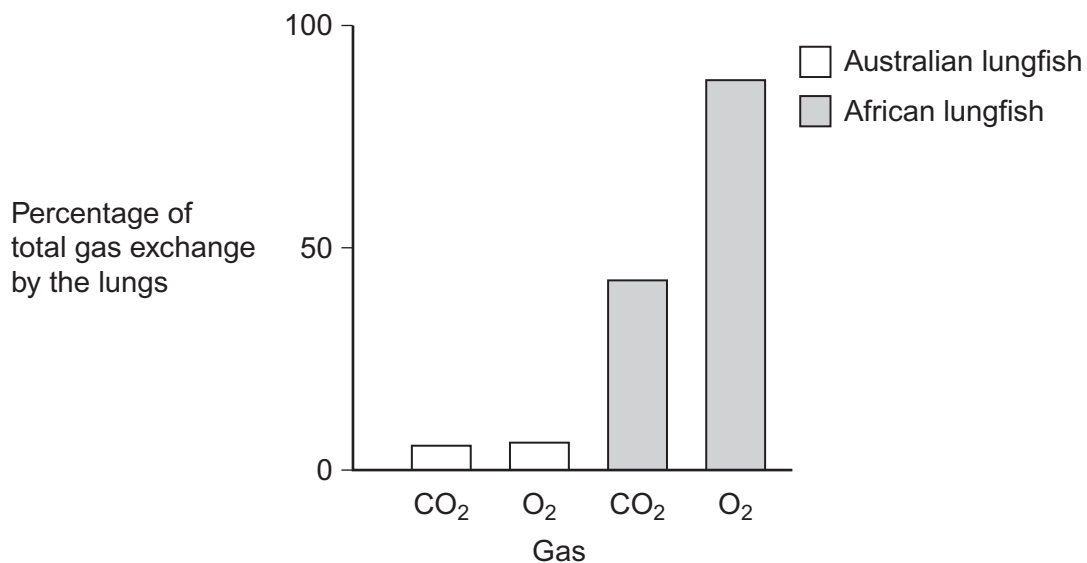
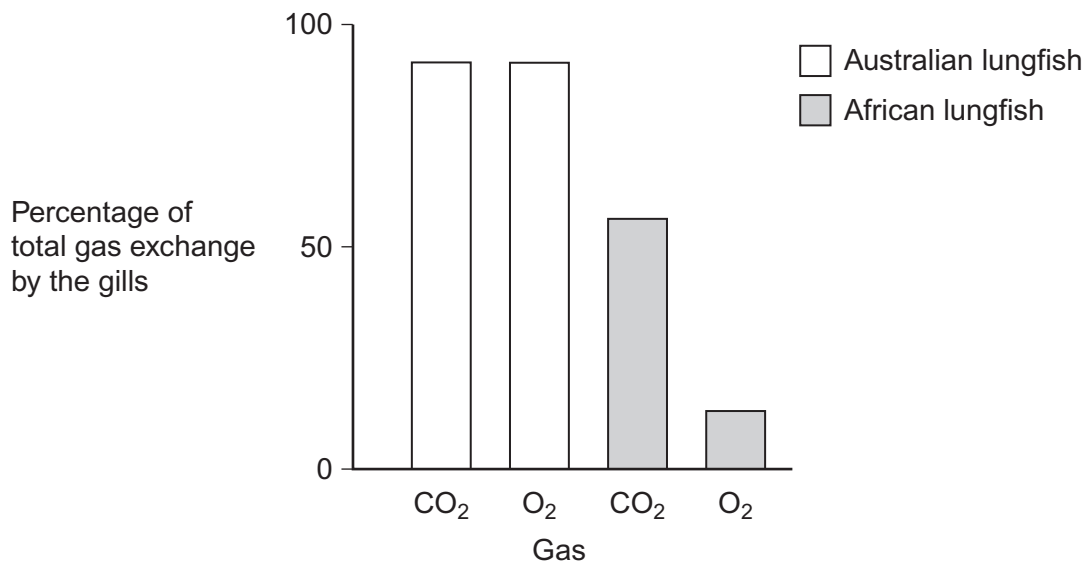
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(2 marks)

- 9 (e) Lungfish are freshwater fish which have gills and lungs. Scientists investigated how Australian and African lungfish use their lungs and gills for gas exchange. The graphs show the results of this investigation.



- 9 (e) (i)** Describe the difference in the way carbon dioxide is lost from the body of an Australian lungfish and an African lungfish.

