Answer **all** the questions.

1 **(a)** A balanced diet is essential for good health.

Complete the following passage by using the most appropriate terms from the list to fill the gaps.

Each term **should not** be used more than once.

haemoglobin **iron** **collagen** **obese**

calcium **anorexic** **sodium**

A balanced diet is one which provides an adequate intake of energy and nutrients for the maintenance of our body. If energy intake exceeds energy usage over a period of time, an individual can become ……..... .

The deficiency disease anaemia can be caused by a lack of the mineral ……..... in the diet. As a result of this deficiency, the body is unable to produce sufficient amounts of the protein ……..... in red blood cells. **[3]**

(b) The Body Mass Index (BMI) is one way of determining whether a person is underweight or overweight.

BMI can be calculated using the formula:

$$\text{BMI} = \frac{\text{mass in kg}}{(\text{height in m})^2}$$

Calculate the BMI of a female of mass 69 kg and a height of 1.67 m.

Show your working. Give your answer to **one decimal place**.

Answer = ... **[2]**

(c) Another way of determining whether a person is underweight or overweight is to use a graph showing the relationship between height and body mass.

Fig. 1.1 is an example of this type of graph.

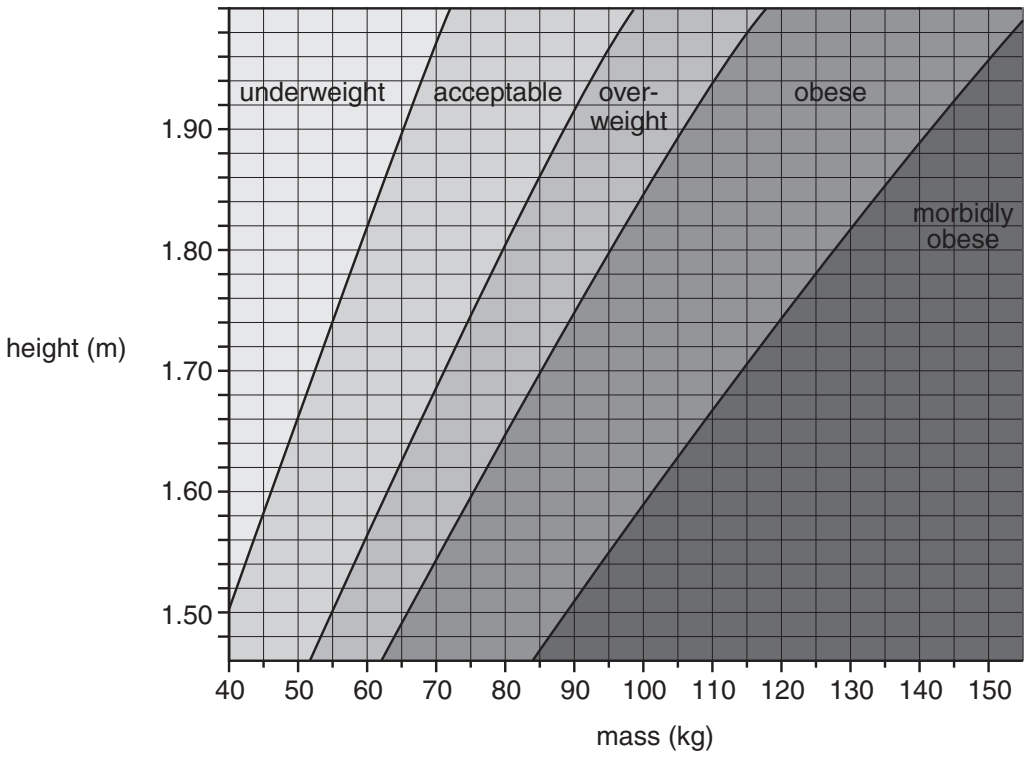

Fig. 1.1

(i) Using Fig. 1.1, state the category into which a female who has a body mass of 69 kg and a height of 1.67 m is placed.

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

(ii) There are many factors that determine the category into which a person is placed. Fig. 1.1 does not take into account all of these factors.

Suggest why the female in **(c)(i)** might be placed in the wrong category.

.....

.....

.....

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

(d) Name **two** diseases associated with obesity.

1 .....

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

[Total: 10]

Turn over

2 Fig. 2.1 represents a water molecule.

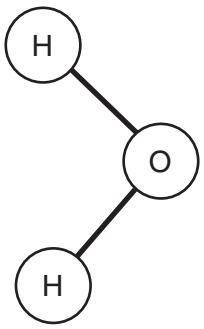

Fig. 2.1

(a) Water molecules are polar. As a result, they attract each other.

Draw a second water molecule on Fig. 2.1.

Your drawing should show:

- the bond(s) between the two molecules
- the name of the bond
- the charges on each atom. **[3]**

(b) Ponds provide a very stable environment for aquatic organisms.

Three properties of water that contribute to this stability are as follows:

- the density of water decreases as the temperature falls below 4 °C so ice floats on the top of the pond
- it acts as a solvent for ions such as nitrates (NO_3^-)
- a large quantity of energy is required to raise the temperature of water by 1 °C.

Explain how these three properties help organisms survive in the pond.

In your answer you should make clear the links between the behaviour of the water molecules and the survival of the organisms.

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..... **[8]**

(c) Water is important in many biological reactions.

Complete Table 2.1 by writing an appropriate term next to each description.

Table 2.1

description	term
the type of reaction that occurs when water is added to break a bond in a molecule	
the phosphate group of a phospholipid that readily attracts water molecules	

[2]

[Total: 13]

3 **(a)** The enzyme DHPS is involved in the production of folic acid in bacteria.

- The substrate for DHPS is a molecule known as PABA.
- The enzyme DHPS is inhibited by the drug sulfonamide.

Fig. 3.1 shows the structure of PABA and that of sulfonamide.

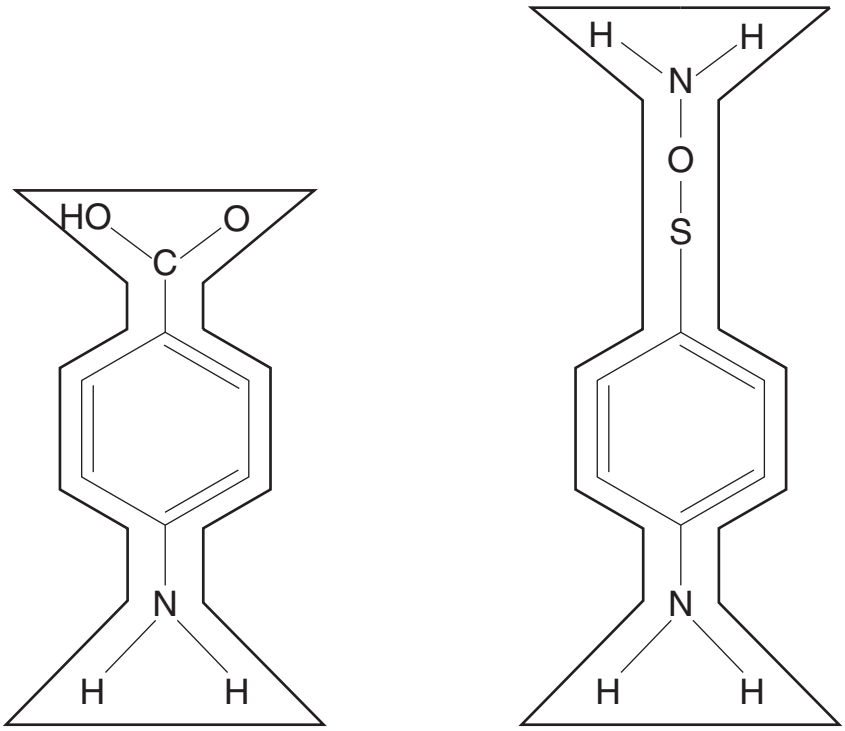
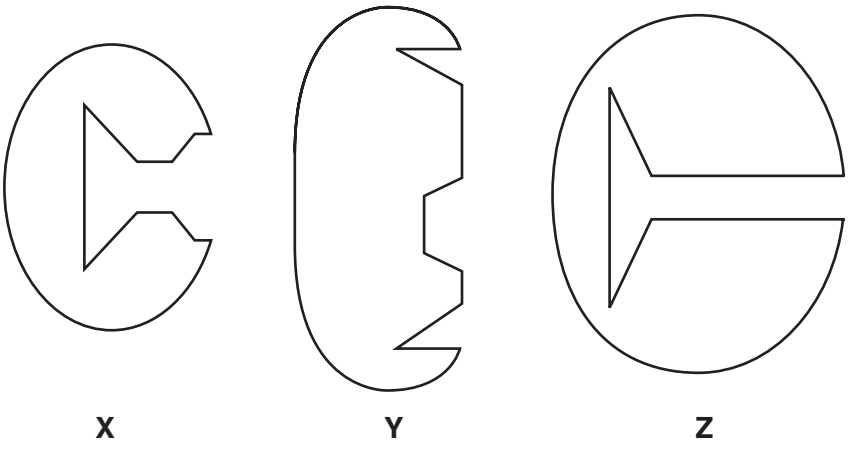


Fig. 3.1

(i) Diagrams **X**, **Y** and **Z** represent these enzyme molecules and their active sites.



State the letter, **X**, **Y** or **Z**, that most accurately represents the enzyme DHPS.

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

(ii) Using the information in Fig. 3.1, explain why sulfonamide acts as a competitive inhibitor of DHPS.

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

(b) Fig. 3.2 shows the effect of increasing the concentration of the substrate (PABA) on the rate of reaction.

- Curve **A** shows the rate of reaction without the presence of the competitive inhibitor sulfonamide.
- Curve **B** shows the rate of reaction in the presence of the competitive inhibitor sulfonamide.

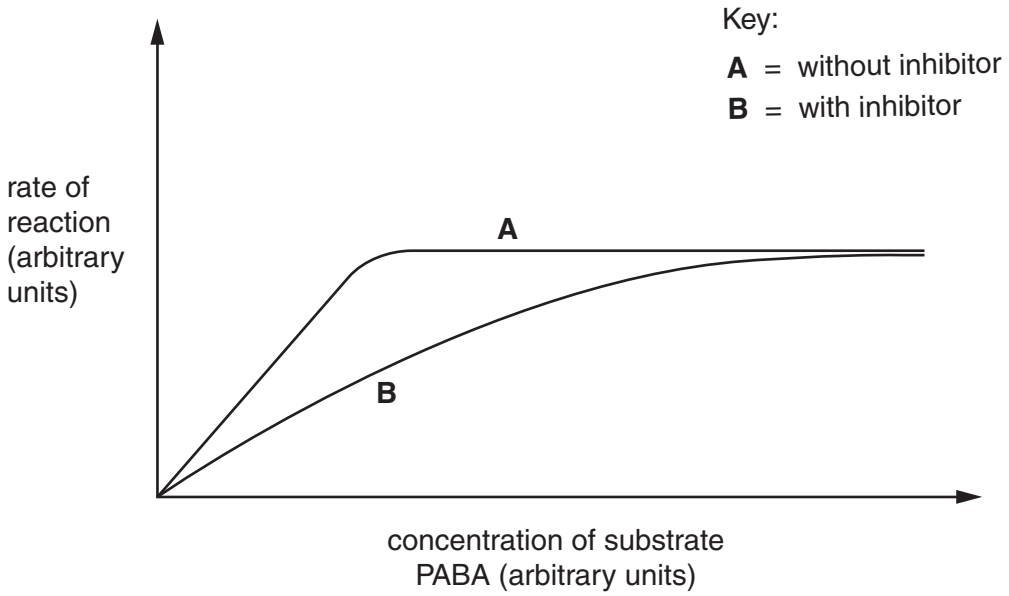

Fig. 3.2

Explain the effect of increasing the concentration of substrate on the rate of reaction;

(i) without inhibitor,

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.....

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.....

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

(ii) with inhibitor.

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

(c) Antibiotic resistance in bacteria is becoming an increasing problem.

Describe how a sulfonamide-resistant population of bacteria could develop.

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..... **[4]**

QUESTION 3(d) STARTS ON PAGE 11

(d) Hospitals can check to see if a strain of bacteria causing an infection is resistant to a range of antibiotics by using a **multodisc**. A multodisc contains different antibiotics.

- The bacteria are isolated from a patient.
- The bacteria are spread on nutrient agar in a Petri dish.
- The multodisc is placed on the agar.

Fig. 3.3 shows a Petri dish with the bacteria, in which is placed a multodisc containing six different antibiotics.

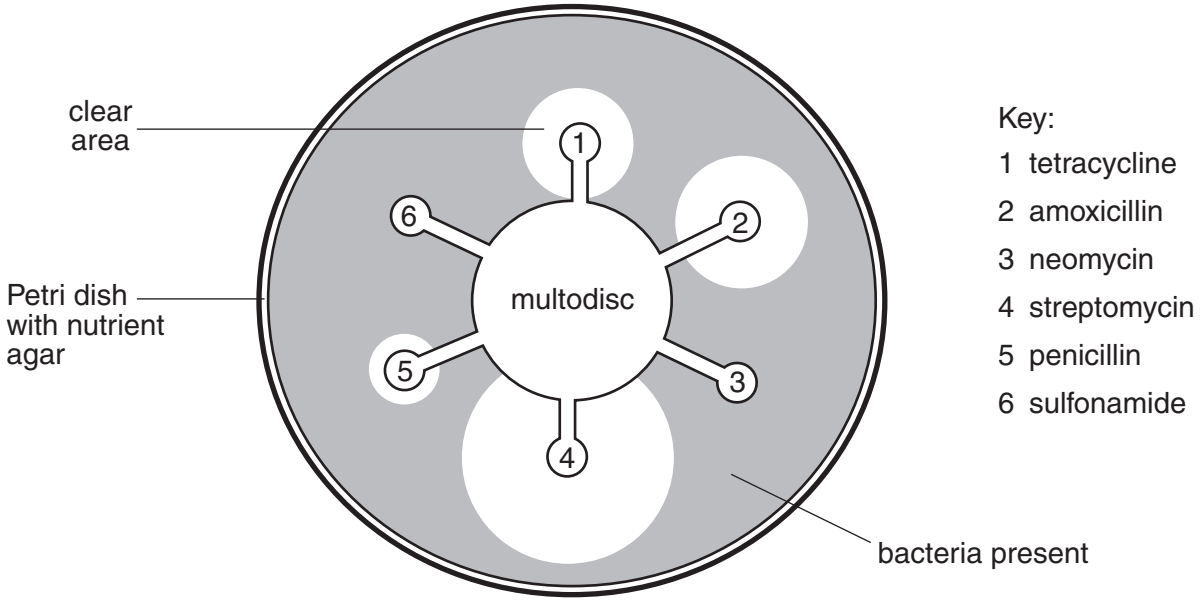

Fig. 3.3

(i) Explain why there are clear areas of agar in the Petri dish.

.....

.....

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

(ii) Using Fig. 3.3, name the antibiotic that is most effective against the bacteria causing the infection.

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

(iii) Suggest **three** reasons why a hospital might use a multodisc to select the most suitable antibiotic for treating a patient.

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

(e) Drugs, such as antibiotics, are often first discovered in the natural environment.

Explain why it may become increasingly difficult to discover new drugs in the future.

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

[Total: 20]

4 **(a)** Amino acids are the basic building blocks for proteins. Fig. 4.1 shows the amino acid cysteine.

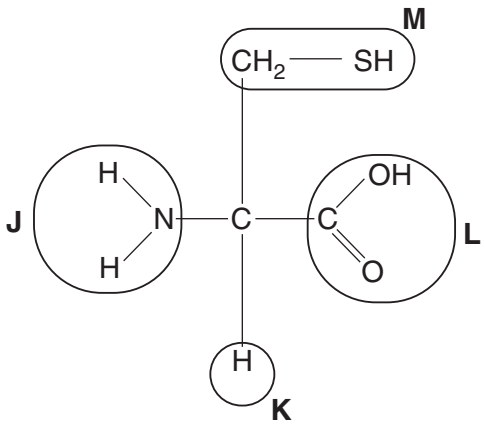

Fig. 4.1

(i) Complete the table by selecting the letter, **J**, **K**, **L** or **M**, that represents the following groups in cysteine.

group	letter
carboxyl	
R group	
amine group	

[3]

(ii) The primary structure of a protein consists of a chain of amino acids.

Describe how a second amino acid would bond to cysteine in forming the primary structure of a protein.

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

(b) Each amino acid has a different R group.

Describe how these R groups can interact to determine the **tertiary** structure of a protein.

