(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.

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..... [2]

[Total: 13]

2 Enzymes are biological catalysts.

(a) Define the term *catalyst*.

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..... [2]

Urease is an enzyme found in bacteria and in the seeds of some species of bean.

The enzyme catalyses the reaction:

urea + water ⟶ carbon dioxide + ammonia

The production of ammonia increases the pH of the area around the bacteria. The formation of ammonia can be used to study the progress of the reaction by testing the pH of the surrounding medium with a pH indicator, such as Universal Indicator solution.

Some students carried out an investigation to find out if there was urease in the seeds of four different species of bean.

- The germinating seeds were ground up in water and filtered to give an extract containing proteins.
- Each extract was added to a urea solution and kept at 30 °C for 30 minutes (tubes **1** to **4**).
- Two more tubes (**5** and **6**) were included in the investigation.
- Samples were taken from the reaction mixture at five-minute intervals and tested with Universal Indicator solution.

The results are shown in Table 4.1.

Table 4.1

test-tube	bean species	urea solution	water	presence of alkaline pH at intervals of 5 minutes						
				0	5	10	15	20	25	30
1	soya		no	×	×	×	×	✓	✓	✓
2	mung		no	×	×	×	×	×	×	×
3	jack		no	×	×	×	✓	✓	✓	✓
4	broad		no	×	×	×	×	×	×	×
5	soya		yes	×	×	×	×	×	×	×
6	no beans	yes	yes	×	×	×	×	×	×	×

✓ = alkaline pH × = not alkaline pH

(b) (i) Explain why the test-tubes were kept at 30 °C.

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..... [2]

(ii) Explain why test-tubes **5** and **6** were included in the investigation.

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..... [2]

(iii) State the conclusions that the students would make from the results of test-tubes **1** to **4**.

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..... [3]

It is thought that some bean seeds produce ammonia as a protection against infection by microorganisms in the soil.

(c) Suggest what would happen to any ammonia that passes into the soil.

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..... [2]

(d) *Helicobacter pylori* is a bacterium that infects the stomach and causes ulcers.

The bacteria secrete urease that helps them to colonise the stomach lining.

(i) Explain why bacteria do not usually grow inside the stomach.

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..... [2]

(ii) Suggest how urease helps the bacteria to colonise the stomach.

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..... [2]

(iii) Explain how the immune system protects against infection by bacteria such as *H. pylo* .

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..... [2]

[Total: 17]

3 The human immunodeficiency virus (HIV) infects white blood cells. The virus is reproduced inside these white blood cells.

(a) Describe what may happen to viruses that leave infected white blood cells.

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..... [2]

(b) Describe the possible long-term effects of HIV on the immune system.

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..... [3]

(c) People with HIV may be treated with a variety of drugs.

(i) Define the term *drug*.

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..... [1]

(ii) Explain why antibiotics cannot be used to control HIV.

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..... [2]

[Total: 8]