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(1 mark)

- 9 (e) (ii)** African lungfish are likely to survive for longer than Australian lungfish when living in pools that dry up. Explain why.

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(2 marks)

15

**Turn over for the next question**

**Turn over ►**

**10** Scientists investigated the effect of drinking tea and coffee on reducing the risk of developing one type of brain cancer. The investigation involved 410 000 volunteers and was conducted in 10 European countries over a period of 8.5 years.

**10 (a) (i)** Apart from age, suggest **two** factors that the scientists should have considered when selecting volunteers for this trial.

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2 ..... (2 marks)

**10 (a) (ii)** Give **two** features of the design of this investigation that would ensure the reliability of the results obtained.

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**10 (b)** The incidence for this type of brain cancer is 6 cases per 100 000 per year. Use this information to calculate the expected number of volunteers developing this cancer during the 8.5 year period of this investigation. Show your working.

Answer ..... (2 marks)

**10 (c)** In analysing the results of this investigation, the scientists took into account the age of the volunteers. Suggest why.

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..... (1 mark)

- 10 (d)** During the investigation, the volunteers were asked to estimate the volume of tea and/or coffee that they drank each day. The types of tea and coffee consumed in different countries varied. When the data from all the countries were collected there was a correlation between drinking more than 100 cm<sup>3</sup> of tea or coffee each day and a reduced risk of developing this type of brain cancer.

Tea and coffee contain caffeine. A newspaper reported the results of this investigation under the headline 'Caffeine helps cut cancer risk'. Explain why scientists could **not** support this view solely on the basis of this investigation.

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(4 marks)

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Question 10 continues on the next page

Turn over ►

**10 (e)** Another group of scientists investigated the effect of caffeine on blood flow to certain parts of the brain. Volunteers were given different concentrations of caffeine solution to drink. A control group was also set up.

**10 (e) (i)** Describe how the control group should have been treated.

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(2 marks)

**10 (e) (ii)** Volunteers who drank the same concentration of caffeine solution often had different concentrations of caffeine in their blood. Suggest **one** reason for the difference in concentration of caffeine in the blood of volunteers.

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(1 mark)

**10 (e) (iii)** The investigation showed that caffeine reduces the blood flow to certain parts of the brain. Suggest **one** way in which this could lead to a reduced risk of brain cancers.

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(1 mark)

**END OF QUESTIONS**

15



Answer **all** questions in the spaces provided.

**1** Ecologists studied a community of fish in a lake.

**1 (a)** Explain what is meant by a community.

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(1 mark)

**1 (b) (i)** The ecologists could have used the mark-release-recapture method to estimate the number of one species of fish in the lake. Describe how.

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(3 marks)

(Extra space) .....

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- 1 (b) (ii) This species of fish breeds at a certain time of the year. During this fish-breeding season, the mark-release-recapture technique might **not** give a reliable estimate. Suggest **one** reason why.

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(1 mark)

- 1 (c) The ecologists found that each species of fish had adaptations to its niche. One of these adaptations was the shape of its mouth.

Suggest how the shape of mouth is an adaptation to its niche.

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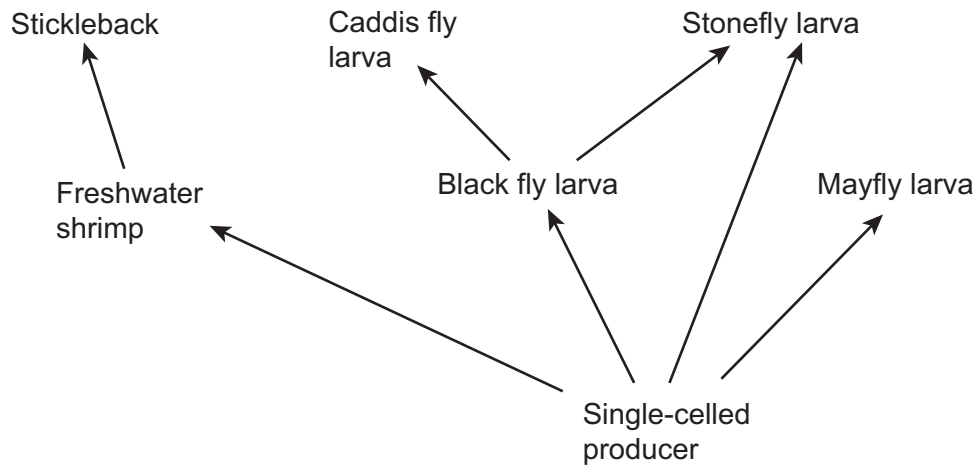
(2 marks)

Turn over for the next question

7

Turn over ►

- 2** The diagram shows organisms in a food web.



