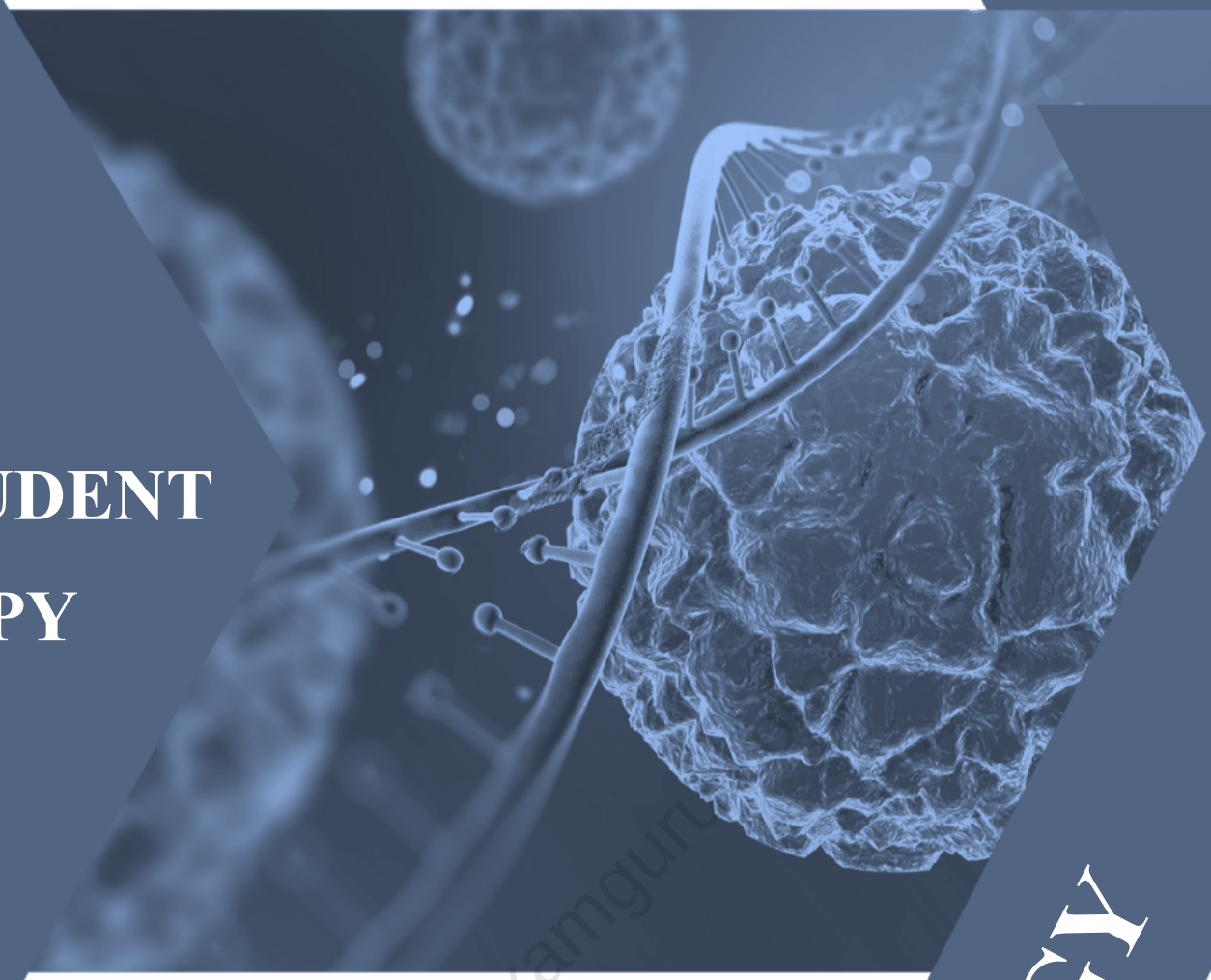

STUDENT COPY

HEADS-UP
REACH FOR THE STARS

IGCSE BIOLOGY

TOPICAL PRACTICE QUESTIONS

PAPER 4

VOL. 5

2020 EDITION

CHAPTERS 17-18

Chapter 17: Inheritance

1 Fig. 4.1 is an electron micrograph of some red blood cells and lymphocytes.

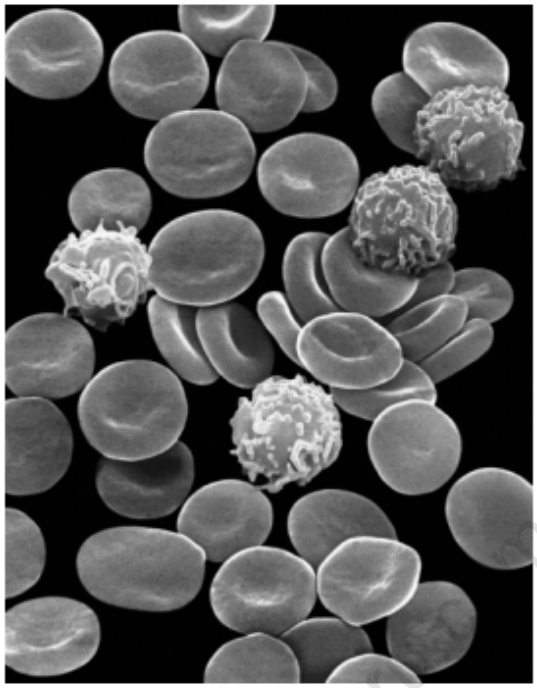

Fig. 4.1

(a) Lymphocytes respond to infection by making and releasing special protein molecules called antibodies.

Describe how antibodies provide protection from diseases caused by viruses and bacteria.

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..... [3]

Red blood cells have special molecules on their cell membranes. These are known as antigens and they stimulate the production of antibodies. These antigens also determine a person's blood group.

Before carrying out kidney transplants, it is important to check that the blood group of the donor matches the blood group of the recipient. This is called blood typing. It is necessary because blood group antigens are present on the inner lining of blood vessels in the kidney.

(b) Explain what would happen if a kidney from a person with blood group A was transferred into the body of a person with blood group O.

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..... [2]

Tissue typing is carried out before transplanting a kidney. This makes sure that there is a close match between the donated kidney and the recipient. However, it is possible to carry out transplants of the cornea without blood typing or tissue typing.

(c) Suggest why it is possible to transplant corneas successfully without carrying out any tissue typing or blood typing.

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..... [1]

The gene for the ABO blood group has three alleles, I^A, I^B and I^o.

(d) A person with blood group O has parents who have blood groups A and B. Complete the genetic diagram to show how this is possible.

Use the symbols, I^A, I^B and I^o, for the blood group alleles.

parental phenotypes	blood group A	×	blood group B
parental genotypes	.....	×	.....
gametes	....	+	....

offspring genotype .....

offspring phenotype blood group O

[3]

(e) Use your answer to **(d)** to give examples of the following. The first one has been completed for you.

term	example
a dominant allele	I^A
heterozygous genotype	.....
codominant alleles	.....
phenotype	.....

[3]

[Total: 12]

2 Haemoglobin is a protein that is made inside developing red blood cells in the bone marrow.

(a) (i) State the function of haemoglobin.

.....

[1]

(ii) Name the small molecules that are combined to make haemoglobin.

.....

[1]

(iii) Name the mineral ion provided in the diet that is needed to make haemoglobin.

.....

[1]

There are many different varieties of haemoglobin. The gene for haemoglobin exists as two alleles, Hb^A and Hb^S.