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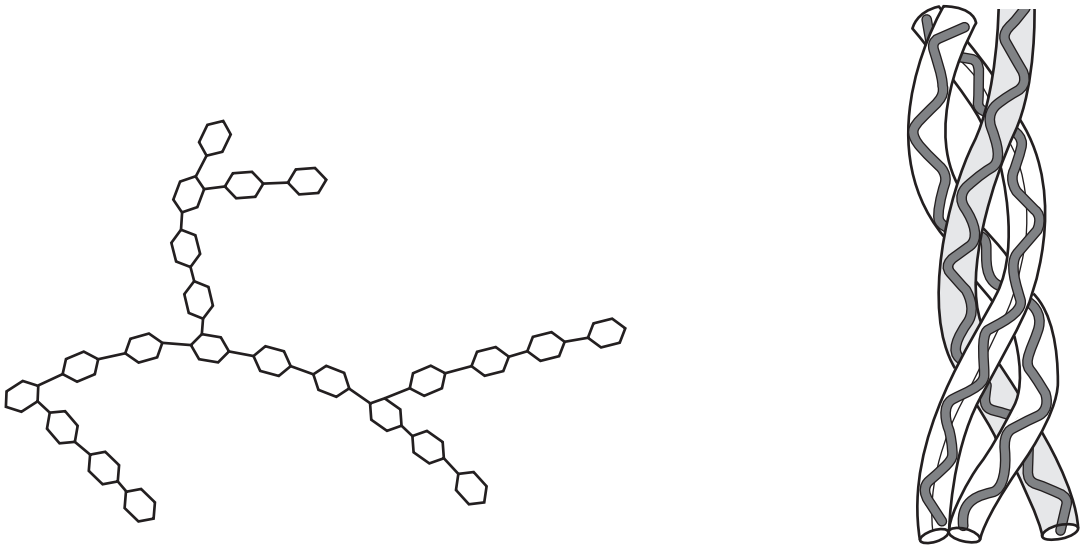
..... **[4]**

(c) Fig. 4.2 shows the structure of two polymers, glycogen and collagen, that are found in mammals.



glycogen collagen

Fig. 4.2

(i) Complete the table below to give three **differences** between the **structure** of glycogen and collagen.

glycogen	collagen

[3]

(ii) Collagen is found in the ligaments which hold bones together at joints.

State **two** properties of collagen that make it suitable for this purpose.

1 .....

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

[Total: 15]

5 **(a)** Coronary heart disease (CHD) can be described as a multifactorial disease. This means that a number of different risk factors contribute to the development of the disease.

Fig. 5.1 shows the percentage of cases of CHD in a population to which each risk factor contributed.

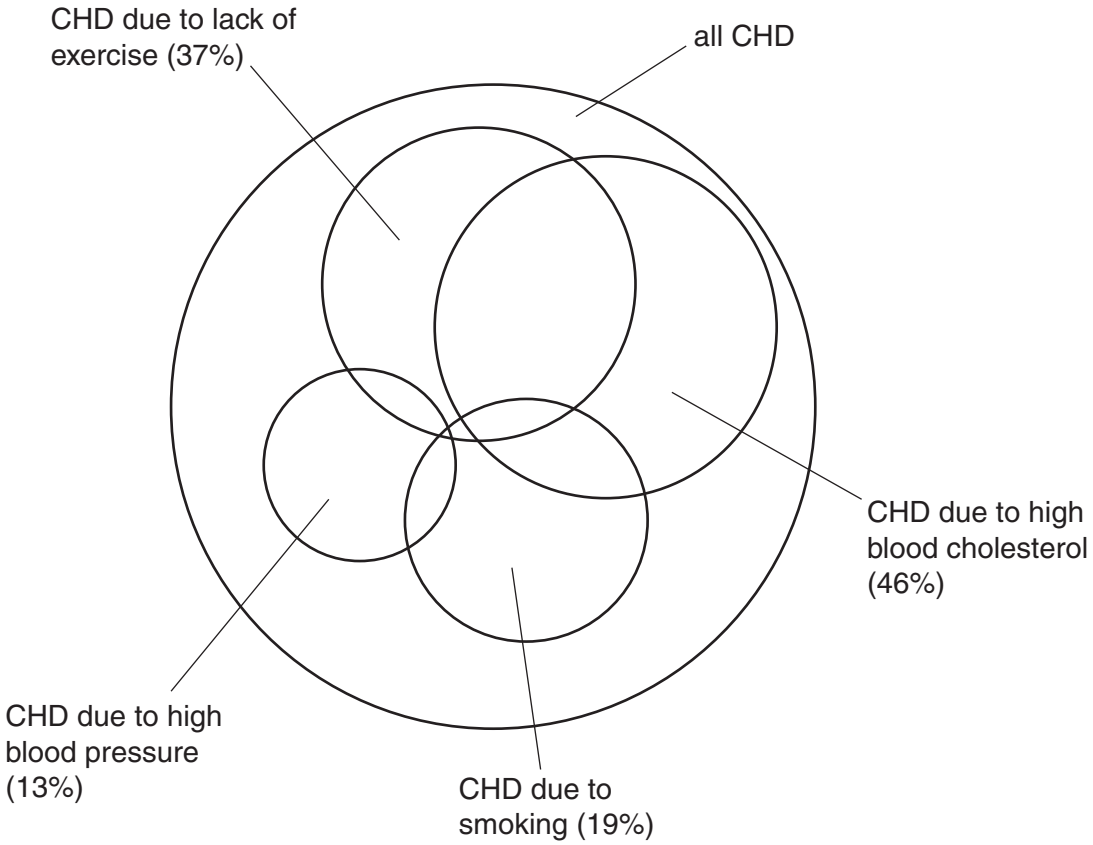


Fig. 5.1

(i) When you add up the different risk factor percentages for the population you find that it is greater than 100%.

Suggest why.

.....

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

(ii) State **two** further risk factors that are **not** shown in Fig. 5.1.

1 .....

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

(iii) Smoking is a contributing factor in 19% of all cases of CHD.

Table 5.1 lists a number of effects of cigarette smoke.

Use a tick (✓) to indicate which component of cigarette smoke causes each effect.

The first row has been done for you.

Table 5.1

effect	nicotine	carbon monoxide
increases heart rate	✓	
constricts arterioles		
damages the lining of arteries		
reduces the ability of haemoglobin to carry oxygen		
makes platelets sticky		

[4]

(b) Cholesterol is transported in the form of lipoproteins. High levels of low density lipoproteins (LDLs) in the blood are a risk factor in heart disease.

Outline the role of LDLs in the formation of an atheroma.

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

(c) An atheroma can grow to a point where it restricts blood flow in a coronary artery, causing coronary heart disease (CHD).

Fig 5.2 shows a method of reducing the symptoms of CHD.

A stent is a tubular device, containing a 'balloon', which can be inserted into the damaged artery. The stent can be opened up by inflating the balloon.

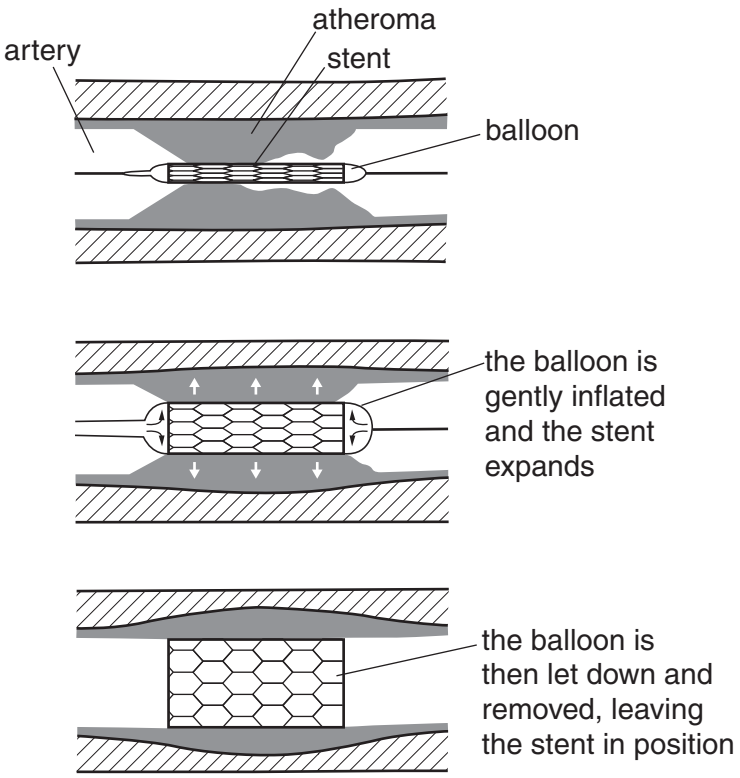

Fig. 5.2

Explain how the inserted stent would reduce the symptoms of CHD.

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..... **[4]**

[Total: 13]

6 DNA and RNA are nucleic acids.

(a) (i) State the components of a **DNA** nucleotide.

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

(ii) Describe how the structure of RNA differs from that of DNA.

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

(b) Before a cell divides, the DNA needs to be accurately replicated.

Describe how a DNA molecule is replicated.

In your answer you should make clear how the steps in the process are sequenced.

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..... **[7]**

QUESTION 6(c) STARTS ON PAGE 21

(c) (i) State what a gene codes for.

.....

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

(ii) Suggest how changing the sequence of DNA nucleotides could affect the final product the DNA codes for.

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

[Total: 15]

7 Fig. 7.1, **on the insert**, shows a photograph of a part of a heathland habitat. A study was carried out on the biodiversity of this habitat.

(a) Define the terms:

habitat .....

.....

.....

biodiversity .....

.....

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

(b) In this study, a student placed his quadrat on areas he considered to have the most biodiversity.

Explain what is wrong with this technique.

.....

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

(c) The student looked at the abundance of three plants at different distances from the bottom of the slope.

The results table drawn by the student is shown below.

Table 7.1

distance from bottom of slope	percentage cover of each plant species		
	cotton grass	ling	bracken
0 m	76	0	0
10 m	68	0	0
20 m	0	2	0
30 m	0	35	0
40 m	0	50	0
50 m	0	60	7
60 m	0	40	17
70 m	0	10	42
80 m	0	0	68
90 m	0	0	71
100 m	0	0	74

(i) The format of the student's table is incorrect.

Suggest **one** way in which the student could correct the table.

.....

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

Fig. 7.2 is a graph showing the distribution of cotton grass and bracken at different distances from the bottom of the slope.

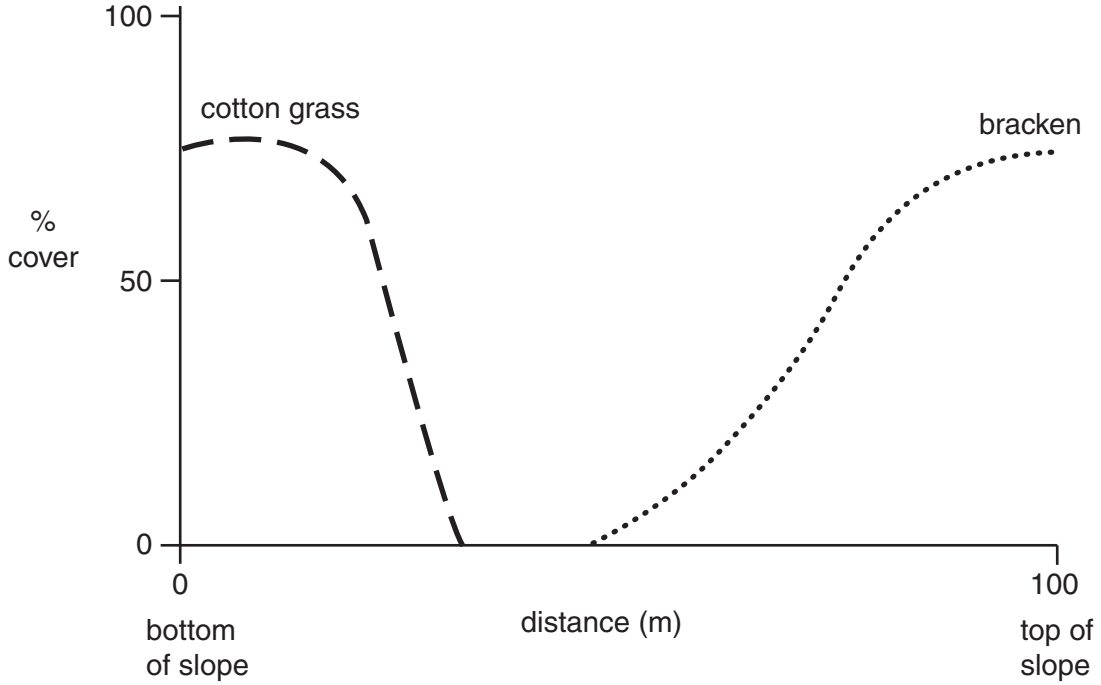

Fig. 7.2

(ii) Using the information in Table 7.1, **sketch on Fig. 7.2** a curve to show the distribution of **ling**. **[3]**

(iii) Describe the distribution of **bracken**.

.....

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

QUESTION 7(d)(i) STARTS ON PAGE 25

(d) (i) The student was asked to calculate the biodiversity using Simpson's Index of Diversity.

Suggest what additional data he would need to **collect** in order to calculate Simpson's Index of Diversity in this habitat.

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

(ii) The student calculated Simpson's Index as 0.2. This is a low value.

State the **significance** of this low value for this habitat.

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

[Total: 14]

END OF QUESTION PAPER

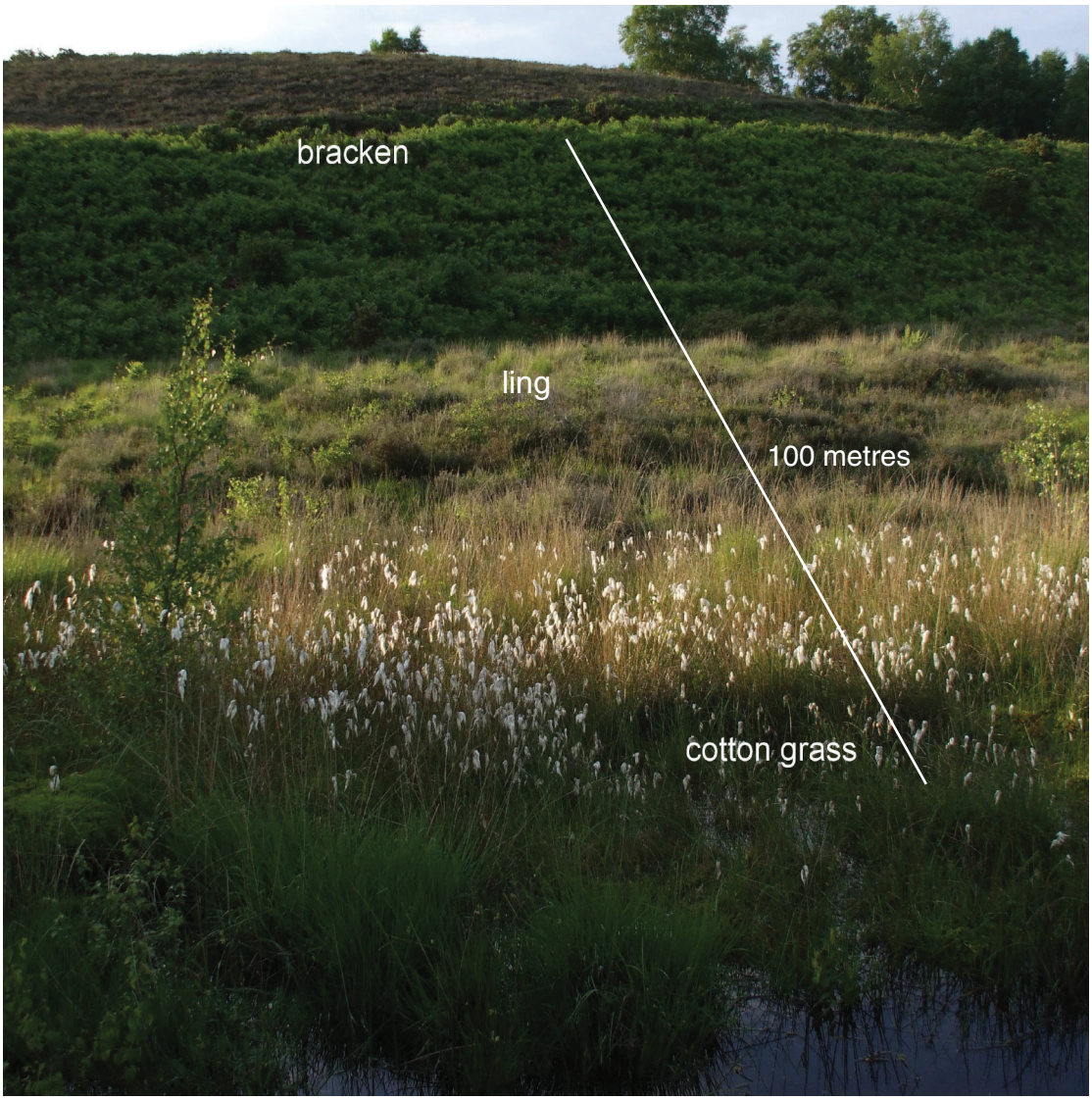

Fig. 7.1

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.