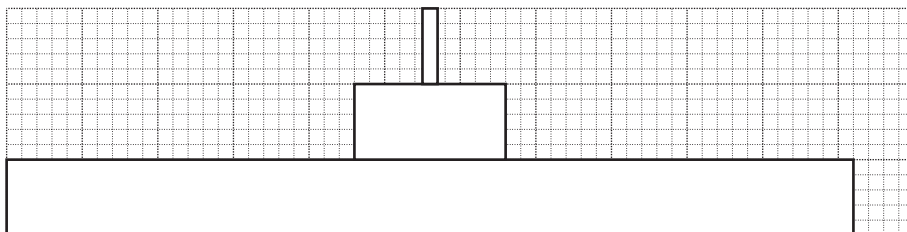
- 2 (a) (i)** Name **all** the secondary consumers in this food web.

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(1 mark)

- 2 (a) (ii)** Use the diagram to explain the likely effect of a sudden decrease in the stickleback population on the population of mayfly larvae.

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(2 marks)

- 2 (b)** A pyramid of energy for this food web is shown below. The bars are drawn to the same scale.



- 2 (b) (i)** Use the pyramid of energy to calculate the percentage efficiency of energy transfer between producers and primary consumers. Show your working.

efficiency = ..... %  
(2 marks)

- 2 (b) (ii)** The average efficiency of energy transfer between producers and primary consumers in pyramids of energy is around 10 %.

Suggest why the efficiency of energy transfer from producers to primary consumers in this food web is higher than 10 %.

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(2 marks)

- 2 (c)** Energy from the sun may ultimately end up in dead plant matter. Describe how.

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(2 marks)

- 3** The photograph shows marram grass growing on a sand dune.



- 3 (a)** Describe how you would investigate the distribution of marram grass from one side of the dune to the other.

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(3 marks)

(Extra space) .....

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- 3 (b)** Marram grass is a pioneer species that grows on sand dunes. It has long roots and a vertically growing stem that grows up through the sand. Sand dunes are easily damaged by visitors and are blown by the wind. Planting marram grass is useful in helping sand dune ecosystems to recover from damage.

Use your knowledge of succession to explain how.

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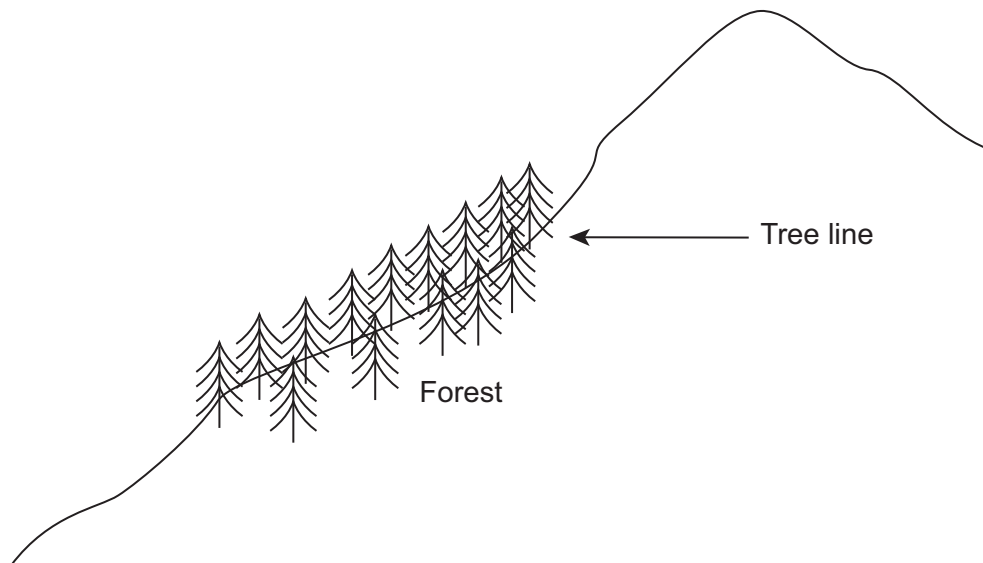
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(2 marks)

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- 4 Mountains are harsh environments. The higher up the mountain, the lower the temperature becomes. The diagram shows a forest growing on the side of a mountain. The upper boundary of the forest is called the tree line. Trees do not grow above the tree line.