People with the genotype Hb^SHb^S have a condition called sickle cell anaemia.

(b) Describe the features of sickle cell anaemia.

.....

.....

.....

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.....

[3]

(c) The allele for Hb^S is rare in many parts of the world, but it is more common in parts of tropical Africa.

Explain why Hb^S is more common in parts of tropical Africa.

.....

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.....

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.....

[3]

(d) The parents of people with sickle cell anaemia rarely have this condition.

Explain, using a genetic diagram, how two parents who do not have sickle cell anaemia may have a child with the condition.

.....

.....

.....

parental genotypes ..... × .....

gametes .... + ...

genotype of child with sickle cell anaemia .....

[3]

(e) Sickle cell anaemia is an example of variation in humans. There are many causes of variation, including nuclear fall-out.

Suggest how nuclear fall-out could cause variation in humans.

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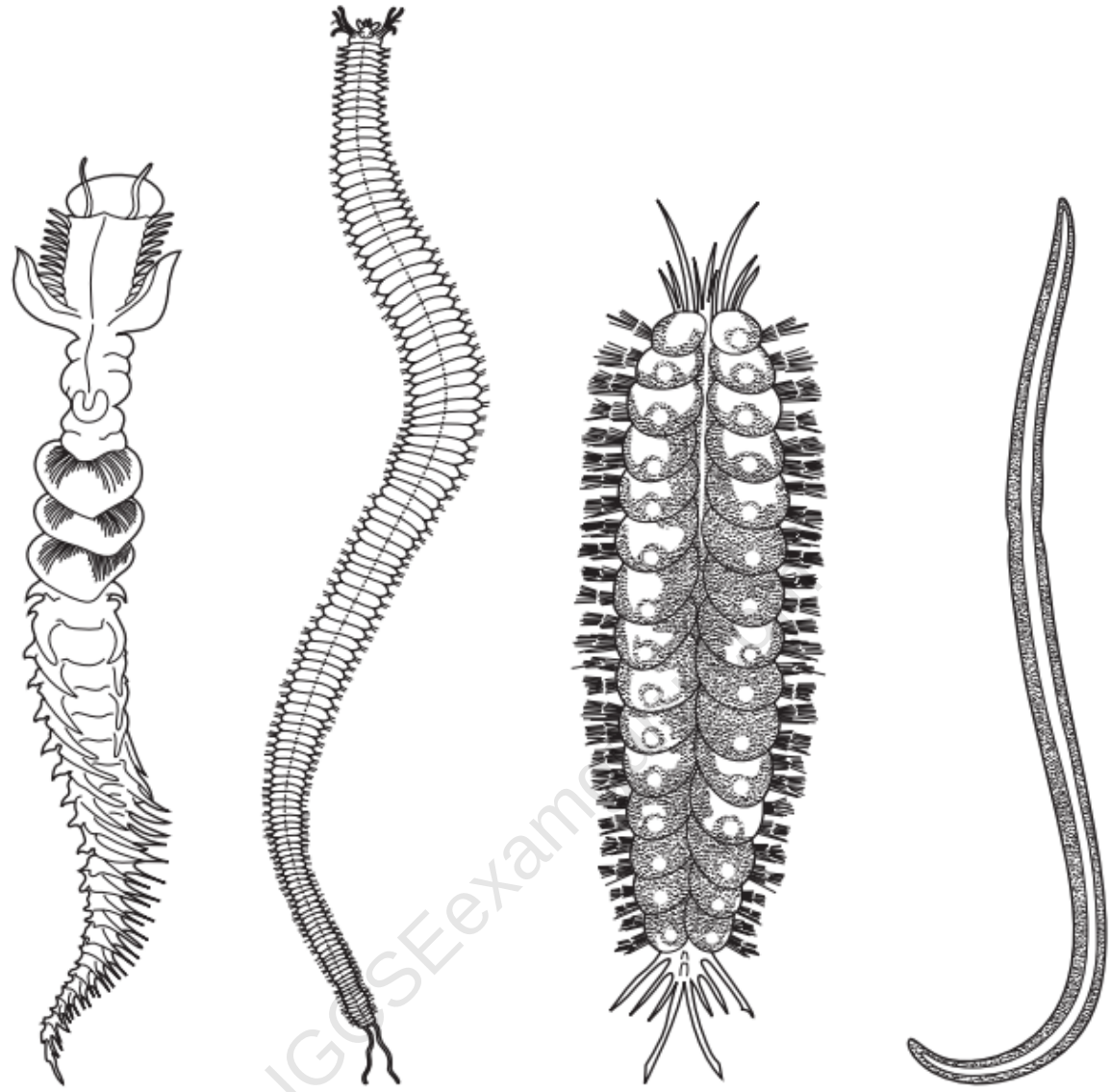
..... [2]

[Total: 14]

3 Fig. 1.1 shows three annelid species and *Ascaris lumbricoides*, a species of nematode.



not drawn to scale

Fig. 1.1

(a) State **three** features shown by the three annelid species that are **not** shown by the nematode species.

1 .....

2 .....

3 ..... [3]

(b) Organisms are given two names, e.g. *Nereis diversicolor*.

State what is meant by the first name.

..... [1]

(c) *N. diversicolor* is a filter feeder. It filters plankton from sea water.

Annelids like *N. diversicolor* form an important part of the ecosystems of estuaries.

Fish feed on annelids when the sea covers the mud in the estuary.

When the tide is out wading birds are the main predators of annelids.

Birds of prey are the main predators of the wading birds.

(i) Explain the term *ecosystem*.

.....

.....

.....

..... [3]

(ii) Use the space below to draw a food chain for the estuary ecosystem **when the tide is out**.

[2]

(iii) Describe the advantages of drawing a food web rather than a food chain for an ecosystem.

.....

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.....

..... [2]

(d) The palolo worm is a species of annelid that lives on coral reefs in the Pacific Ocean.

At certain times of the year, all the worms in an area leave their burrows to swim to the surface.
They all release their gametes into the water at the same time.
This is known as mass spawning.

Suggest the advantages of having mass spawning occurring only at certain times of the year and not all year round.

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..... [3]

(e) Meiosis is involved in producing gametes in palolo worms.

Describe how meiosis differs from mitosis **and** explain why meiosis is important for the production of gametes.

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..... [4]

[Total: 18]

4 **(a)** Sickle cell anaemia is a genetic disorder that is found among people in certain parts of the world.

A sample of blood was taken from a person with sickle cell anaemia and examined with an electron microscope.

Fig. 4.1 shows some of the red blood cells in the sample.

Fig. 4.1

Explain the problems that may occur as these cells circulate in the blood system.

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..... [4]

(b) The gene for haemoglobin exists in two alternative forms:

H^A codes for the normal form of haemoglobin;
H^S codes for the abnormal form of haemoglobin.

(i) State the name for the alternative forms of a gene.

..... [1]

(ii) A child has sickle cell anaemia. The parents do not have this disorder.

Complete the genetic diagram to show how the child inherited the disorder.