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

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

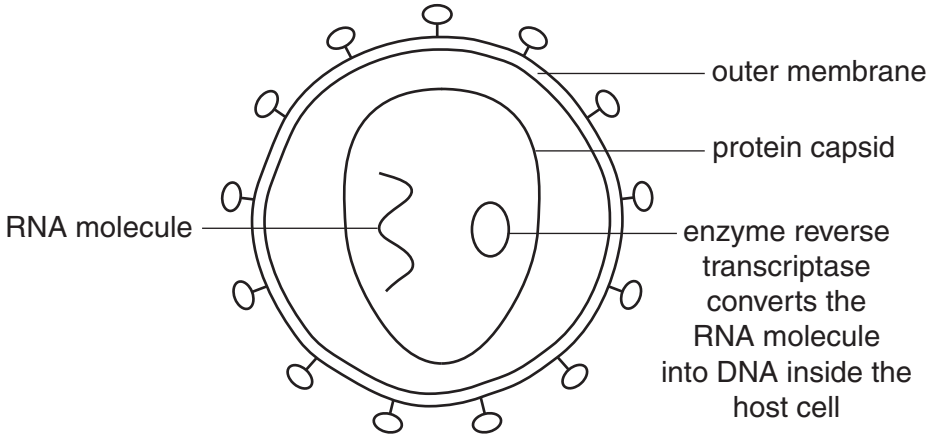

Fig. 1.1

(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]

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.

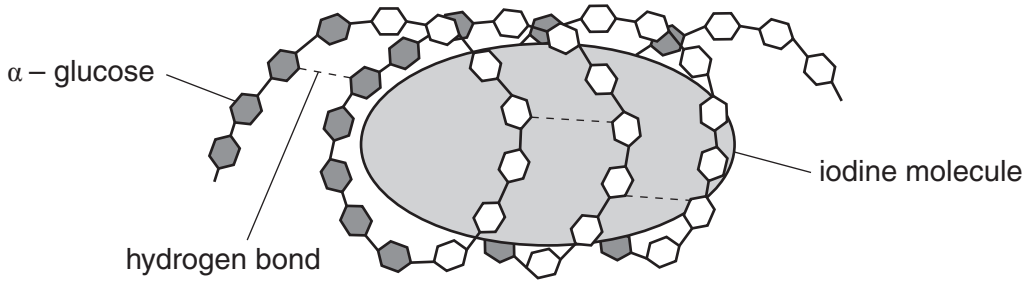

Fig. 2.1

(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 °C.

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

(b) **Amylase** is an enzyme that hydrolyses amylose to maltose. Maltose, like glucose, is a reducing sugar.

A student investigated the action of amylase on amylose. She mixed amylase with amylose and placed the mixture in a water bath.

Describe how she could measure the change in concentration of maltose (reducing sugar) as the reaction proceeds.

In your answer, you should ensure that the steps in the procedure are sequenced correctly.

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..... **[7]**

(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.

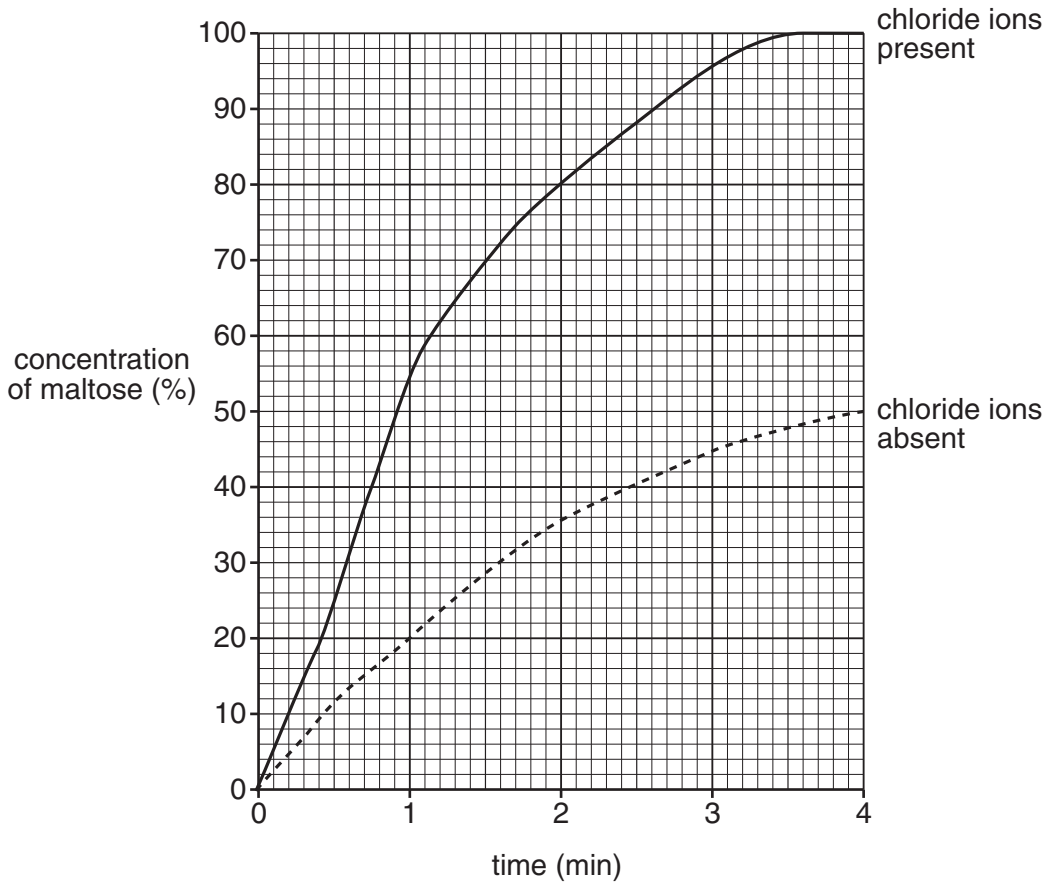

Fig. 2.2

(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 7

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.

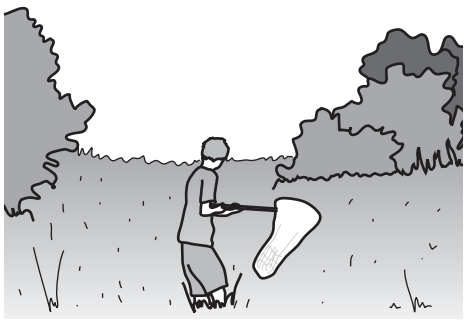

Fig. 3.1

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]**

(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]

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 .....

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..... **[4]**

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

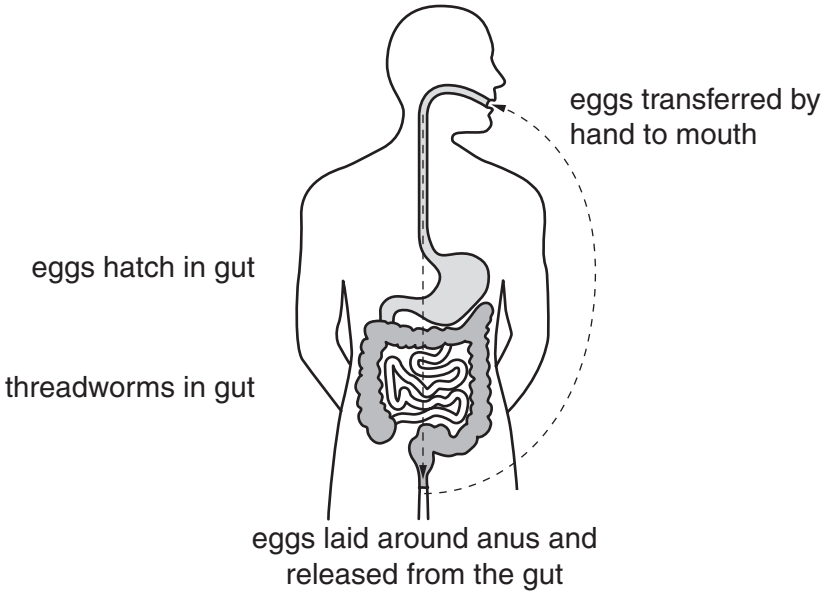

Fig. 4.1

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

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..... **[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 (**D**) or RNA only (**R**) or both DNA and RNA (**B**)
contains thymine	D
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.

.....

.....

.....

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

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

.....

.....

.....

..... **[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.

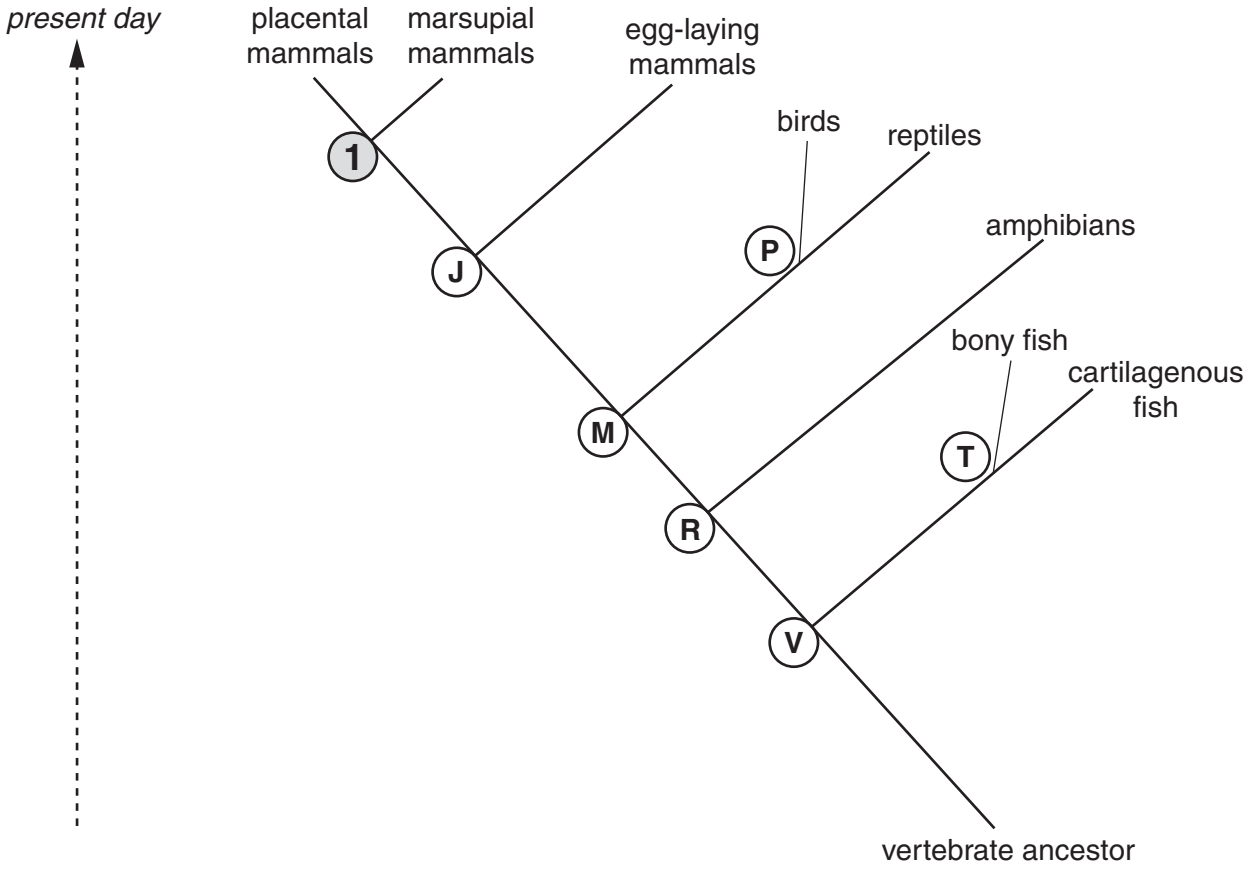

Fig. 5.1

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]**

(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.

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..... **[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]

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.

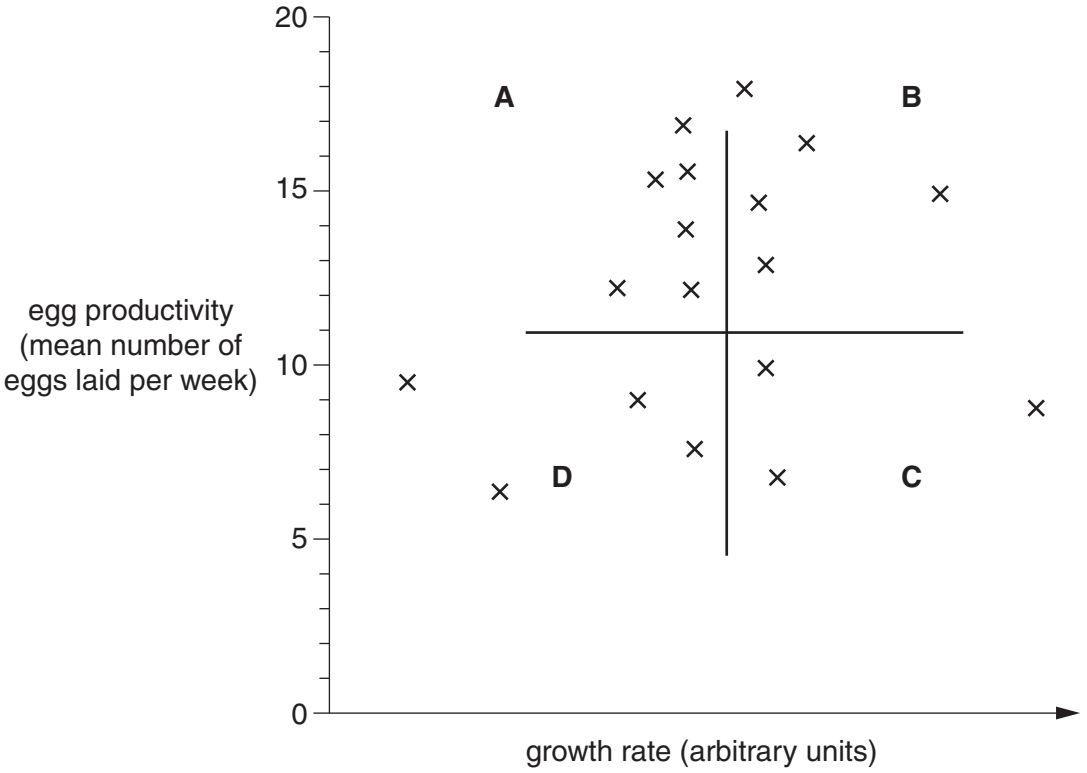

Fig. 6.1

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

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

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..... **[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.

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..... **[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.

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

(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 .....

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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.

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

[Total: 13]

7 **(a)** Haemoglobin is a globular protein.

Describe the structure of a haemoglobin molecule.

In your answer, you should include details of the secondary, tertiary and quaternary structure of the molecule.

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..... **[7]**

(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 20

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

Answer **all** the questions.

1 Biological molecules are held together by a variety of bonds.

(a) The diagram in Fig. 1.1 represents an amino acid.

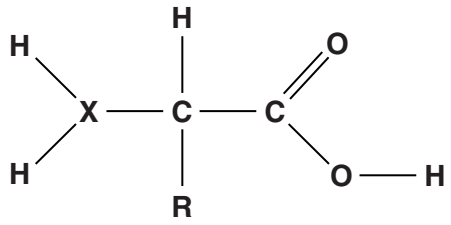

Fig. 1.1

(i) One of the atoms that make up an amino acid has been replaced with the letter **X**.

State the chemical symbol of the atom represented by the letter **X** in Fig. 1.1.

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

(ii) Name the polymer formed from a chain of amino acids.

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

(iii) Name the bond that is formed when two amino acids are joined together. Describe the formation of this bond.

name of bond .....

description of formation

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

(b) Fig. 1.2 shows a hydrogen bond between two water molecules.

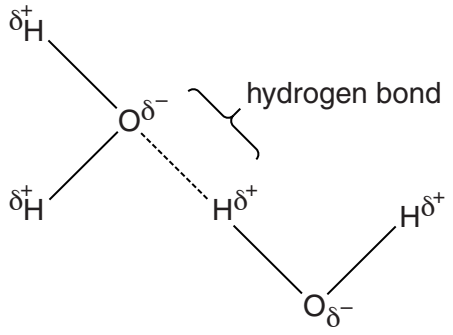

Fig. 1.2

(i) Many of the physical properties of water arise as a result of these hydrogen bonds.

Describe ways in which the physical properties of water allow organisms to survive over a range of temperatures.

In your answer you should make clear links between the properties of water and the survival of organisms.

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..... **[9]**

(ii) List **three other** examples of where hydrogen bonds are found in biological molecules.

1 .....

2 .....

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

[Total: 17]

2 Malaria is a disease caused by a eukaryotic parasite.

(a) State **two** features of the malarial parasite that indicate that it is **not** a prokaryote.

1 .....

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

(b) In a piece of word-processed homework, a student stated that one species of parasite that causes malaria is called:

Plasmodium Vivax

State **one** error made by the student.

.....