- 4 (a) (i) The position of the tree line is determined by abiotic factors. What is meant by an abiotic factor?

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(1 mark)

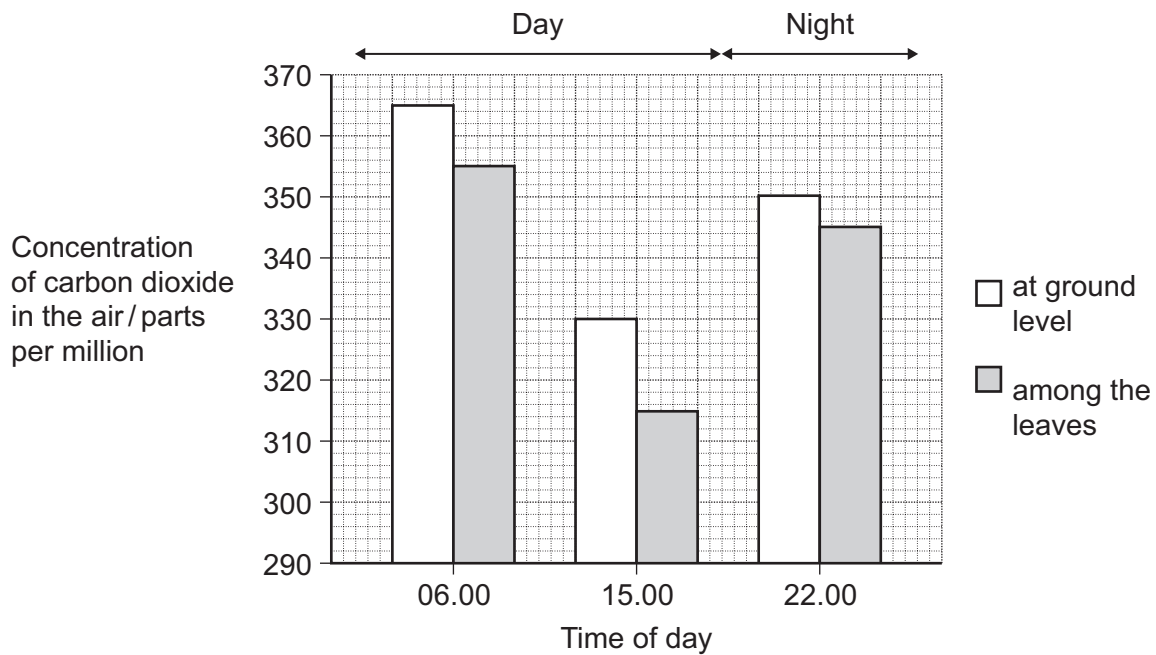
- 4 (a) (ii) Other than temperature, suggest **one** abiotic factor that is likely to affect the position of the tree line on the mountain.

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(1 mark)

Question 4 continues on the next page

Turn over ►

- 4 (b)** Scientists measured the concentration of carbon dioxide in the air in one part of the forest. They took measurements at different times of day and at two different heights above the ground. Their results are shown in the bar chart.



Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

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(4 marks)

(Extra space) .....

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- 4 (c)** The population of trees in the forest evolved adaptations to the mountain environment. Use your knowledge of selection to explain how.

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(Extra space)

(3 marks)

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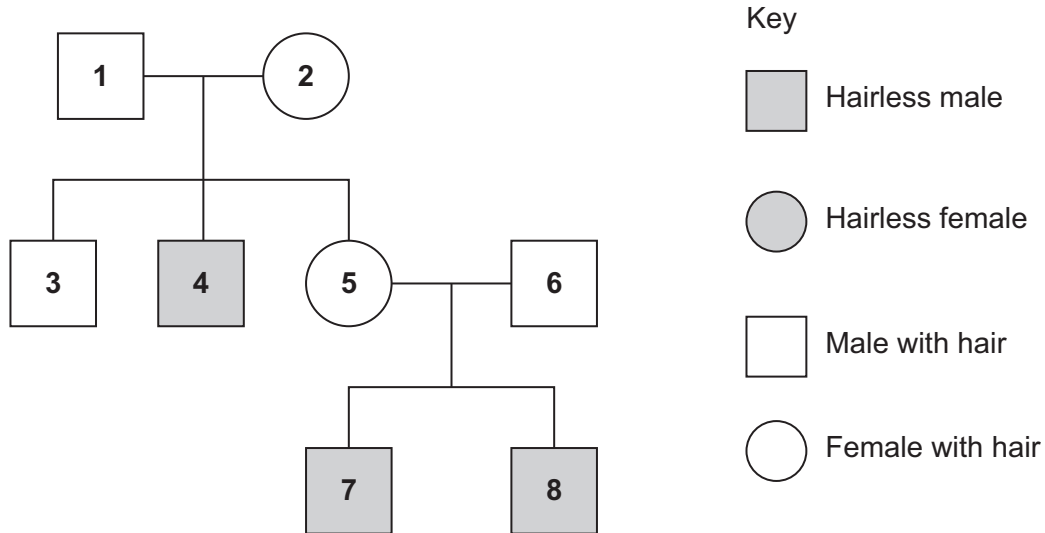
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**Turn over ►**