Use the symbols H^A and H^S in your answer.

parental phenotypes	normal	×	normal
parental genotypes	H^AH^S	×	H^AH^S
gametes	○ ○	+	○ ○
child's genotype	.....		
child's phenotype	sickle cell anaemia		

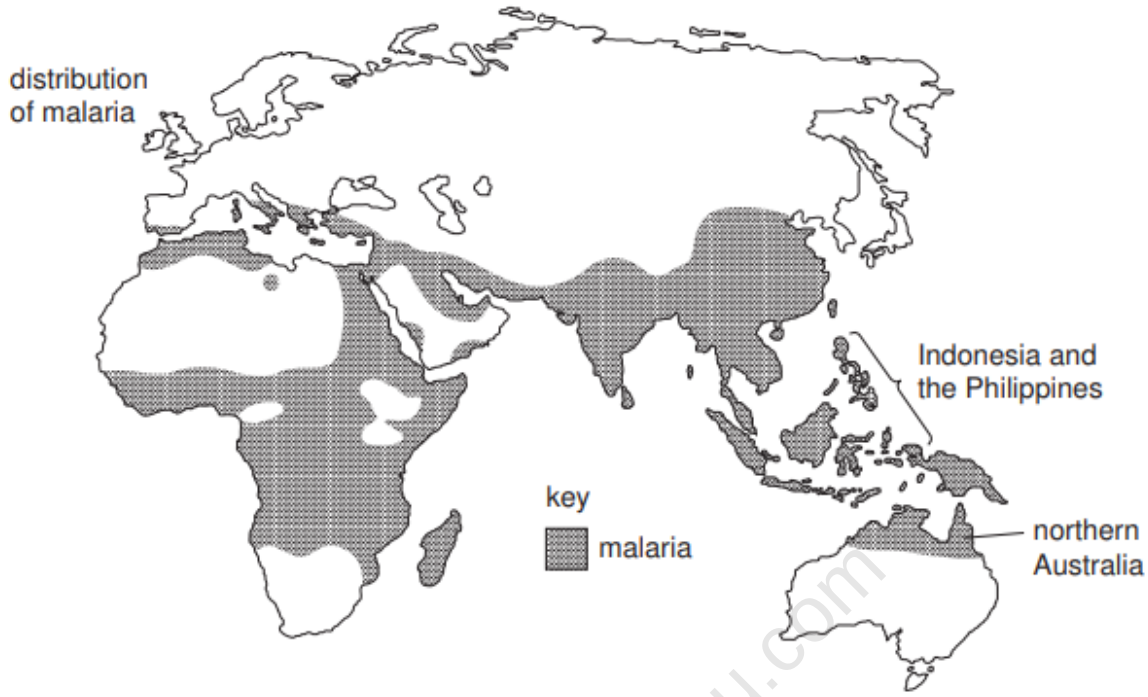
[2]

(iii) The parents are about to have another child.

What is the probability that this child will have sickle cell anaemia?

..... [1]

(c) The maps in Fig. 4.2 show the distribution of sickle cell anaemia and malaria in some parts of the world.



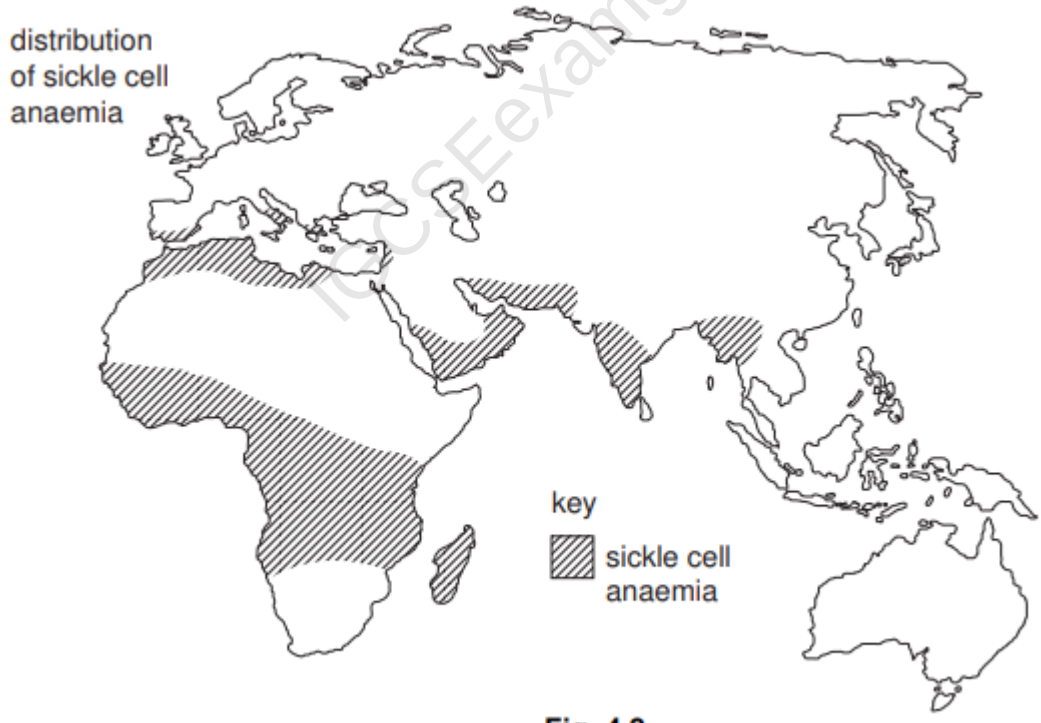


Fig. 4.2

(i) Explain why sickle cell anaemia is common in people who live in areas where malaria occurs.

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.....

..... [4]

(ii) Suggest why sickle cell anaemia is very rare among people who live in Indonesia and northern Australia.

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..... [2]

[Total: 14]

5 **(a)** The production of human gametes involves the type of nuclear division known as meiosis.

State **two** reasons why meiosis is suitable for gamete production.

1 .....

.....

2 .....

..... [2]

(b) The sex of a human fetus is determined by the sex chromosomes, X and Y.

Fig. 5.1 shows the determination of sex in four different examples.

Examples **3** and **4** show sex determination in twins.