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

(c) The malarial parasite is carried by an insect, the female *Anopheles* mosquito.

(i) Describe how the mosquito transmits the malarial parasite to a human.

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

(ii) In order to fight the spread of malaria, insecticides have been used in areas where the *Anopheles* mosquito breeds.

One problem that can occur when using insecticides in this way is the development of insecticide resistance.

Suggest **one other** reason why some people might be concerned about using insecticides.

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

(iii) Suggest how the effects of insecticide use on a population of *Anopheles* mosquitoes could be measured **and** state the steps that should be taken in order to produce valid and reliable results.

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..... **[5]**

[Total: 12]

3 Cholesterol is an important biological molecule.

(a) State **two** roles of cholesterol in living organisms.

1 .....

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2 .....

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

(b) Fig. 3.1 represents the structure of a cholesterol molecule.

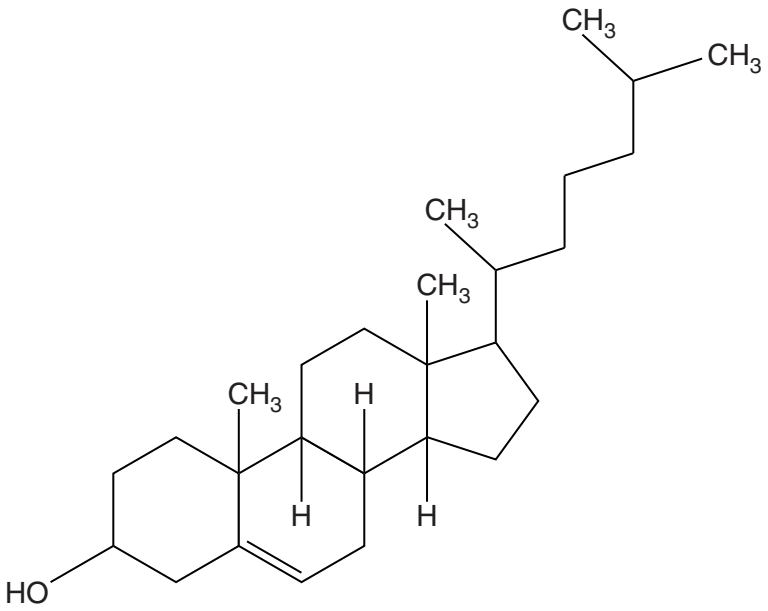

Fig. 3.1

(i) Identify **one** way in which the molecular structure of cholesterol is similar to the molecular structure of a carbohydrate.

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

(ii) Cholesterol is transported in the blood within molecules of low-density lipoprotein (LDL).

Name **two** molecules that combine with cholesterol to form LDLs.

.....

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

(iii) LDL and a similar molecule, high-density lipoprotein (HDL), carry cholesterol in the blood. LDL and HDL affect the formation of atheromas in the arteries.

Describe the different ways in which LDLs and HDLs affect the formation of atheromas.

In your answer you should make clear the differences in the involvement of LDL and HDL in the formation of atheromas.

[7]

Turn over

(c) (i) In countries such as the UK, in which red meat forms a large part of the diet, people tend to have high levels of blood cholesterol compared with people in countries in which little red meat is eaten.

Suggest why diets with a high red meat content are associated with high blood cholesterol.

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

(ii) Name a disease, other than atherosclerosis, for which high blood cholesterol is a risk factor.

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

[Total: 15]

4 The system used by scientists for classifying living things has developed from the original classification system proposed by Carl Linnaeus around 250 years ago.

(a) Complete the following paragraph by using the most appropriate term(s).

The system of classifying organisms according to their observable features or genetic characteristics is called ..... . Organisms are classified into large groups which are then subdivided into increasingly smaller groups. A system such as this is called a ..... . The term that describes the evolutionary relationship between organisms is ..... .

[3]

(b) New Zealand is made up of two large and many smaller islands and is situated a long distance from any other land mass.

In New Zealand there is a large variety of birds not found elsewhere in the world.

Among its many species of the parrot family, Psittacidae, are:

- kaka (*Nestor meridionalis*)
- kea (*Nestor notabilis*)
- kakapo (*Strigops habroptila*)

These birds are shown in Fig. 4.1 **on the insert**.

(i) State **two** characteristics that birds, such as parrots, share with other members of the animal kingdom.

1 .....

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

(ii) Name the **domain** to which the parrot belongs.

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

(iii) Species that are more closely related in evolutionary terms have more genes in common than species that are less closely related.

Using the information provided, suggest the likely genetic relationship between the three parrot species.

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..... **[4]**

QUESTION 4 CONTINUES ON PAGE 11

(c) The kakapo is one of the world's largest and rarest parrot species. The variation in mass of adult birds in the kakapo population has been reported to be between 950 g and 4000 g.

(i) Define the term *variation*.

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

(ii) Suggest **two** reasons why the kakapo varies in size.

1 .....

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

(iii) Suggest **two** reasons why the reported mass range for the adult kakapo may not be accurate.

1 .....

.....

2 .....

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

(d) At some point in the past, distinct species of New Zealand parrot are likely to have arisen from an original ancestral population.

State the name of the process by which new species arise **and** suggest the mechanisms necessary for this process to occur.

name of process .....

mechanisms necessary for this process to occur .....

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

[Total: 19]

5 **(a)** The black poplar was once a common tree throughout southern Britain. Its numbers have decreased by 94% since 1942 and it is in danger of becoming extinct in the wild.

There are thought to be approximately 2500 black poplars surviving in Britain today.

Use the information above to calculate the original number of black poplar trees in 1942.

Show your working.

Answer = ... **[2]**

(b) Species such as the black poplar contribute to the biodiversity of the UK.

Suggest **three** reasons why the conservation of the black poplar is important.

1 .....

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2 .....

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3 .....

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

(c) Botanic gardens are important in the conservation of plant species.

(i) State why the conservation of a species in a botanic garden is described as *ex situ*.

.....

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

(ii) Many botanic gardens use seed banks as a method of plant conservation.

Outline the **advantages** of using a seed bank, as opposed to adult plants, in order to conserve an endangered plant species.

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..... **[4]**

(iii) Suggest why it is important to ensure that, for each species, the seeds in a seed bank have been collected from several different sites in the wild.

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

[Total: 13]

QUESTION 6 STARTS ON PAGE 14

6 **(a)** In his book 'On the Origin of Species', Charles Darwin made the following four observations:

W Offspring generally appear similar to their parents.
X No two individuals are identical.
Y Organisms have the ability to produce large numbers of offspring.
Z Populations in nature tend to remain relatively stable.

From these observations he made a number of deductions, which are listed below in Table 6.1.

The deductions are supported by one **or more** of the observations (**W**, **X**, **Y** or **Z**).

In Table 6.1, indicate which of the above observations supported each deduction.

You may use each letter (**W**, **X**, **Y**, or **Z**) once, more than once or not at all.

Table 6.1

deduction	supporting observation(s)
characteristics are passed on to the next generation	
there is a struggle for existence	
individuals with beneficial characteristics are among the few who survive	

[3]

(b) Resistance to antibiotics has evolved in some pathogenic bacteria, such as MRSA.

Suggest why the resistance of MRSA to existing antibiotics is of major concern to humans.

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

(c) The evolution of antibiotic resistance in bacteria is evidence to support the theory of evolution.

How does **fossil** evidence support the idea that evolution has taken place?

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

[Total: 8]

QUESTION 7 STARTS ON PAGE 16

7 **(a)** Lymphocytes are important components of the immune system and can be classified into B lymphocytes and T lymphocytes.

For each of the statements in the table below, identify whether the description applies to:

- only B lymphocytes
- only T lymphocytes
- both B and T lymphocytes
- neither.

You may use each response once, more than once, or not at all. The first one has been done for you.

statement	can be applied to ...
form part of immune response	*both*
matured in thymus	
secrete substances which kill infected cells	
manufacture antibodies	
undergo clonal expansion	
activate other lymphocytes	

[5]

(b) Fig. 7.1 shows the concentration of antibodies in a patient's blood following an initial infection with a pathogen. This is known as the primary response.

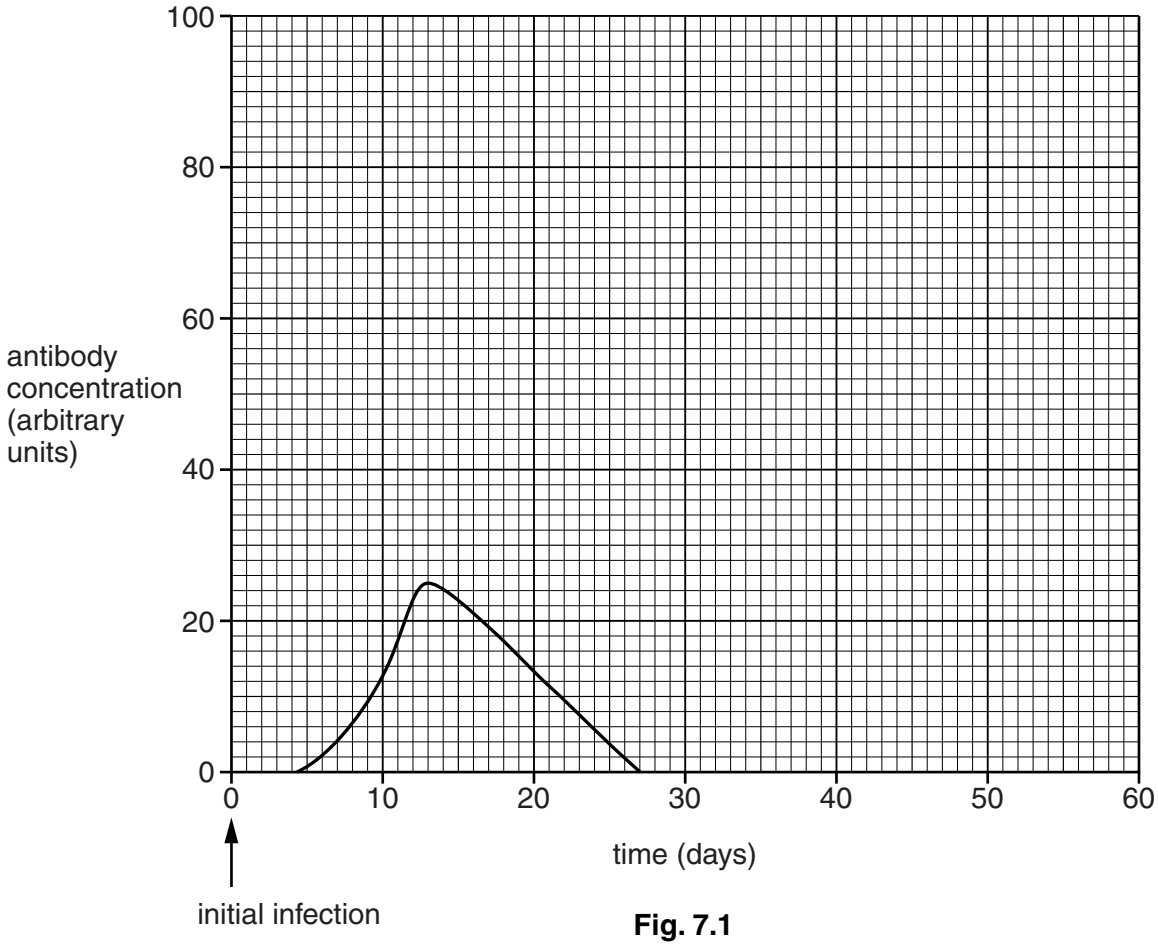

Fig. 7.1

(i) Describe the changes in antibody concentration that occur in the patient's blood during the primary response.

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

(ii) The patient was subsequently infected with the same pathogen 30 days after the initial infection.

Draw a line **on the graph** to show the likely concentration of antibodies in the patient's blood from 30 days onwards.

..... *The answer to this question must be drawn on Fig. 7.1* ..... **[2]**

QUESTION 7(c) STARTS ON PAGE 18

(c) Fig. 7.2 shows the structure of an antibody.

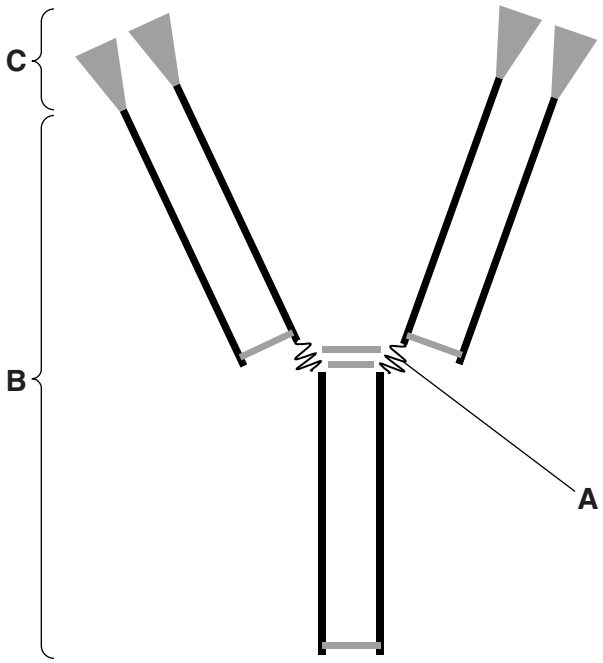


Fig. 7.2

Complete the table below by stating the name and function of each of the regions **A**, **B** and **C**.

region	name	function
A		
B		
C		

[6]

[Total: 16]

END OF QUESTION PAPER

mock papers 4

1 All organisms are made up of one or more cells.

(a) For each of the descriptions below, put a cross ☒ in the box that corresponds to the correct statement about the features of animal, plant and prokaryotic cells.

(6)

(i) Genetic material is

☒ **A** separate strands in animal and prokaryotic cells

☒ **B** separate strands in animal and plant cells

☒ **C** circular in animal and prokaryotic cells

☒ **D** circular in animal and plant cells

(ii) Centrioles are present in

☒ **A** plant cells only

☒ **B** animal cells only

☒ **C** prokaryotic cells only

☒ **D** animal, plant and prokaryotic cells

(iii) The cell surface membrane is present in

☒ **A** plant cells only

☒ **B** animal cells only

☒ **C** prokaryotic cells only

☒ **D** animal, plant and prokaryotic cells

(iv) Pits are found in the cell walls of

☒ **A** plant cells only

☒ **B** prokaryotic cells only

☒ **C** plant and prokaryotic cells

☒ **D** animal, plant and prokaryotic cells

(v) The tonoplast may be present in

☒ **A** plant cells only

☒ **B** prokaryotic cells only

☒ **C** plant and prokaryotic cells

☒ **D** animal, plant and prokaryotic cells

(vi) Cell walls are found in

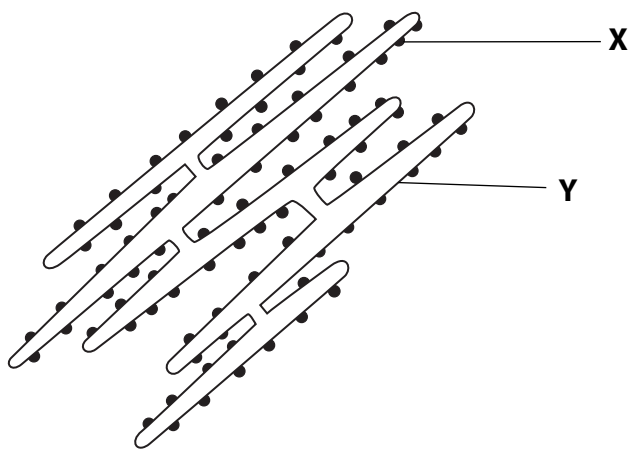
☒ **A** plant cells only

☒ **B** prokaryotic cells only

☒ **C** plant and prokaryotic cells

☒ **D** animal, plant and prokaryotic cells

(b) The diagram below shows a structure found in the cytoplasm of both plant and animal cells, as seen using an electron microscope.



(i) Name the structure shown in the diagram.

(1)

.....

(ii) Name the parts labelled **X** and **Y**.

(2)

X .....

Y .....

(Total for Question 1 = 9 marks)

2 The phenotype of an organism is affected by its genotype and its environment.

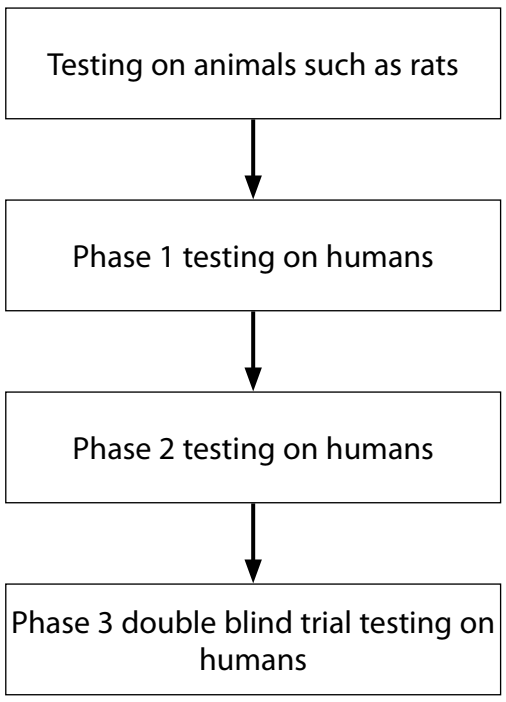
(a) The table below shows the mean difference in two phenotypes, height and mass, from a study on several human identical twins and non-identical twins. Each pair of twins was brought up together.