- 5** A single gene controls the presence of hair on the skin of cattle. The gene is carried on the X chromosome. Its dominant allele causes hair to be present on the skin and its recessive allele causes hairlessness.

The diagram shows the pattern of inheritance of these alleles in a group of cattle.



- 5 (a)** Use evidence from the diagram to explain
- 5 (a) (i)** that hairlessness is caused by a recessive allele

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(2 marks)

- 5 (a) (ii)** that hairlessness is caused by a gene on the X chromosome.

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(1 mark)

- 5 (b)** What is the probability of the next calf born to animals **5** and **6** being hairless?  
Complete the genetic diagram to show how you arrived at your answer.

Phenotypes of parents

Female with hair

Male with hair

Genotypes of parents

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Gametes

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Genotypes of offspring

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Phenotypes of offspring

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Probability of next calf being hairless .....

(4 marks)

7

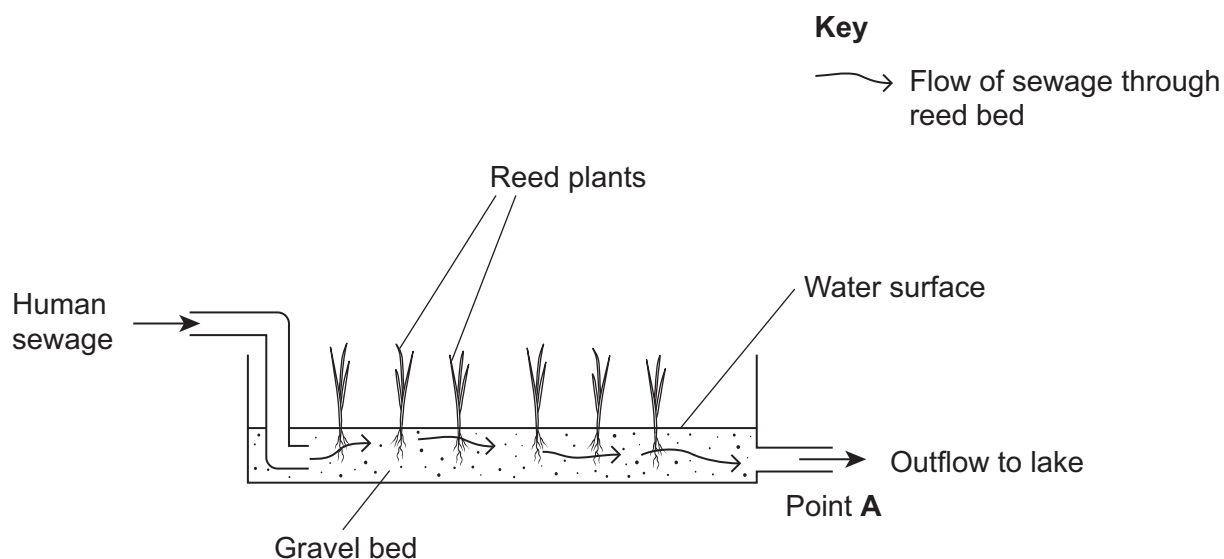
**Turn over for the next question**

**Turn over ►**

- 6 (a) Name the process by which some bacteria oxidise ammonia to nitrate.

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(1 mark)

Reeds are plants that grow with their roots under water. A reed bed contains a large number of growing reeds. Reed beds may be used to absorb nitrates produced when bacteria break down human sewage. The diagram shows a reed bed.



- 6 (b) Reeds have hollow, air-filled tissue in their stems which supplies oxygen to their roots. Explain how this enables the roots to take up nitrogen-containing substances.

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(2 marks)

- 6 (c) (i)** There is an optimum rate at which human sewage should flow through the reed bed. If the flow of human sewage is too fast, the nitrate concentration at point **A** falls. Explain why.