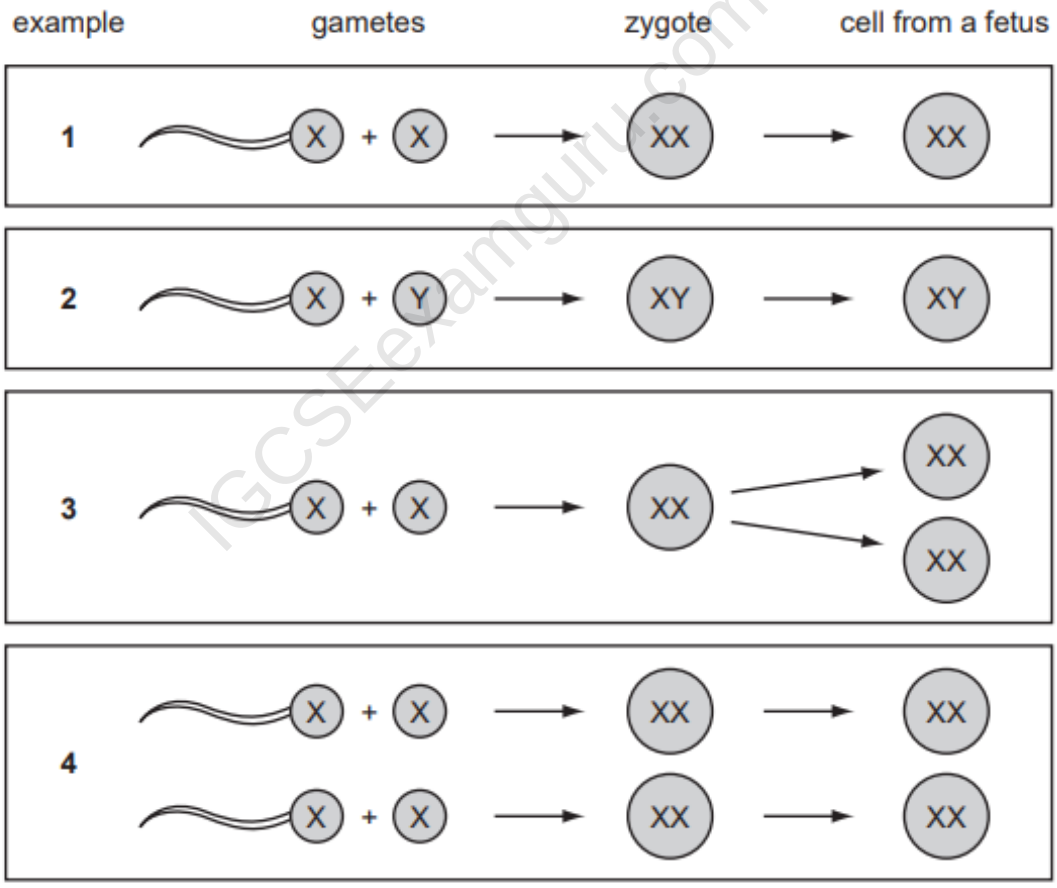

Fig. 5.1

(i) Use 5.1 to explain how the sex of a fetus is determined.

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..... [2]

(ii) Examples **3** and **4** show two ways in which twins are formed.

The twins in example **3** are identical.

Use Fig. 5.1 to explain why.

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.....

.....

..... [2]

(c) During the development of a fetus, different genes are expressed at different times.

Explain what is meant by the term *development*.

.....

.....

.....

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..... [2]

(d) One of the genes that controls the ability of blood to clot is found **only** on the X chromosome.

X^H represents an X chromosome with the dominant allele for normal blood clotting.

X^h represents an X chromosome with the recessive allele which causes the blood to clot slowly.

The Y chromosome is small and does not have the gene for blood clotting.

Here is a list of four genotypes.

X^HX^H, X^HX^h, X^HY, X^hY

Choose the genotype from the list that matches each of the following:

- gives a phenotype of long clotting time; .....
- is heterozygous; .....
- is homozygous. ..... [3]

(e) Haemophilia is a rare genetic condition in which the blood clots very slowly.

In the USA, haemophilia affects 1 in 5000 male births each year. In some cases these births occur in families where the condition has not occurred before.

Explain how boys can have haemophilia when the condition has not previously existed in their family.

.....

.....

.....

.....

..... [2]

[Total: 13]

6 Dairy cattle are kept for milk production. Approximately half of all the calves born are male.

(a) Sex is determined in cattle in exactly the same way as it is in humans.

Explain why 50% of all cattle are born male.

You may draw a genetic diagram to help your explanation.

.....

.....

.....

.....

.....[4]

(b) Dairy farmers only need a very small number of male calves. They limit the number by using sex selection. Sperm cells are identified and sorted before they are used in artificial insemination (AI).

Explain how artificial insemination is carried out.

.....

.....

.....

.....

.....[2]

(c) Table 2.1 shows the composition of 100 g of cow's milk compared with the same quantities of commercial formula milk and human milk.

Table 2.1

nutrient	cow's milk	formula milk	human milk
carbohydrate/g	6.5	7.3	7.5
protein/g	3.3	1.3	1.3 – 1.6
fat/g	3.9	3.6	4.1
calcium/mg	120	42	34
iron/mg	0.02	0.64	0.07
vitamin D/µg	0.05	1.20	0.06
vitamin A/µg	19	66	58

Some women do not breast-feed their babies but bottle-feed them using formula milk. Health authorities advise against the use of cow's milk until babies are about 9 months old.

Use the information in Table 2.1 to explain the advantages of using formula milk rather than cow's milk.

.....

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.....[4]

One of the components of human milk is the enzyme lysozyme that is present in many body fluids and is responsible for breaking down the cell walls of bacteria.

(d) Define the term *enzyme*.

.....

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.....[2]

(e) The effect of human lysozyme on two common species of bacteria, **A** and **B**, was investigated at two different values of pH.

The investigation was set up as shown in Fig. 2.1.

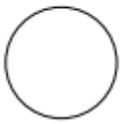
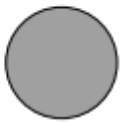
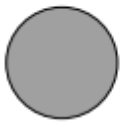
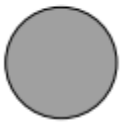
The test-tubes were kept at 37 °C for 24 hours.

tube number	1	2	3	4
species of bacteria	A	A	A	B
pH of medium	4.0	4.0	9.0	4.0
fresh lysozyme	✓		✓	✓
boiled lysozyme		✓		

Fig. 2.1

After 24 hours, samples were taken from each test-tube. Each sample was placed onto nutrient agar in Petri dishes. The dishes were incubated at 28 °C for a further 24 hours to allow any bacteria to grow.

The results are shown in Fig. 2.2.

sample from test-tube	1	2	3	4
result after incubation for 24 hours				

Key:

 no growth of bacteria

 growth of bacteria

Fig. 2.2

Explain the results shown in Fig. 2.2 by comparing the following pairs:

1 and **3** .....

.....

.....

.....[2]

1 and **4** .....

.....

.....

.....[2]

1 and **2** .....

.....

.....

.....[2]

(f) Human milk also contains antibodies. Explain the benefits of antibodies to a newborn child.

.....

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.....

.....[2]

[Total: 20]

7 Fig. 5.1 shows the nematode, *Caenorhabditis elegans*.

Fig. 5.1

(a) (i) State the genus of this nematode.

.....[1]

(ii) State two **structural** features of nematodes.

1 .....

2 .....

[2]

(b) Nematodes feed on dead and decaying material. Explain why this gives nematodes an important role in ecosystems.

.....

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.....

.....[3]

(c) Fig. 5.2 shows the life cycle of *C. elegans*. The diploid number of this species is 12.