	Type of twins	
Phenotype	**Identical**	**Non-identical**
Mean height difference / cm	1.7	4.4
Mean mass difference / kg	1.9	4.6

Explain how the data in the table show the effects that genotype and the environment have on the phenotypes.

(3)

(b) When a drug is being developed, it goes through a series of different test stages.
Some of these are shown below.



(i) Suggest why a drug can be tested on rats before testing on humans.

(2)

Turn over ▶

(ii) State what is done during each of the following phases of testing on humans.

(3)

Phase 1 .....

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Phase 2 .....

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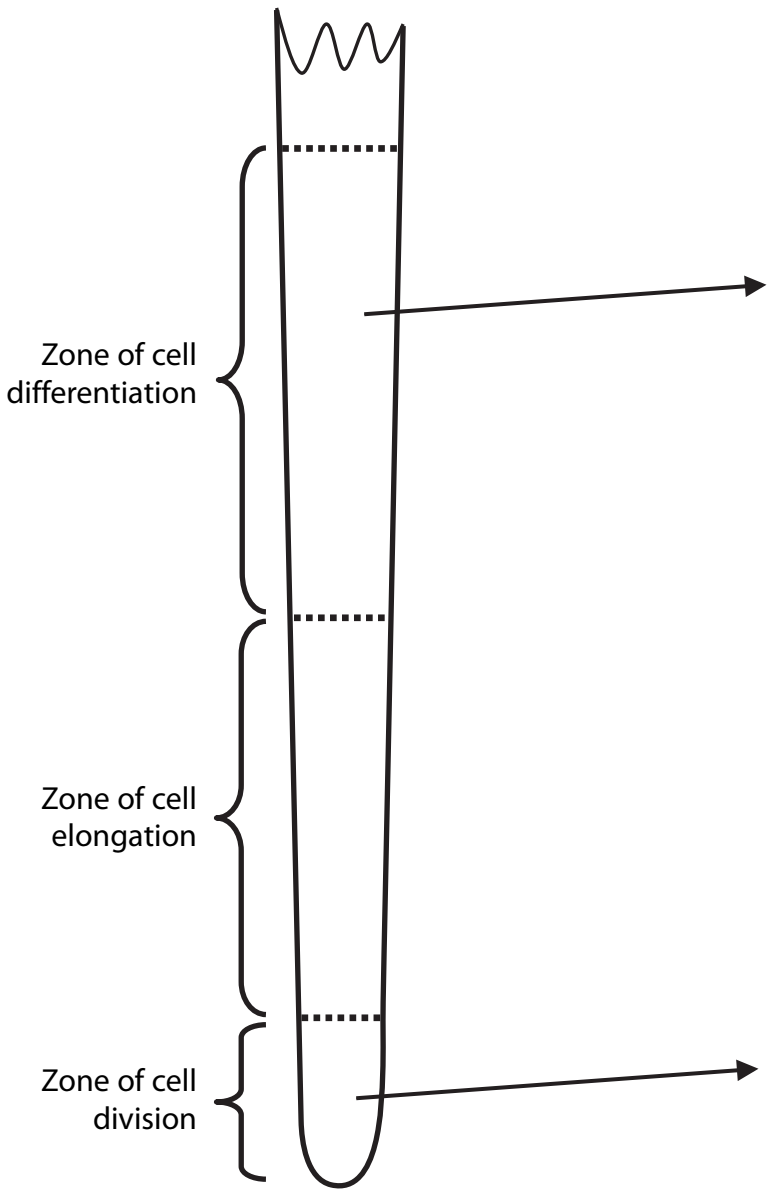
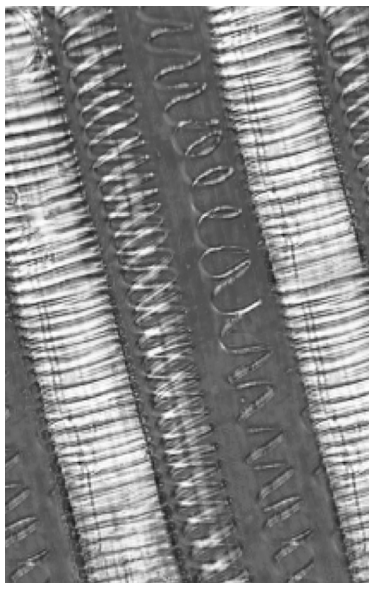
(Total for Question 2 = 8 marks)

3 In the roots of plants, cell division, cell elongation (growth) and cell differentiation occur in different zones near the root tip.

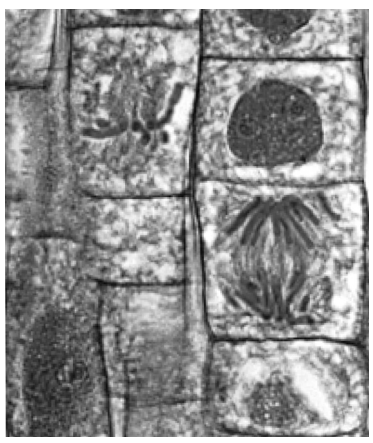
The diagram below show the three different zones in a root. Photographs **A** and **B** show some of the tissues present in two of these zones.



Photograph A



Photograph B



Turn over ▶

(a) (i) Name the specialised tissue shown in photograph **A**.

(1)

*(ii) Describe and explain how this tissue is adapted for the transport of water and support in a plant.

(4)

(b) Explain how differential gene expression could result in the specialisation of cells.

(3)

(c) Only one of the two tissues shown in the photographs **A** and **B** is totipotent. Describe how you could use a plant tissue culture technique to show which of the two tissues is totipotent.

(4)

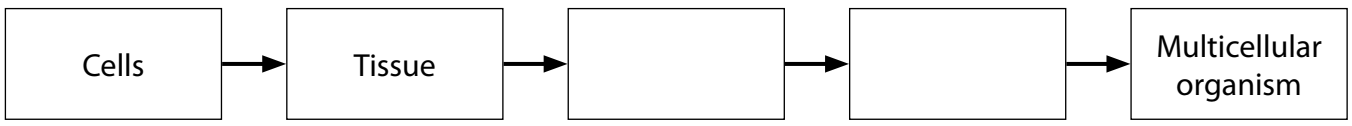
(Total for Question 3 = 12 marks)

Turn over ▶

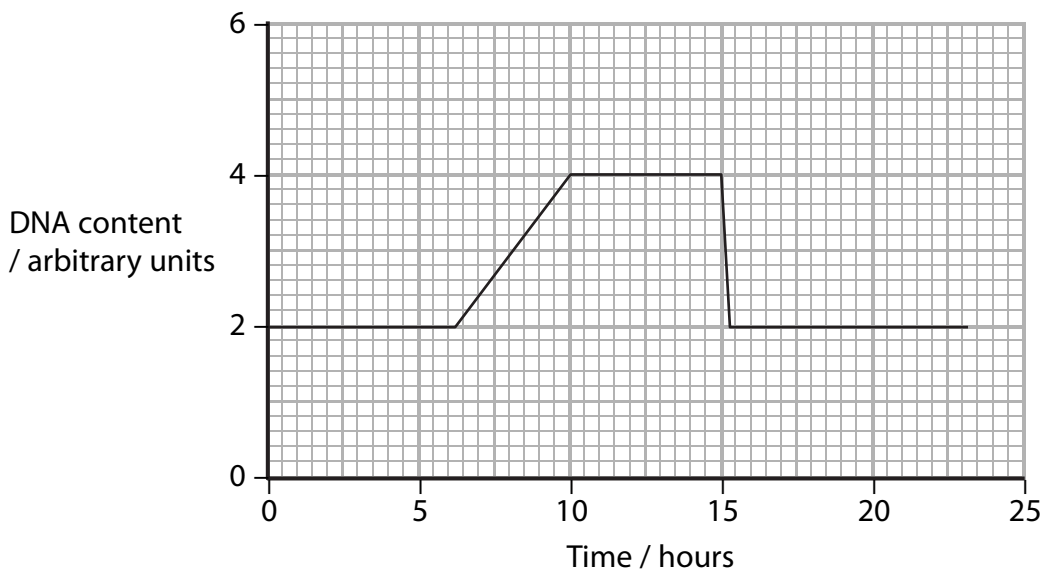
4 Cell division produces more cells. Groups of cells become organised into tissues and further organisation results in the formation of a multicellular organism.

(a) Complete the diagram below by writing in the boxes the missing levels of organisation in the correct order.

(2)



(b) The graph below shows the changes in the DNA content of an onion cell, during one cell cycle.



(i) Explain why the DNA content of the cell doubles.

(2)

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.....

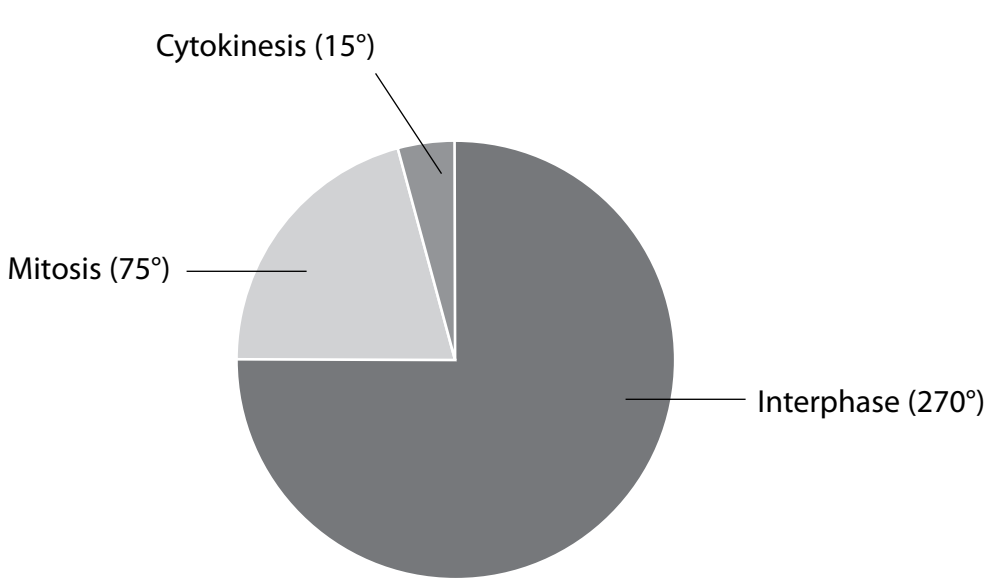
(ii) Using the graph, state how long the S phase (DNA synthesis) takes.

(1)

..... hours

(iii) In onion cells, interphase lasts an average of 18 hours. Using this information and the diagram below, calculate how long mitosis takes. The figures in brackets show the number of degrees for each sector of the circle. Show your working.

(2)



Answer ..... hours

Turn over ▶

*(c) Prophase is a stage in mitosis. Describe the events that occur during prophase.

(3)

(Total for Question 4 = 10 marks)

5 Meiosis is involved in producing gametes such as sperm cells and egg cells.

(a) Describe **three** structural differences between a human sperm cell and a human egg cell.

(3)

1 .....

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2 .....

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3 .....

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(b) When a sperm cell reaches an egg cell, enzymes are released from the head of the sperm. Explain the reasons for the release of these enzymes.

(2)

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(c) Describe what happens in the egg cell once the sperm cell nucleus has entered it.

(2)

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(d) In plants, a double fertilisation occurs.

(i) One fertilisation involves a male gamete nucleus fusing with the egg cell nucleus. Give **two** functions of this fertilisation.

(2)

1 .....

.....

2 .....

.....

(ii) In the second fertilisation, the other male gamete nucleus fuses with two polar nuclei forming a triploid structure. Name the triploid structure formed.

(1)

.....

(Total for Question 5 = 10 marks)

6 The diversity of ant species in a habitat can be used as an indicator of environmental conditions and conservation status.

(a) A study of the effect of high copper levels on ant diversity was undertaken in Brazil. Ants were collected in the same way at three different sites in one habitat. The number of different species at each site was recorded. Site 1 and Site 2 were near a copper mine and had high levels of copper present. Site 3 had normal levels of copper. The amount of vegetation present at each site was also recorded.

The results are shown in the table below.

Site	Number of ant species found	Amount of vegetation present
1	14	Very little
2	16	Little
3	45	Rich and dense

(i) Using the information in the table, what is the evidence that ant diversity can be used as an indicator of environmental conditions?

(1)

.....

.....

.....

(ii) It has been suggested that there is no **direct** effect of copper on ants. Suggest how the data in the table support this suggestion.

(2)

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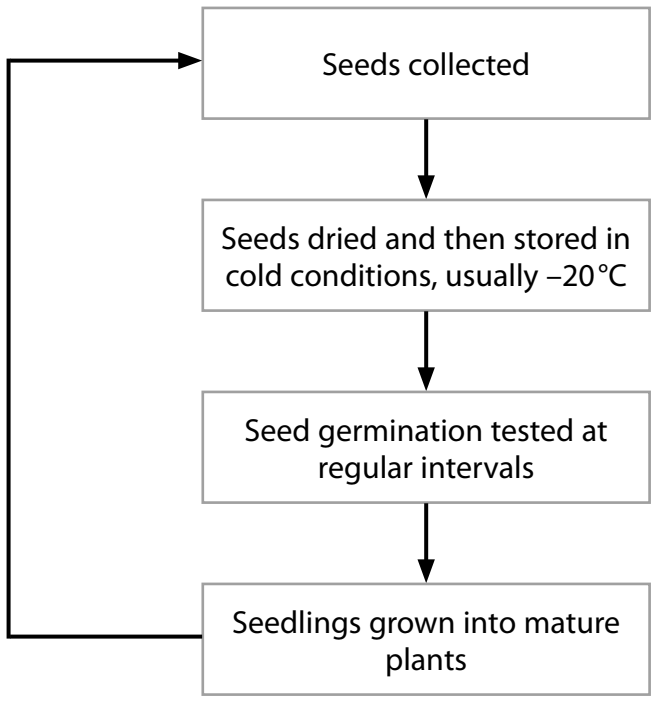
(b) Seedbanks have been set up around the world to help conserve rare plant species.
The process for storing seeds includes the following stages.



(i) Suggest **two** reasons why the seeds need to be dried and then stored in cold conditions.

(2)

1 .....

.....

.....

2 .....

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(ii) Suggest why seed germination is tested at regular intervals.

(2)

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(c) One of the aims of both seedbanks and zoos is to conserve endangered species.

Give **two** ways in which zoos help to conserve endangered species.

(2)

1 .....

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2 .....

.....