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(2 marks)

- 6 (c) (ii)** An increase in nitrate concentration in the water entering the lake could affect algae and fish in the lake. Explain how.

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(3 marks)

(Extra space) .....

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Turn over ►

- 7** In some countries, pigs are reared in intensive units in which the temperature is controlled. Agricultural scientists investigated the effect of temperature on pig growth and on the efficiency with which the pigs converted food to biomass.

- 7 (a) (i)** In the investigation, the scientists used pigs of the same breed, with similar genotypes. Explain why.

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(2 marks)

- 7 (a) (ii)** The pigs were allowed to eat as much food as they wanted. How could this have decreased the reliability of any conclusions drawn from the investigation?

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(2 marks)

The table shows the results of this investigation.

Temperature / °C	Mean growth rate / kg per day	Efficiency of conversion of food to biomass / %
0	0.54	19
10	0.80	42
20	0.85	48
30	0.45	37
35	0.31	37

- 7 (b) (i)** Describe the effect of temperature on mean growth rate.

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(1 mark)

- 7 (b) (ii) A student concluded from these data that the mean growth rate of the pigs was fastest at 20 °C. Do you agree with this conclusion? Explain your answer.

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(2 marks)

- 7 (c) (i) Pigs can survive at temperatures above 35 °C. Use the data to suggest why scientists did **not** carry out any investigations at temperatures higher than 35 °C.

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(2 marks)

- 7 (c) (ii) The efficiency of conversion of food to biomass is lower at 0 °C than it is at 20 °C. Suggest an explanation for the lower efficiency.

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(2 marks)

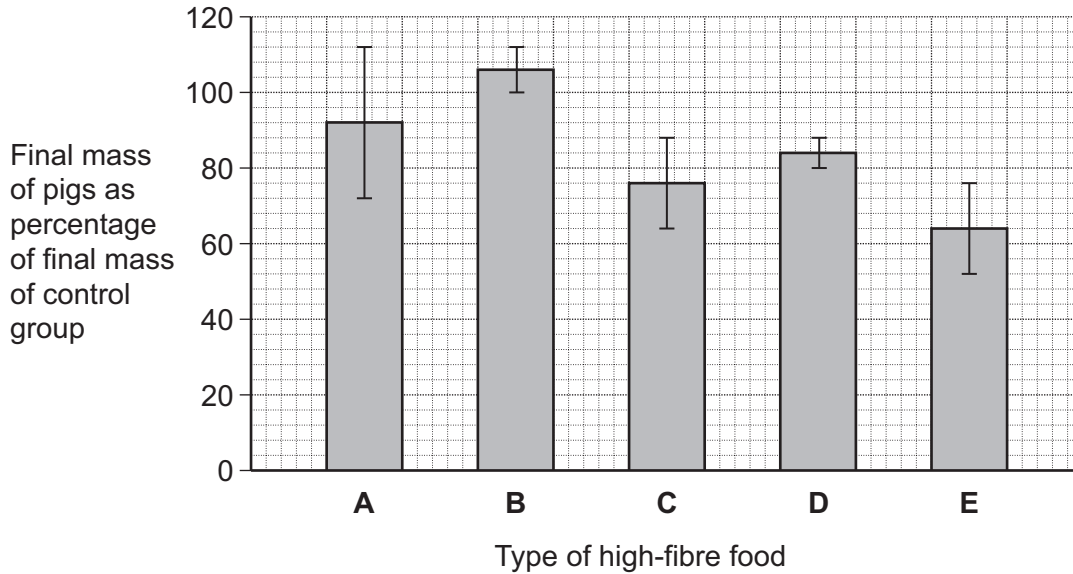
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Turn over ►

**7 (d)** Pigs require a mixture of fibre and protein in their food. The greater the ratio of fibre to protein, the less the food costs.

Scientists took five large groups of pigs. They fed each group a different high-fibre food. Each of the foods contained fibre from different plant species, but they all had the same energy content. The scientists fed a control group of pigs a low-fibre food with the same energy content. After 10 days, the scientists compared the masses of the pigs fed on high-fibre food to those fed on low-fibre food.

The graph shows the results of the investigation. The bars represent  $\pm 2$  standard errors of the mean.



A farmer saw these results and concluded that he should replace his pigs' usual food with food **B**. Evaluate this conclusion.

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(Extra space) ..... (4 marks)

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**8 (a)** ATP is useful in many biological processes. Explain why.

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(4 marks)

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**Question 8 continues on the next page**

**Turn over ►**



**8 (b)** Describe how ATP is made in mitochondria.

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