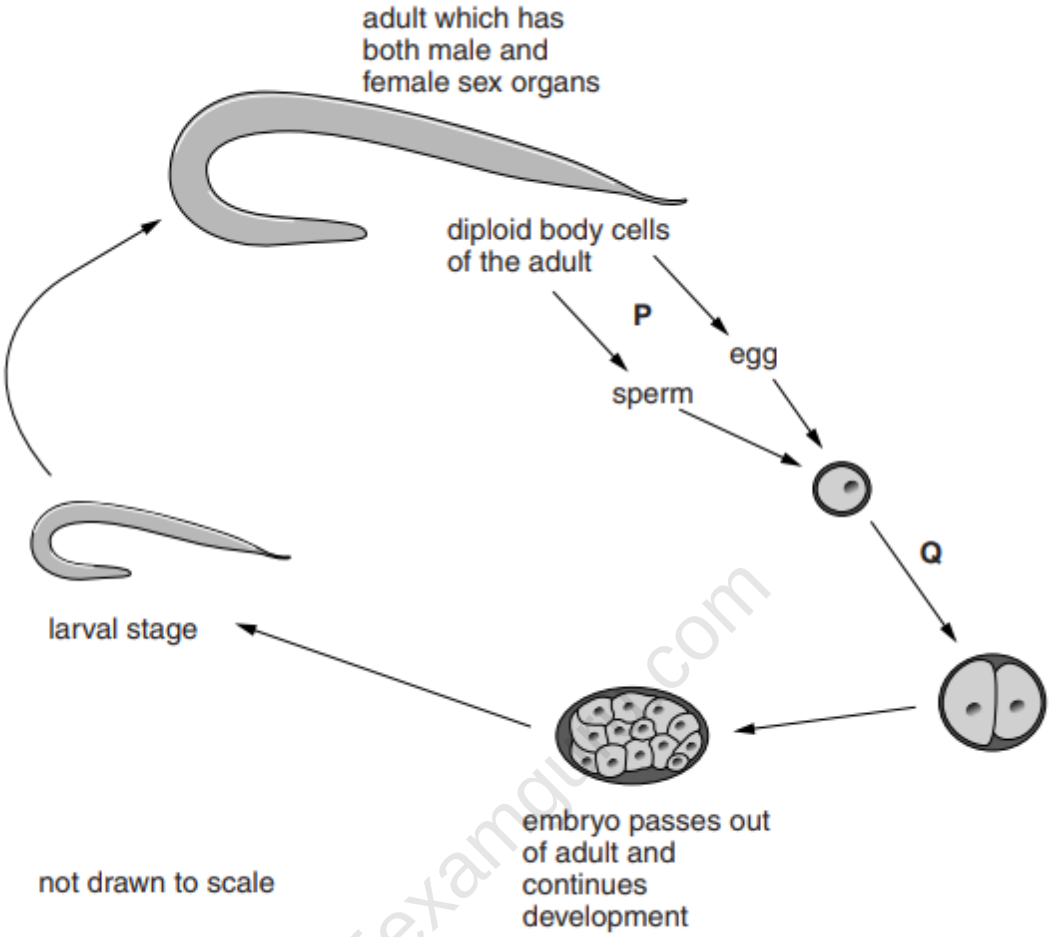

Fig. 5.2

(i) Suggest why there is very little genetic variation in the offspring of the adult nematode shown in Fig. 5.2.

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.....

.....[2]

(ii) State the haploid number of *C. elegans*.

.....[1]

(iii) Explain why **meiosis** occurs at **P** and **mitosis** occurs at **Q**.

meiosis at **P**.....

.....

.....

.....

mitosis at **Q** .....

.....

.....

.....[3]

(d) *C. elegans* was one of the first organisms to have its genome sequenced.

An organism's genome is the sum of all its genetic material. Gene sequencing identifies all the component parts of the DNA that makes up the genome.

State where DNA is located in a cell.

.....

.....[2]

[Total: 14]

8 In tulip plants, the petals can have markings called flecks.
There are two alleles for flecks in tulip plants: with flecks **F**; and without flecks **f**.

(a) Explain the meaning of the term *dominant* allele.

.....

..... [1]

(b) A tulip grower crosses two tulip plants.

He finds that 76 of the offspring have petals with flecks and 23 of the offspring have petals without flecks.

(i) Complete the genetic diagram to explain this result.

parental genotypes ..... X .....

parental phenotypes ..... X .....

gametes (....) (....) X (....) (....)

offspring genotypes ....

offspring phenotypes petals with flecks present petals without flecks

[5]

(ii) The tulip grower wants to produce a pure-breeding variety of tulips with petals without flecks.

State the genotypes of the parent plants he should use to produce tulip plants without flecks. Explain your answer.

parental genotypes ..... X .....

explanation .....

.....

..... [2]

[Total: 8]

9 **(a)** Sickle cell anaemia is an inherited disease. The gene for haemoglobin exists in two forms, Hb^N and Hb^S. People who are Hb^SHb^S have the disease and experience symptoms including fatigue and extreme pain in their joints. People who are Hb^NHb^S are carriers of the disease and may have mild symptoms, if any at all.

(i) Table 2.1 shows four genetic terms.

Complete Table 2.1 by stating a specific example, used in the paragraph above, of each genetic term.

Table 2.1

genetic term	example used in the passage
an allele	
a heterozygous genotype	
a homozygous genotype	
phenotype	

[4]

(ii) Sickle cell anaemia is not found throughout the whole world. Most cases of the disease occur in sub-Saharan Africa and in parts of Asia. The distribution is similar to that for the infectious disease malaria.

Explain why the distribution of sickle cell anaemia and malaria are similar.

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.....[5]

(b) Down's syndrome is an example of a characteristic that shows discontinuous variation.

State the cause of Down's syndrome.

.....

.....[1]

(c) Explain how discontinuous variation differs from continuous variation, in its expression and cause.

.....

.....

.....

.....

.....

.....[3]

[Total: 13]

1 **(a)** Explain the meaning of the term *transpiration*.

.....

.....

.....

..... [2]

(b) Root hair cells provide a large surface area for the absorption of water from the soil.

Explain, using the term **water potential**, how water is absorbed from the soil into root hair cells.

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.....

..... [3]

Some plants are adapted for life in dry habitats where it can be very hot during the day and very cold at night.

Fig. 3.1 shows some saguaro cacti from the Sonoran desert in Arizona and Mexico.

Fig. 3.2 shows the surface of the stem of a saguaro cactus.

Fig. 3.1

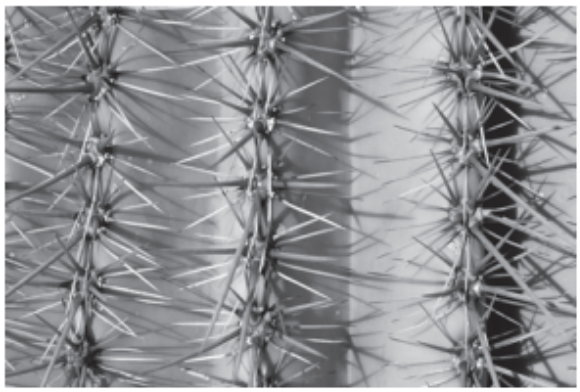

Fig. 3.2

(c) Explain how two features, **visible in Fig. 3.1 or Fig. 3.2**, are adaptations to the conditions in the Sonoran desert.

feature 1 .....

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.....

.....

feature 2 .....

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..... [4]

(d) The stomata of some desert plants, such as the saguaro cactus, open at night and close during the day.

Explain how this allows the cacti to survive in the desert, but limits their growth rate.

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..... [4]

[Total: 13]

2 Cicadas are insects that make a lot of noise.

Fig. 1.1 shows an adult chorus cicada, *Amphipsalta zelandica*, that is only found in New Zealand.

Fig. 1.1

(a) State three features, **visible in Fig. 1.1**, that show that the chorus cicada is an insect.

1 .....

2 .....

3 ..... [3]

(b) Insects are classified in the same group as crustaceans, arachnids and myriapods.

Name the group that contains all these animals.

..... [1]

Evolutionary relationships between different species are investigated by examining DNA.

(c) State precisely where DNA is found in a cell.

.....

..... [2]

Small sections of DNA in 14 species of cicada found in Australia, New Caledonia and New Zealand (**1** to **14**) were examined for similarities and differences.

The results of the DNA examination of these species were used to make a diagram showing how these cicada species may have evolved. Species that are closely related are grouped together on the right of Fig. 1.2.

The brackets show that the cicada species in New Zealand are in two separate groups.