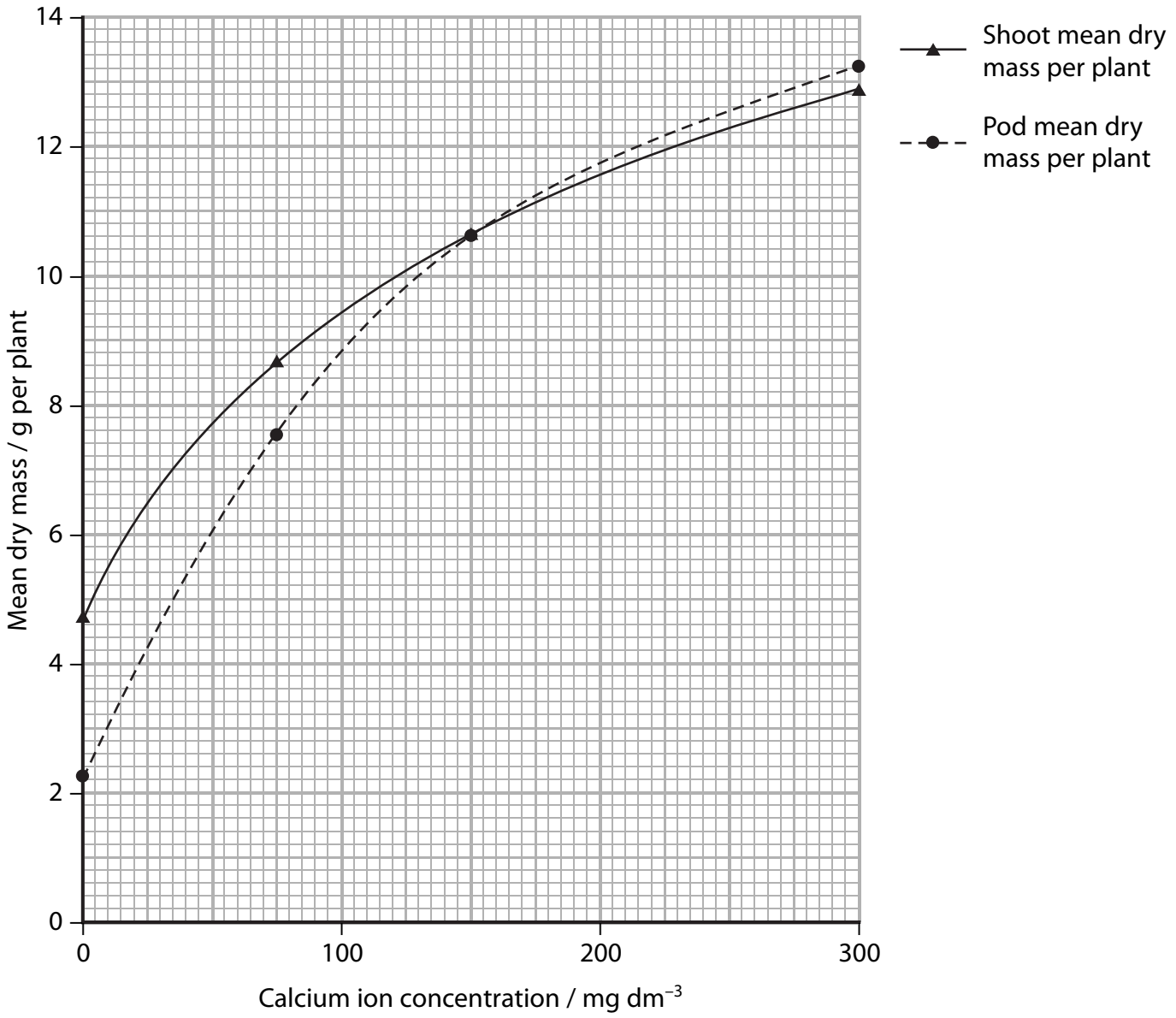
(Total for Question 6 = 9 marks)

7 A study was undertaken to investigate the effect of calcium ion concentration on the mass of shoots and the mass of pods of bean plants.

Two bean plants were grown in a pot and watered regularly with a solution containing all the required mineral ions except calcium. When the plants had produced mature bean pods, the shoots and the pods were dried and the mean dry masses were recorded.

This experiment was repeated three times, each with a different calcium ion concentration added to the watering solution.

The results are shown in the graph below.



(a) (i) Using the information in the graph, compare the effect of calcium ion concentration on the mean dry mass of shoots and the mean dry mass of pods in bean plants.

(3)

(ii) Suggest how calcium ions contributed to the change in mass in the shoot of the bean plant.

(1)

(b) During this investigation, it was found that there was a relationship between calcium ion concentration in the watering solution and total nitrogen uptake by the bean pods. The data are shown below.

Calcium ion concentration in the watering solution / mg dm^{-3}	**Total nitrogen uptake by the bean pods / mg**
0	70
75	220
150	290
300	350

(i) Describe the relationship between calcium ion concentration and total nitrogen uptake by the bean pods.

(2)

(ii) Suggest the form in which the nitrogen was supplied in the watering solution.

(1)

.....

*(iii) Suggest how the protein content of the bean pods from plants grown in the watering solution containing a calcium ion concentration of 300 mg dm^{-3} would differ from those watered with a lower calcium ion concentration.

Give an explanation for your answer.

(3)

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(Total for Question 7 = 10 marks)

8 A student investigated the antimicrobial properties of tea tree oil.

She cut three identical discs of blotting paper. She soaked disc 1 in 100% tea tree oil, disc 2 in 50% tea tree oil and 50% vegetable oil and disc 3 in 100% vegetable oil. She then placed all three discs onto a single suitably-prepared Petri dish as shown in diagram 1.

She incubated the Petri dish at 25 °C for 24 hours. The results of the incubation are shown below in diagram 2.

Diagram 1

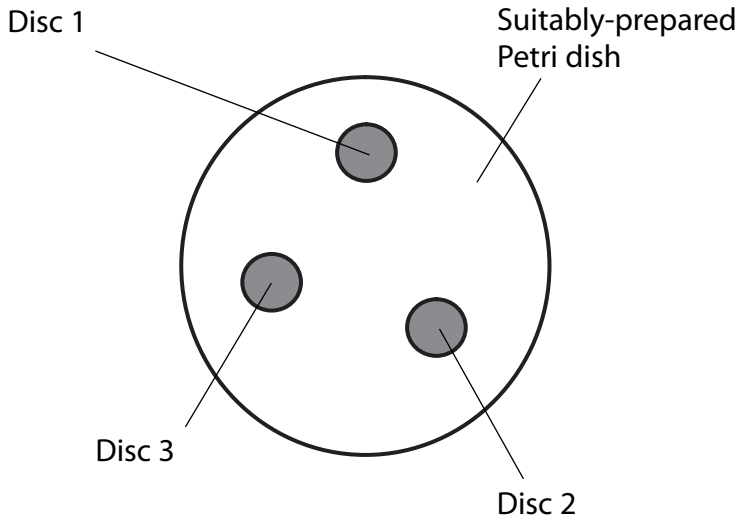
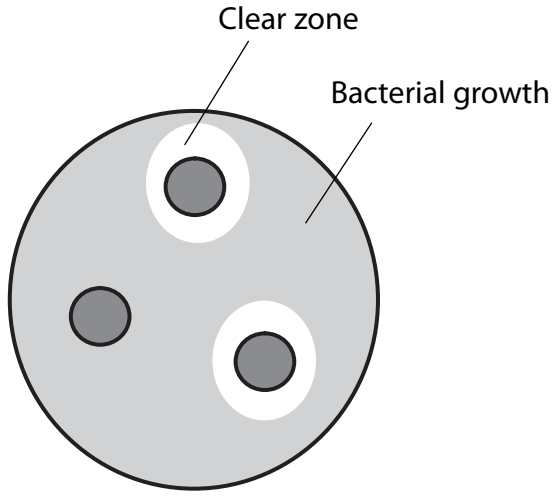


Diagram 2



(a) Suggest what is meant by the phrase **suitably-prepared Petri dish**.

(2)

(b) (i) Describe the function of disc 3.

(1)

(ii) Explain why clear zones are found around disc 1 and disc 2.

(2)

(iii) The clear zone around disc 1 is not a circle. Suggest how you would calculate the mean diameter of this clear zone.

(2)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(c) The mean diameters of the clear zones around disc 1 and disc 2 were found to be the same. This suggests that both strengths of tea tree oil had equally effective antimicrobial properties.

Describe how you would determine the minimum strength of tea tree oil that would be as effective as the 100% tea tree oil.

(3)

(d) Suggest **one** reason why it was good safety practice to incubate the Petri dish at 25 °C rather than at 37 °C.

(2)

(Total for Question 8 = 12 marks)

TOTAL FOR PAPER = 80 MARKS

mock papers 5

1 The phenotype of an individual is dependent on a variety of factors.

(a) (i) Complete the following sentence by writing the most appropriate word or words on the dotted lines.

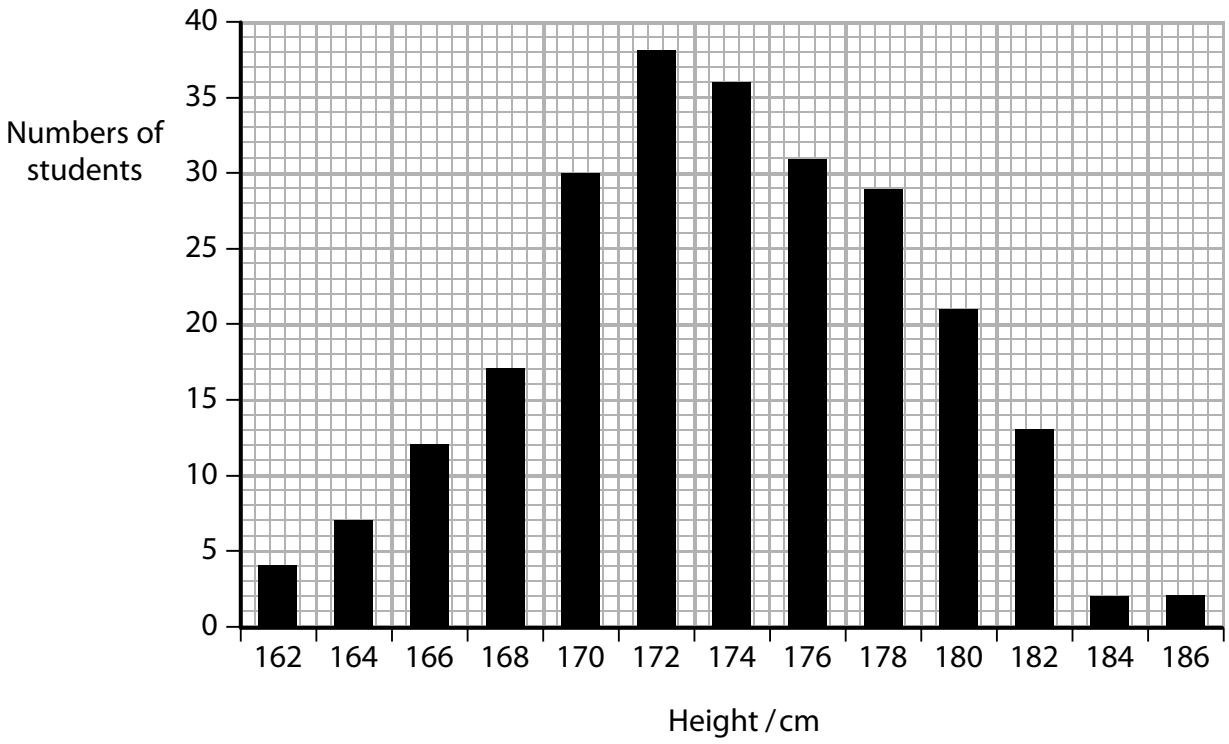
(2)

In polygenic inheritance, the phenotypes are affected by forms of genes called

..... found at many ..... on chromosomes.

(ii) The graph below shows some data on the numbers of students of different heights.

Height is an example of polygenic inheritance.



State the heights that represents the median and the mode for this group of students.

(2)

Median height ..... cm

Mode height ..... cm

(b) (i) Complete the following short passage by writing the most appropriate word or words on the dotted lines.

(2)

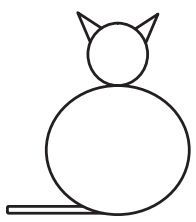
Animal fur colour is an example of a phenotype. The phenotype of an animal can be the result of an interaction between the ..... and the ..... .

(ii) The enzyme tyrosinase is involved in producing dark coloured fur in cats. Tyrosinase is active at the cat's body temperature.

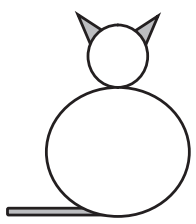
Some cats have a defective form of tyrosinase. The defective tyrosinase is inactive at normal body temperature, but becomes active in the cooler extremities of cats living in a cold environment.

The diagrams below show four cats with different fur colour distributions. Shaded areas represent dark coloured fur and non-shaded areas represent light coloured fur.

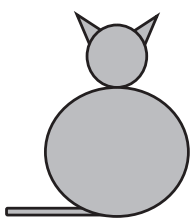
Cat A



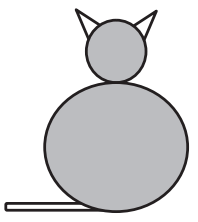
Cat B



Cat C



Cat D



Place a cross ☒ in the most appropriate box to select the diagram which represents:

(3)

a cat with normal tyrosinase	☒ A	☒ B	☒ C	☒ D
a cat with defective tyrosinase, in a hot country	☒ A	☒ B	☒ C	☒ D
a cat in a cold country with defective tyrosinase	☒ A	☒ B	☒ C	☒ D

(Total for Question 1 = 9 marks)

2 Stem cells are considered to be a potential treatment for many conditions. However, research on stem cells needs to be regulated.

*(a) Explain the meaning of the term **stem cell**.

(2)

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.....

(b) State **three** potential sources of human stem cells.

(3)

1 .....

2 .....

3 .....

(c) (i) Suggest **two** reasons why there are regulating authorities for human embryo research.

(2)

1 .....

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2 .....

.....

(ii) Suggest why these regulating authorities should include people involved in human embryo research and people not involved in embryo research.

(2)

People involved in embryo research .....

.....

.....

People not involved in embryo research .....

.....

.....

(Total for Question 2 = 9 marks)

3 In the 1990s, a scientist called Woese suggested a new way of grouping organisms into domains.

(a) The table below shows Woese's three domains and gives some of the characteristics of each domain.

Domain	Some characteristics of each domain
P	True nucleus absent Small (70S) ribosomes present Smooth endoplasmic reticulum absent RNA polymerase made up of 14 subunits
Q	True nucleus present Large (80S) ribosomes present Smooth endoplasmic reticulum present RNA polymerase made up of 14 subunits
R	True nucleus absent Small (70S) ribosomes present Smooth endoplasmic reticulum absent RNA polymerase made up of 4 subunits

(i) Place a cross ☒ in the box which shows the two domains which are most **distantly related**.

(1)

☒ **A** P and Q

☒ **B** P and R

☒ **C** Q and R

(ii) Place a cross ☒ in the box which shows the domain that represents eukaryotic organisms.

(1)

☒ **A** P

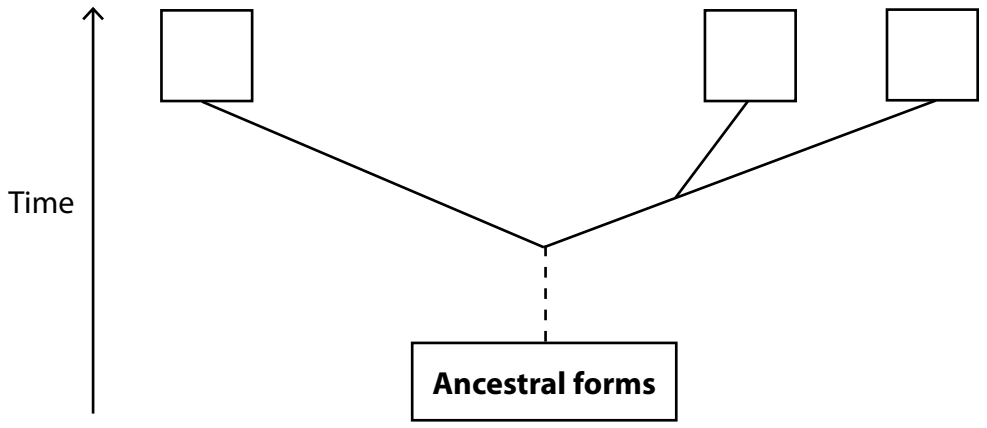
☒ **B** Q

☒ **C** R

(iii) The diagram below represents the phylogenetic tree for the three domains.

Place a cross (×) in the box on the diagram that correctly identifies the eukaryotic domain.

(1)



(iv) Give the name of **one** of the other two domains.

(1)

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(b) One domain includes the plants and these have cells with a cell wall.

*(i) Describe the structure of a plant cell wall.

(4)

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(ii) A student studied the cell wall arrangement between two adjacent plant cells. He noticed several features which he could not name. Two of these are described in the table below.

Complete the table by writing in the name of each feature described.

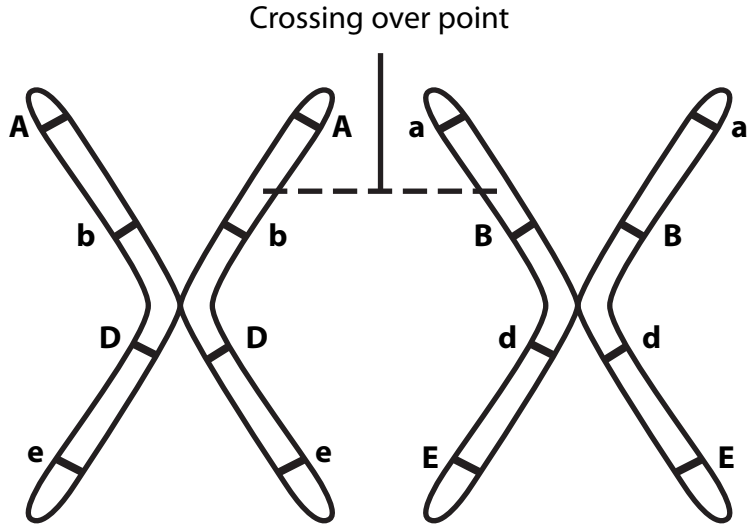
(2)

Feature described	Name of feature
Site where there was no cell wall and the cytoplasm linked the two adjacent cells	
Dark line that is the boundary between one cell and the next cell	

(Total for Question 3 = 10 marks)

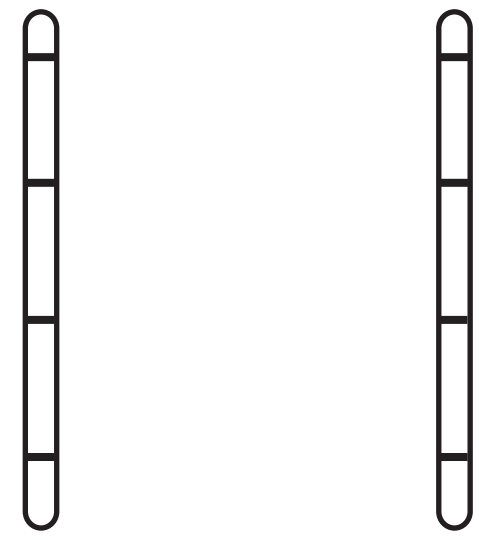
4 Meiosis leads to the production of gametes and is important in allowing genetic variation to occur.