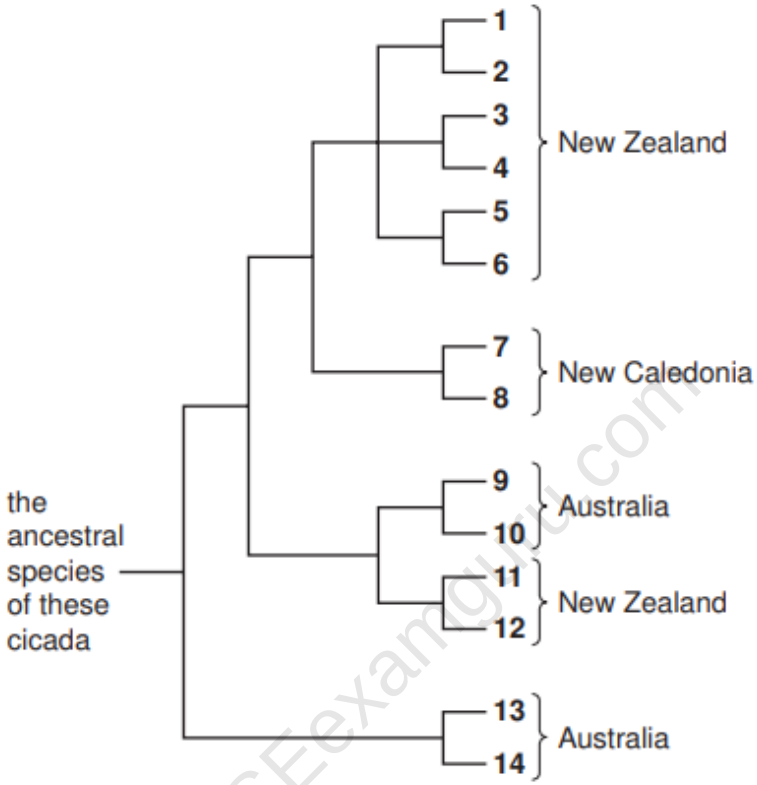

Fig. 1.2

(d) It is suggested that the eight cicada species in New Zealand originated from two migrations, **A** and **B**, from Australia as shown in Fig.1.3.

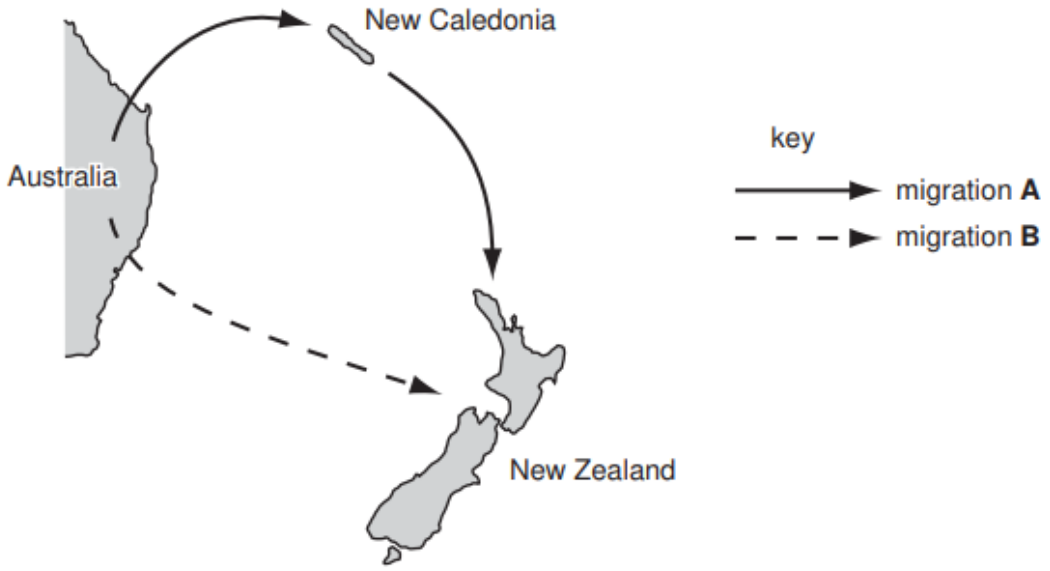

Fig. 1.3

Explain how the results in Fig. 1.2 support the idea that the eight cicada species in New Zealand originated from two migrations of cicadas as shown in Fig. 1.3.

You can use the numbers from Fig. 1.2 in your answer.

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..... [3]

Islands in the Pacific have been colonised by populations of animals that have migrated from Australia, mainland Asia and the Americas. Over many generations these populations have changed. Now they are unable to breed with animals of the original populations in Australia, mainland Asia and the Americas.

(e) Explain how natural selection has resulted in changes in the populations of animals on islands in the Pacific.

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..... [4]

[Total: 13]

3 Antibiotics are used to treat human diseases.

Many bacteria have become resistant to antibiotics. Some antibiotics can no longer be used to treat certain diseases.

Samples of bacteria were taken from a person who had an infectious disease. They were spread onto four Petri dishes of agar (agar plates). Three of these agar plates contained the antibiotics **1**, **2** or **3**.

The results are shown in Fig. 2.1.

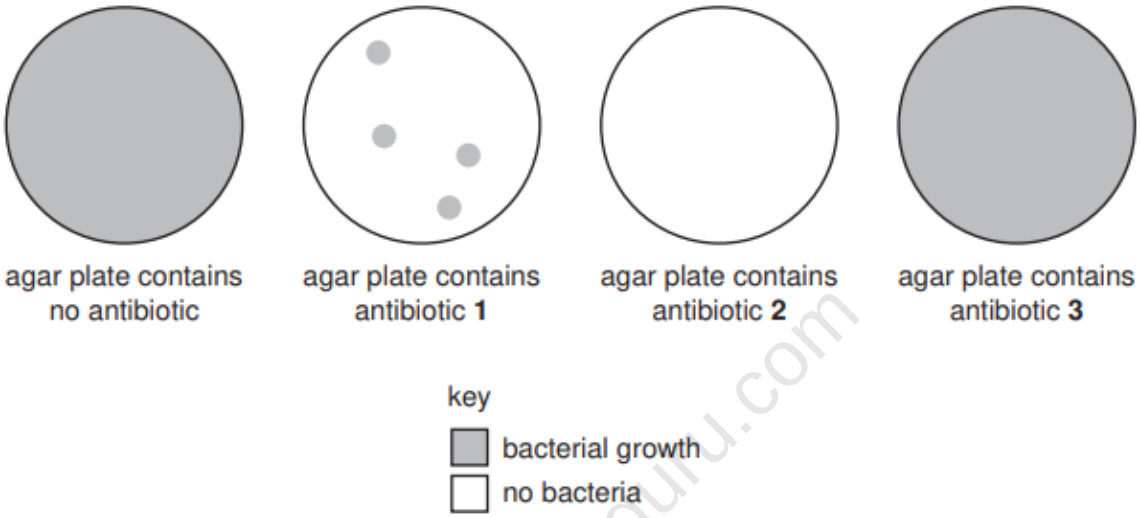

Fig. 2.1

(a) Explain why:

(i) no bacteria grew in the agar plate with antibiotic **2**;

.....

.....

..... [1]

(ii) bacteria grew in the agar plate with antibiotic **3**;

.....

.....

..... [1]

(iii) only a small number of bacteria grew with antibiotic **1**.

.....

.....

.....

.....

..... [2]

(b) Explain why it is important to carry out a test similar to that shown in Fig. 2.1 before giving an antibiotic to a person infected with a bacterial disease.

.....

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..... [2]

(c) Antibiotic resistance has become a major problem worldwide.

Suggest how the problem of antibiotic resistance can be limited.

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..... [4]

(d) Hormones are used to treat a variety of conditions.

The most common hormonal treatment is the use of insulin to treat diabetes. Most of the insulin is produced using cells that are grown in large fermenters. These cells have been genetically engineered to produce human insulin.

Fig. 2.2 shows the stages involved in transferring the gene for insulin from human cells to bacterial cells.