(a) The diagram below shows one homologous pair of chromosomes during early meiosis.
Four genes (A, B, D and E) and the crossing over point have been labelled.



At the end of meiosis, four gametes will have been produced, each with a different combination of alleles.
Complete the diagram below to show the combination of alleles for the two recombinant chromosomes.

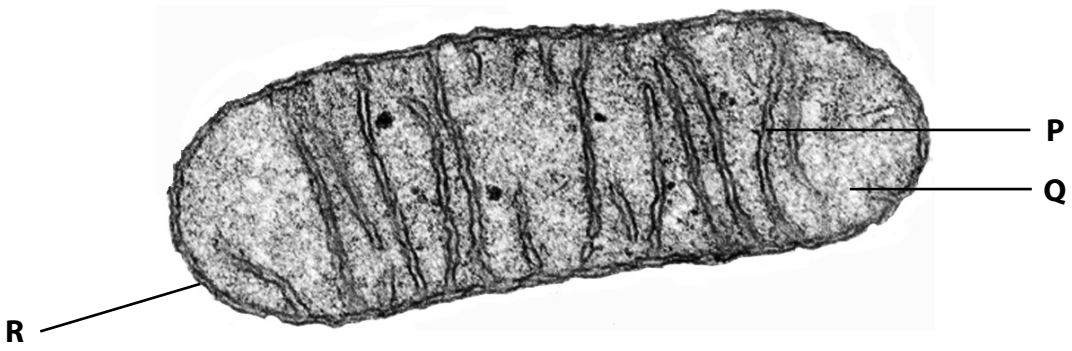
(1)



(b) Sperm cells are gametes. They contain mitochondria in their mid region.

(i) The photograph below shows a mitochondrion as seen using an electron microscope.

(3)



CNRI / Science Photo Library
Magnification x 90 000

Name the labelled structures shown in the photograph above.

P .....

Q .....

R .....

(ii) Explain the function of mitochondria in sperm cells.

(3)

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(c) In some species of mammal, at fertilisation most of the sperm cell enters the egg cell. The fertilised cell then divides by mitosis.

(i) A sperm cell containing 65 mitochondria fertilises an egg cell containing 100 000 mitochondria.
Calculate the percentage of the total mitochondria in this fertilised cell that come from the sperm cell. Show your working.

(2)

Answer ..... %

(ii) State how many cells there would be after the fertilised egg has divided, by mitosis, **four** times.

(1)

.....

(Total for Question 4 = 10 marks)

5 The rice plant is a type of grass and reproduces by producing grains.

Tom Myers / Agstockusa / Science Photo Library

(a) The rice grains are full of starch.

(i) Starch is a polymer of one monosaccharide.
Name this monosaccharide.

(1)

.....

*(ii) Describe **two** ways in which the structure of starch is related to its function.

(4)

Structure .....

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Function .....

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Structure .....

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Function .....

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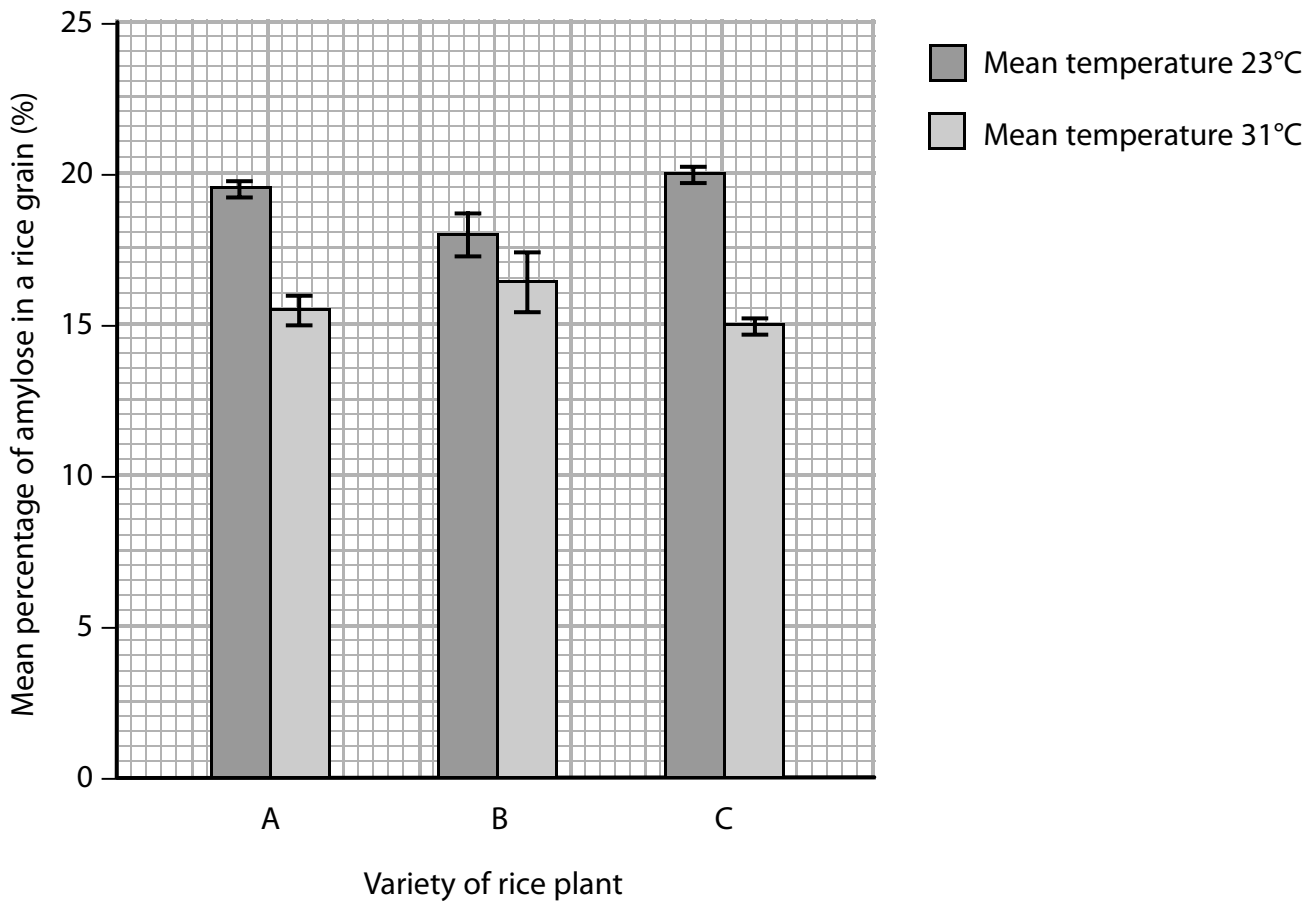
Turn over ▶

(b) Starch is made up of amylose and amylopectin. An investigation was undertaken to study the effect of temperature on amylose production in rice grains. Three different varieties of rice plant, A, B and C, were grown at a mean temperature of 23°C until they had produced mature rice grains. All other variables were kept constant.

Fifty rice grains were then collected from each variety and the mean percentage of amylose in a rice grain was determined.

This investigation was repeated at a mean temperature of 31°C.

The results are shown in the graph below.



(i) Describe the effect of temperature on the mean percentage of amylose in the rice grains of all three varieties of rice plant.

(2)

(ii) Using the information in the graph, suggest which set of data is least supportive of the statement that 'temperature has an effect on the percentage of amylose present in rice grains'. Explain your answer.

(3)

(Total for Question 5 = 10 marks)

6 Biodiversity, including both species richness and genetic diversity, is an important concept to be considered when organising captive breeding programmes.

(a) Explain what is meant by each of the following terms.

(3)

Niche .....

.....

.....

Species richness .....

.....

.....

.....

(b) One way to measure genetic diversity is to find the percentage of genes that have different alleles.

The table below shows the percentage of genes that have different alleles in four types of cat.

Type of cat	Percentage of genes with different alleles (%)
Cheetah	4
Domestic cat	23
Lion	12
Ocelot	21

*(i) Using the information in the table above and your own knowledge, suggest why the cheetah is the cat at most risk if the environment changes.

(3)

Turn over ▶

(ii) Cheetahs are unusual amongst the big cats.

Cheetah and cub

Dr P. Marazzi / Science Photo Library

A female cheetah often mates with several different males and gives birth to two or three cubs at a time, each having a different father.

Suggest why this may be advantageous to cheetahs.

(2)

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(c) Rafa was a male cheetah involved in breeding programmes in several zoos.
The table below shows some data from Rafa's studbook.

Name of zoo housing Rafa	Event	Date of event
WINSTON	Birth of Rafa	24 Dec 1974
SD-WAP	Transfer	26 Nov 1980
LAGUNA HI	Transfer	9 Apr 1982
SD-WAP	Transfer	5 Dec 1984
BATON ROUGE	Transfer	11 Feb 1986

Suggest what effect transferring Rafa from one zoo to another had on genetic diversity in this species.

(2)

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(d) Place a cross ☒ in the box to the right of the statement that correctly describes an endemic animal.

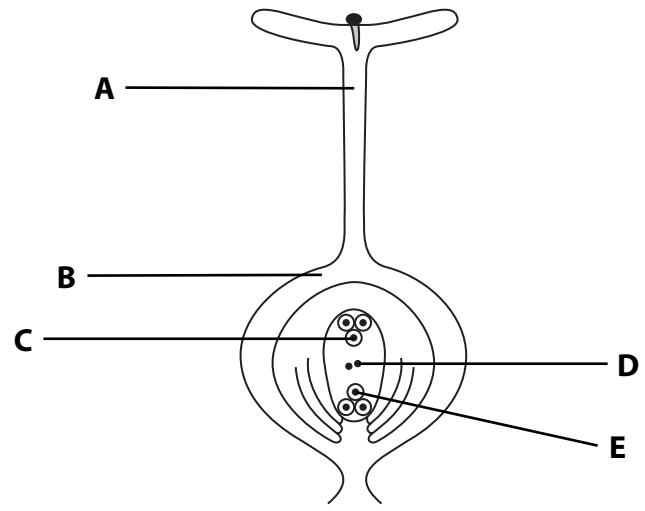
(1)

Statement	
Ducks that migrate from one continent to another	☒
House fly that is found in all continents except Antarctica	☒
Cheetahs that are exclusive to one continent	☒

(Total for Question 6 = 11 marks)

7 Pollen germination and pollen tube growth are important stages in plant sexual reproduction.

(a) The diagram below shows a pollen grain on the stigma of a flower.



(i) On the diagram above, draw a line to show the route taken by the pollen tube, from the pollen grain to the micropyle.

(2)

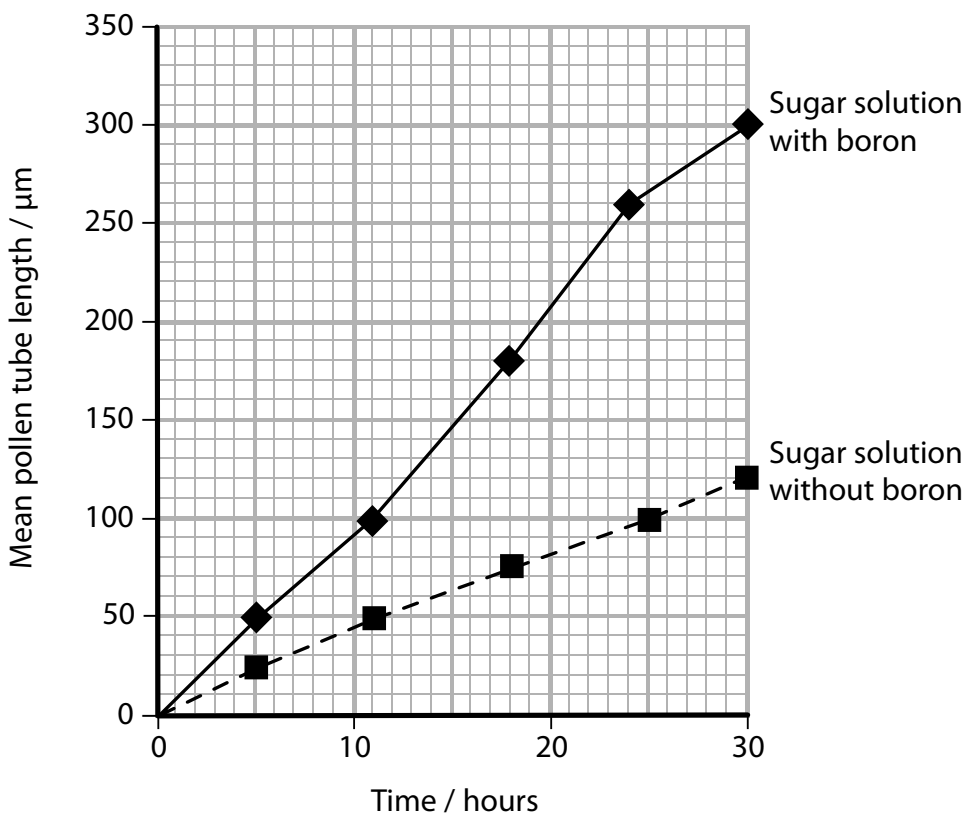
(ii) The table below shows the structures labelled on the diagram. Place a tick (✓) in the box next to each one in which the chromosome number increases at fertilisation.

(2)

Labelled structure	Tick (✓) if chromosome number increases at fertilisation
A	
B	
C	
D	
E	

(b) An investigation was undertaken to study the effect of the element boron on the growth of pollen tubes.
A large number of pollen grains was placed in a dilute sugar solution. Every six hours, for 30 hours, 500 pollen grains were removed and the length of the pollen tube of each was measured. The mean length of the pollen tubes was then calculated.
This was repeated with boron added to the dilute sugar solution.

The results are shown in the graph below.



(i) Using the information in the graph, compare the mean pollen tube length in these two sugar solutions, over this 30-hour period.

(3)

(ii) Using the result of this investigation, a student concluded that boron was necessary for pollen tube growth.
Suggest why another student disagreed with this conclusion.

(1)

(iii) Using the information in the graph, suggest an appropriate conclusion for the effect of boron on the rate of growth of pollen tubes.

(1)

(iv) Suggest the advantages to flowering plants of increased pollen tube growth.

(2)

(Total for Question 7 = 11 marks)

Turn over ▶

8 Plants usually take up nitrogen as nitrate ions for use in growth.

(a) An investigation was undertaken to study the effect of nitrate ion concentration on mitosis in the root tip of wheat seedlings.

Wheat seedlings were grown in a mineral solution containing a nitrate ion concentration of 3.3 mmol dm^{-3}. Root tip samples were taken and the number of cells undergoing mitosis per 500 cells was counted.
This was repeated using a nitrate ion concentration of 6.6 mmol dm^{-3}.
The results are shown in the table below.

Nitrate ion concentration / mmol dm^{-3}	Number of cells undergoing mitosis per 500 cells
3.3	25
6.6	19

(i) Using the information in the table, describe the effect of nitrate ion concentration on mitosis in root tips.

(2)

(ii) Suggest why a prediction of the number of cells undergoing mitosis, if the nitrate ion concentration used were 9.9 mmol dm^{-3}, would be unreliable.

(2)

(iii) To count the number of cells undergoing mitosis, a root tip squash was carried out.

Give **two** potential safety risks associated with the root tip squash technique. For one of the risks you have given, suggest a precaution to reduce the risk.

(3)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(b) Describe an experiment to find the optimum nitrate ion concentration for the growth of wheat seedling roots.

(3)

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(Total for Question 8 = 10 marks)

TOTAL FOR PAPER = 80 MARKS

mock papers 6

1 A white blood cell is an example of a typical eukaryotic animal cell.

(a) Place a cross ☒ in the box next to the correct word or words to complete each of the following statements.

(i) In eukaryotic cells, two organelles with a double membrane are

(1)

☒ **A** the nucleus and smooth endoplasmic reticulum

☒ **B** a nucleus and a mitochondrion

☒ **C** a mitochondrion and a ribosome

☒ **D** a mitochondrion and smooth endoplasmic reticulum

(ii) White blood cells, plant cells and prokaryotic cells all contain

(1)

☒ **A** a nucleus

☒ **B** Golgi apparatus

☒ **C** ribosomes

☒ **D** smooth endoplasmic reticulum

(iii) A structure present in prokaryotic cells but not present in a white blood cell is

(1)

☒ **A** a cell wall

☒ **B** a centriole

☒ **C** a ribosome

☒ **D** rough endoplasmic reticulum

(b) There are several types of stem cell found in humans.

The table below shows some features of two types of stem cell. If the feature applies to the stem cell place a tick (✓) in the box and if it does not apply, place a cross (✗) in the box.

(2)

Features	Totipotent stem cell	Pluripotent stem cell
Can give rise to totipotent stem cells		
Can give rise to differentiated cells		

*(c) Human bone marrow contains stem cells that can give rise to various types of blood cell including white blood cells.
Suggest how a stem cell in the bone marrow can become a differentiated blood cell.

(4)

(Total for Question 1 = 9 marks)

2 Many drugs used in medicine are developed from plants. These drugs have to be tested before they are used.

(a) In 1775, William Withering published details of testing digitalis soup on patients with dropsy.
Compare this historic drug testing with contemporary drug testing protocols.

Give **one** similarity and **two** differences, other than the use of a **placebo**, between these two protocols.

(3)

Similarity .....

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Difference 1 .....

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Difference 2 .....

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.....

(b) One of the stages in a drug trial may use a placebo.
In a drug trial, people with schizophrenia were given one of four treatments.
The table below shows the recorded improvement in people with schizophrenia for each of the four treatments.

Treatment	Concentration of drug / mg	Recorded improvement / arbitrary units
1 (placebo)		18.8
2	400	24.8
3	600	30.9
4	800	31.3

(i) Complete the table to give the concentration of the drug in treatment 1 (placebo).

(1)

(ii) Suggest why there was a recorded improvement when the placebo was used.

(1)

(iii) To calculate the actual improvement due to the drug, the effect of the placebo must be considered. This can be done by subtracting the recorded improvement for treatment 1 from each of the other treatments.

Complete the table below by filling in the actual improvements for treatments 2, 3 and 4.

(1)

Treatment	Concentration of drug / mg	Actual improvement / arbitrary units
2	400	
3	600	
4	800	

(iv) Use the information in this table to describe the relationship between the concentration of the drug used and the actual improvement in people with schizophrenia.

(2)

(Total for Question 2 = 8 marks)

3 There are now over 1400 seedbanks in the world and they store plant seeds to maintain genetic diversity. Plant seeds are carefully selected and processed so they can be stored for years in a seedbank.

(a) Give **two** differences between genetic diversity and species richness.

(2)

1 .....

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2 .....

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(b) (i) Suggest **two** reasons why it is better to store seeds rather than to store whole plants.

(2)

1 .....

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2 .....

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(ii) Suggest why it is better to store seeds from several individual plants of one species rather than seeds from one individual plant.

(2)

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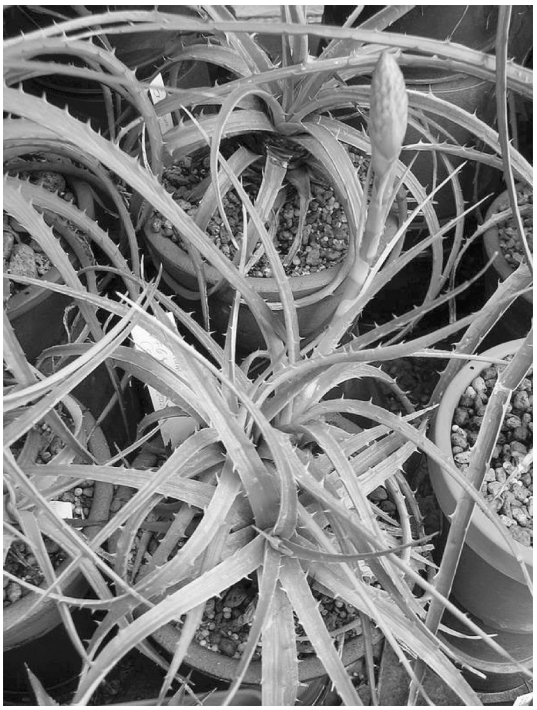
QUESTION 3 CONTINUES ON THE NEXT PAGE

(c) Seeds that are selected for storage are usually dried to remove most of the water before they are placed in a seedbank.

An investigation was carried out to study the effect of drying on the germination success of seeds from *Encholirium* plants, shown in the photograph below.



Magnification ×0.2

One hundred seeds were collected from each of four species of *Encholirium*. The seeds from each species were separated into two groups, each containing 50 seeds.

One group of 50 seeds was planted immediately after collection. The other group of 50 seeds was dried after collection and then planted. Germination success was measured as the number of seeds that germinated out of the 50 seeds planted.

This was repeated several times and the mean germination success was calculated. The results are shown in the table below.

***Encholirium* species**	**Mean germination success for 50 seeds**	
	Planted immediately	**Planted after drying**
A	48	45
B	40	23
C	45	45
D	48	37

(i) Use the data in the table to calculate, for *Encholirium* species A, the percentage decrease in mean germination success for dried seeds compared with seeds planted immediately. Show your working.

(2)

Answer ..... %

(ii) Using the data in the table, suggest which of the four species is **least** likely to survive storage in a seedbank. Give reasons for your answer.

(3)

(iii) Suggest how seeds from these *Encholirium* species may need to be treated to ensure their long term survival in a seedbank.

(2)

(Total for Question 3 = 13 marks)

4 Meiosis is involved in the formation of human gametes.

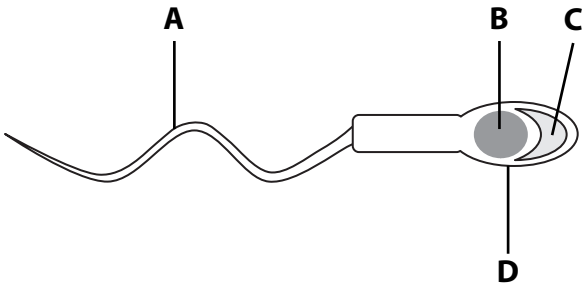
(a) Explain the importance of meiosis in the formation of human sperm and egg cells.

(3)

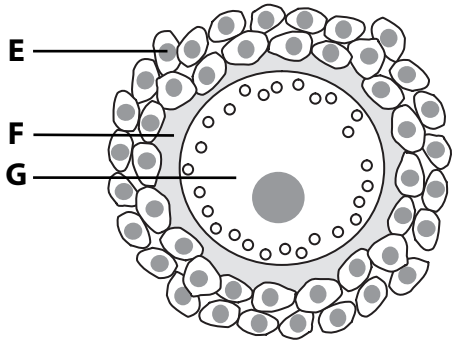
(b) Sperm cells release acrosin, an enzyme found in the acrosome. This enzyme is involved in digesting the zona pellucida (jelly layer) during fertilisation.

The diagrams below show a human sperm cell and a human egg.

Human sperm cell



Human egg



(i) The table below describes four sites.
Place a cross ☒ in the box below the letter that correctly links the statement to one of the labels on the diagrams above.

(4)

Statement	A	B	C	D	E	F	G
Site containing acrosin	☒	☒	☒	☒	☒	☒	☒
Site where acrosin works	☒	☒	☒	☒	☒	☒	☒
Site containing the haploid number of chromosomes	☒	☒	☒	☒	☒	☒	☒
Site containing mitochondria	☒	☒	☒	☒	☒	☒	☒

(ii) Describe how the acrosin is released from the acrosome.

(2)

(c) An investigation was carried out to study the effect of acrosin activity on fertilisation success. Sperm cells with different levels of acrosin activity were mixed with human eggs in a glass container. The number of eggs fertilised was then counted and the percentage of eggs fertilised was calculated.

The results are shown in the table below.

Acrosin activity / arbitrary units	Percentage of eggs fertilised (%)
2.5	33
3.0	66
4.0	85
5.0	100

(i) A student stated that acrosin needs to be active for the eggs to be fertilised and that the higher the acrosin activity, the greater the percentage of eggs fertilised.

Give **one** piece of evidence from the table that supports some of his statement.

(1)

(ii) Using the data in the table, suggest why the student could **not** support all of his statement.

(1)

Total for Question 4 = 11 marks

5 Plants are multicellular organisms that contain organic molecules such as starch and cellulose.

(a) Multicellular organisms contain organs and tissues.
Suggest why organs are considered more complex than tissues.

(2)

*(b) (i) Compare the structure of a cellulose molecule with the structure of starch.

(4)

(ii) Cellulose molecules form cellulose microfibrils.
Explain how the arrangement of cellulose microfibrils contributes to the physical properties of plant fibres.

(2)

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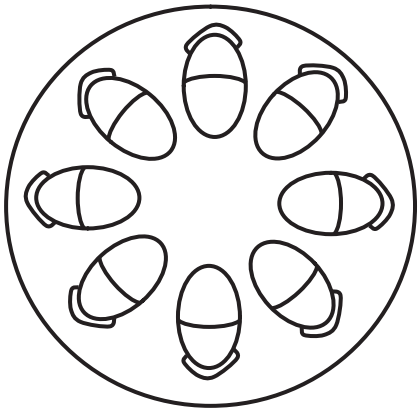
(c) (i) The diagram below shows a transverse section through a stem.

On the diagram, put a label **X** to indicate where xylem vessels are present.

(1)



(ii) Give **two** functions of xylem vessels.

(2)

1 .....

2 .....

(Total for Question 5 = 11 marks)

6 Mitosis is part of the cell cycle.

(a) Give **two** roles of the cell cycle.

(2)

1 .....

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2 .....

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(b) For each of the statements about mitosis below, place a cross ☒ in the box that identifies the correct word or words.

(i) The following disappear during prophase in an animal cell

(1)

☒ **A** nucleus and centrioles

☒ **B** nucleus and nucleolus

☒ **C** nucleolus and mitochondria

☒ **D** nucleus and ribosomes

(ii) The following are formed during prophase in an animal cell

(1)

☒ **A** DNA

☒ **B** Golgi apparatus

☒ **C** mitochondria

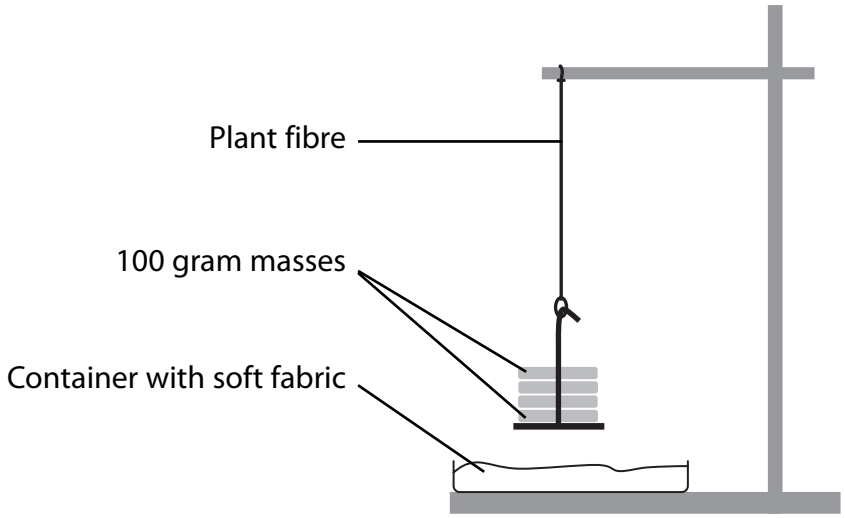
☒ **D** spindle fibres

(c) A student prepared a root tip squash to observe the stages in mitosis.
Describe how the student could distinguish between a cell in metaphase and a cell in anaphase.

(3)

(Total for Question 6 = 7 marks)

7 The diagram below shows a technique used by a student to investigate the mass needed to break dry plant fibres. In this investigation, 100 gram masses were added until the fibre broke.



(a) The student carried out the investigation four times to achieve reliable results.

(i) Suggest **three** factors that would need to be kept constant in this investigation.

(3)

1 .....

2 .....

3 .....

(ii) Describe how the results obtained would be processed to produce a mean.

(2)

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(b) Suggest why increasing the mass by 50 grams each time, rather than 100 grams, could increase the accuracy of the student's results.

(1)

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(c) The diagram shows a container with soft fabric in it. Suggest the safety role of this container.

(1)

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(d) This student also investigated the mass required to break four samples of an oil-based plastic fibre.

The table below shows the data the student collected for the plastic fibre.

Sample	Mass required to break the plastic fibre / g
1	13 300
2	2 300
3	13 600
4	13 600
Mean	13 500

(i) The student calculated the mean using only three of the results from the table.
Explain why the mean for the plastic fibre was calculated using only these three results.

(1)

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(ii) Suggest why the use of oil-based plastic fibres such as nylon, rather than plant fibres, does not contribute to sustainability.

(2)

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(Total for Question 7 = 10 marks)

8 Various internal and external factors can affect the phenotype of humans.

(a) Explain what is meant by the term **phenotype**.

(2)

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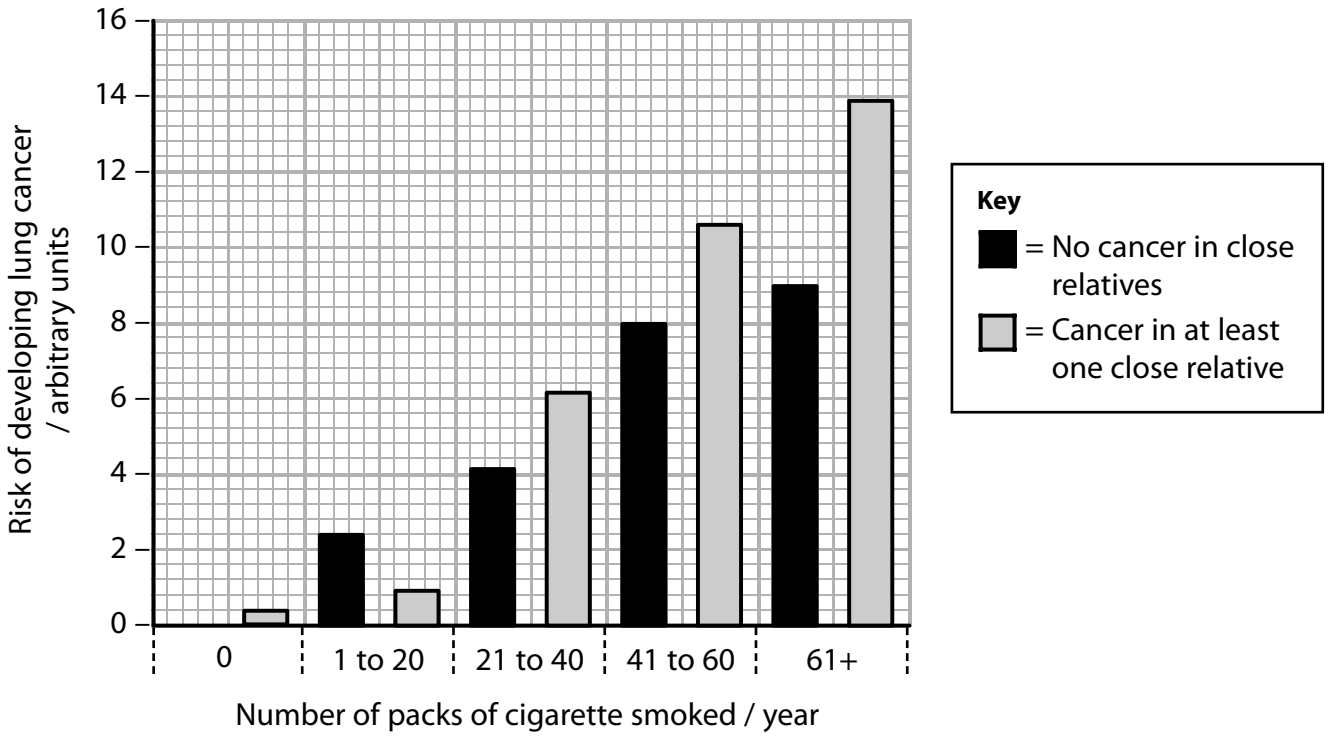
(b) A survey was carried out to investigate the factors affecting the risk of developing lung cancer. In this survey, people were asked how many packs of cigarettes they smoked per year. They were also asked whether a close relative (a brother, sister or parent) had developed some form of cancer.

The results of the survey are shown in the graph below.
A risk of developing lung cancer of 0 arbitrary units means that there is no increased risk.



(i) Identify the control group in this survey and suggest why they were included.

(2)

(ii) State the phenotype being investigated.

(1)

(iii) Describe the effect of smoking on the increased risk of developing lung cancer, for the people who had close relatives who developed cancer.

(2)

(iv) Use evidence from the graph to support the suggestion that genetic factors may influence the risk of developing lung cancer.

(2)

(v) Give **one** piece of evidence from the graph which suggests that genetic factors may **not** influence the risk of developing lung cancer.

(1)

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(vi) Give **one** piece of evidence from the graph which suggests that external factors may influence the risk of developing lung cancer.

(1)

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(Total for Question 8 = 11 marks)

TOTAL FOR PAPER = 80 MARKS