P	gene from human cell removed from chromosome 11
Q	bacterium produces human insulin
R	plasmid vector enters bacterium
S	gene for human insulin found to be on chromosome 11
T	bacterium divides by binary fission
V	gene for human insulin inserted into a plasmid vector

Fig. 2.2

(i) Put the stages into the correct sequence. Two have been done for you.

S					**Q**

[1]

(ii) Diabetes is often treated with human insulin that has been produced by genetically modified cells. In most countries this type of insulin has replaced the insulin that was prepared from animals.

Suggest the advantages of providing human insulin to people with diabetes rather than insulin obtained from animals.

.....

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.....

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.....

.....

..... [3]

[Total: 14]

4 Fig. 6.1 shows Soay sheep on St. Kilda, a group of small remote islands off the coast of Scotland. These islands experience extreme conditions of cold, wind and rain.

Sheep were introduced to the islands thousands of years ago and the Soay sheep are descended from them.

The islands of St. Kilda have been uninhabited by people since 1930. The sheep are now left unfarmed and in their natural state.

Fig. 6.1

(a) The populations of Soay sheep on St. Kilda show much more variation in their phenotype than modern breeds of sheep.

Explain, by using an example from Fig. 6.1, what is meant by variation in their phenotype.

.....

.....

.....

.....

..... [2]

(b) Scientists have recorded the numbers of Soay sheep and lambs on St. Kilda for many years.

Each year between 1985 and 1996, the lambs (young sheep) were caught, marked and weighed. In some years, the total number of sheep on St. Kilda was lower than in other years.

Fig. 6.2 shows the frequency of lambs of different body mass in years when the total number of sheep was low and years when the total number was high.

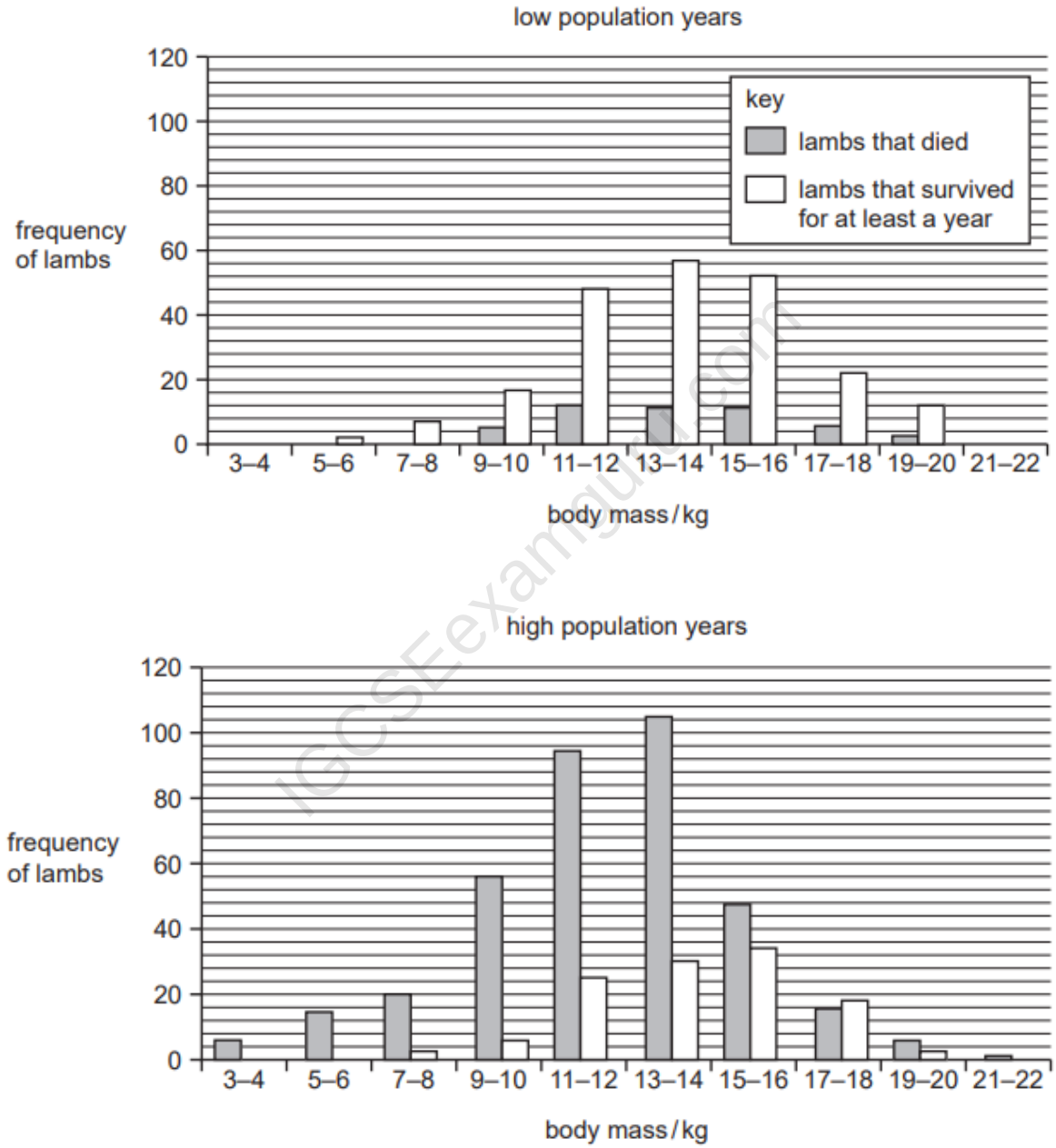

Fig. 6.2

(i) Population size has a great effect on the survival of lambs on St. Kilda.

Describe the evidence from Fig. 6.2 that supports this statement.

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..... [2]

(ii) Suggest an explanation for the effect that you have described.

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..... [3]

(c) Soay sheep are adapted to the extreme conditions experienced on St. Kilda.

Explain how natural selection could account for the adaptive features of Soay sheep.

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..... [4]

[Total: 11]

5 **(a)** Fig. 4.1 shows a section through the anther of a lily flower. The cells in the centre are dividing by meiosis.

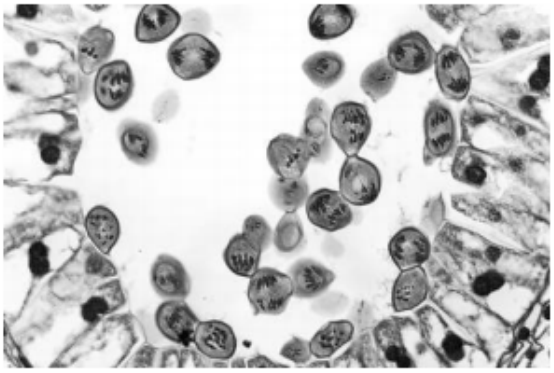

Fig. 4.1

(i) Name the product of meiosis that is formed in anthers.

.....[1]

(ii) Explain the importance of meiosis in sexual reproduction.

.....

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.....

.....[2]

(b) Fig. 4.2 shows a flower of *Lilium polyphyllum*, a lily that grows in the Himalayan mountains. This species is cross-pollinated by insects.

Fig. 4.2

(i) Explain what is meant by *cross-pollination*.

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.....[2]

(ii) Name **one** feature **visible** in Fig. 4.2 that helps to attract insects.

.....[1]

(c) Plants of this species that grow at low altitudes produce flowers 60 days before the plants of the same species that grow at high altitudes.

(i) Suggest **one** environmental reason why lilies that grow at lower altitudes flower earlier than the lilies at higher altitudes.

.....[1]

(ii) Explain why flowering time is an example of continuous variation.

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.....[2]

(d) Scientists think that plants of *L. polyphyllum* growing at high altitudes may evolve into a new species.

Explain how natural selection could lead to the evolution of a new species of lily.

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.....[5]

[Total: 14]

6 Fig. 1.1 shows a common emerald dove, *Chalcophaps indica*.

Fig. 1.1

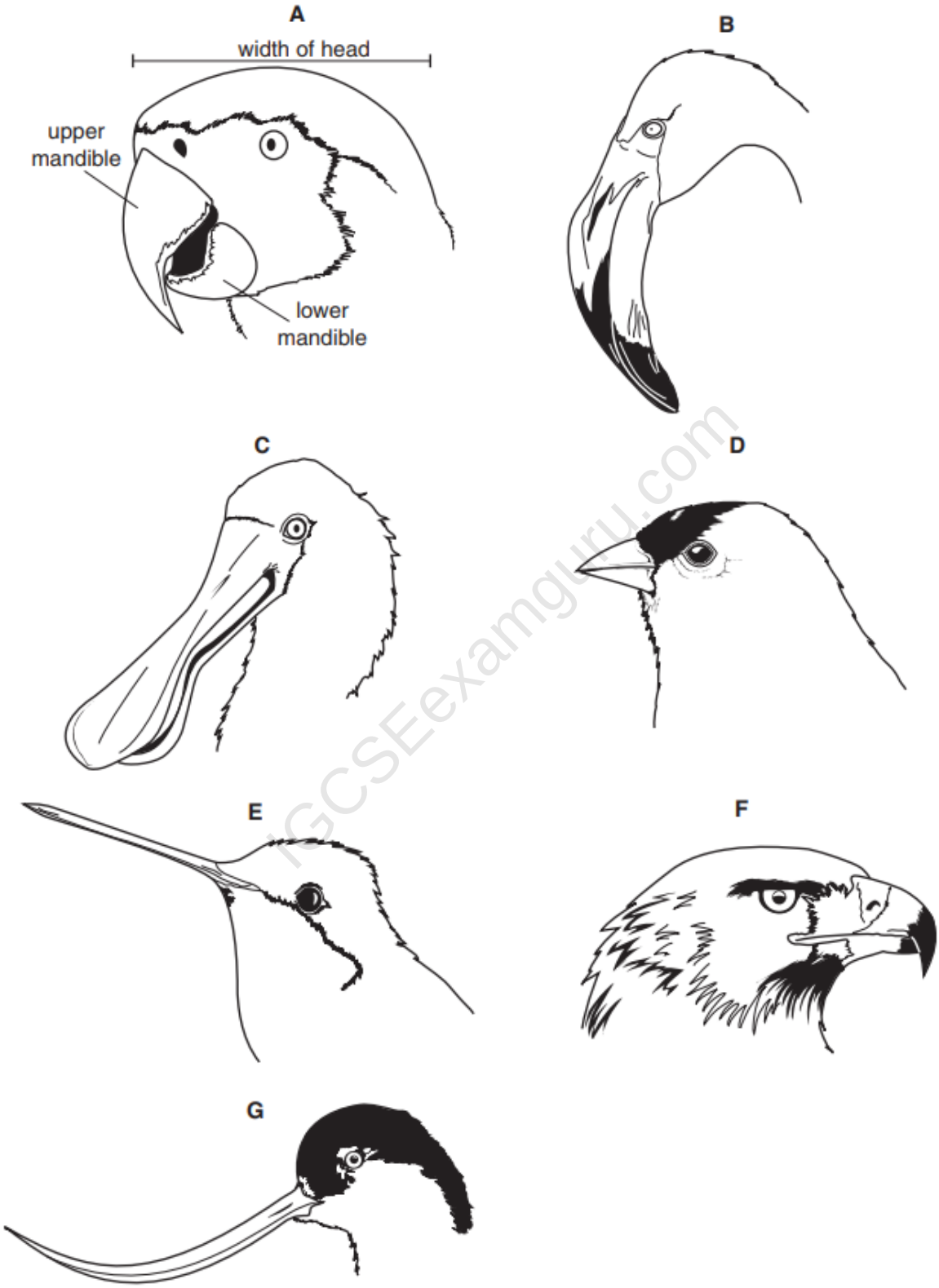
(a) Two distinguishing features of birds are beaks and wings.

State **one other** feature shown **only** by birds that is visible in Fig. 1.1.

.....[1]

(b) Birds show variation in the sizes and shapes of their beaks. A beak is composed of an upper mandible and a lower mandible.

Fig. 1.2 shows the heads of seven different species of bird.



not drawn to scale
Fig. 1.2

Use the key to identify each species. Write the letter of each species (**A** to **G**) in the correct box beside the key. One has been done for you.

key

1	(a)	beak is shorter than the width of the head	go to 2	
	(b)	beak is longer than the width of the head	go to 4	
2	(a)	upper mandible is same length as the lower mandible	*Spinus tristis*	
	(b)	upper mandible is longer than the lower mandible	go to 3	
3	(a)	lower mandible is about half the length of the upper mandible	*Ara ararauna*	**A**
	(b)	lower mandible is more than half the length of the upper mandible	*Aquila chrysaetos*	
4	(a)	both mandibles widen at the end of the beak	*Platalea regia*	
	(b)	both mandibles are a similar width along their whole length	go to 5	
5	(a)	beak is straight	*Trochilus polytmus*	
	(b)	beak is curved	go to 6	
6	(a)	beak curves upwards	*Recurvirostra americana*	
	(b)	beak curves downwards	*Phoenicopterus minor*	

[3]

(c) Fig. 1.3 shows the events that occur during sexual reproduction in birds. The numbers in brackets indicate the number of chromosomes in the nuclei of the cells of the common emerald dove.

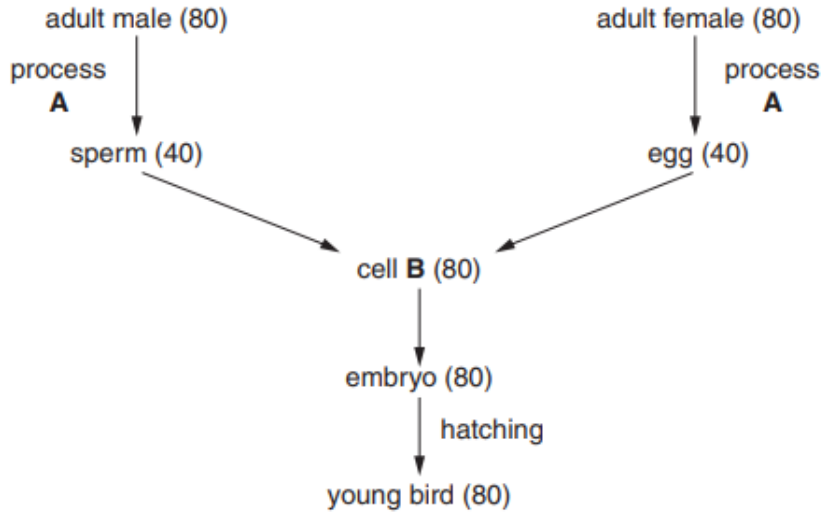


Fig. 1.3

(i) Name process **A** and cell **B**.

A .....

B .....
[2]

(ii) State why cell **B** is described as a diploid cell.

.....[1]

(iii) The embryo of the bird develops from cell **B**.

State what is meant by the term *development*.

.....

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.....[1]

(iv) Sexual reproduction usually leads to variation.

Explain why variation is an advantage for a species such as the common emerald dove.

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.....[2]

[Total: 10]