1 **(a** Starch, glucose and fructose are carbohydrates. Fructose syrup is used as a sweetening agent as an alternative to sucrose.

The flow chart in Fig. 3.1 shows how fructose is prepared from maize starch.

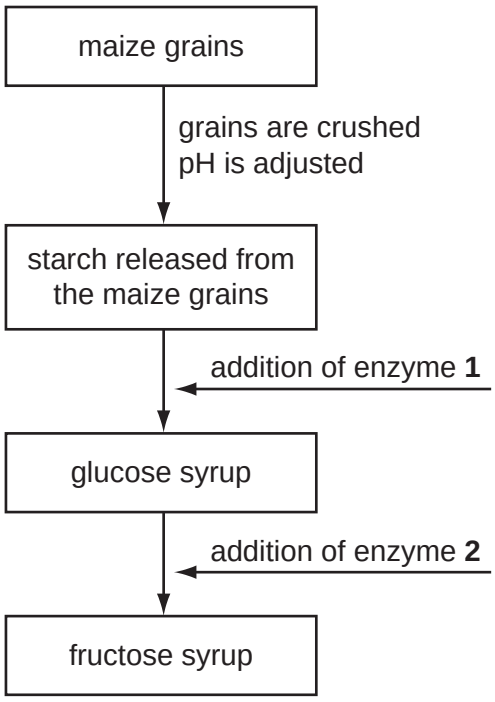

Fig. 3.1

(i) Name enzyme **1**.

.....

[1]

(ii) State why it is necessary to adjust the pH before an enzyme is added to the process.

.....

.....

[1]

(b) Maize grains contain protease enzymes. With reference to the processes shown in Fig. 3.1, suggest why it is important that these enzymes do not contaminate the glucose syrup.

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.....

[1]

(c) The formation of fructose syrup from glucose syrup is carried out at a temperature of 60 °C.

Suggest an important property of enzyme **2** that allows it to be used at temperatures as high as 60 °C.

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..... [1]

(d) Enzyme **2** is found naturally in many bacteria. Enzymes for use in washing powders are obtained from bacteria.

Describe how bacteria are used to produce enzymes for washing powders.

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..... [3]

(e) Pectinase is an enzyme that breaks down compounds known as pectins. Cell walls of fruits, such as apples and mangoes, contain pectins.

Explain the **advantages** of using pectinase in fruit juice production.

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..... [3]

[Total: 10]

2 In Sichuan, in China, a sauce is made from broad bean seeds that have germinated and then have been left to ferment.

Fig. 3.1 shows a germinating broad bean seed.

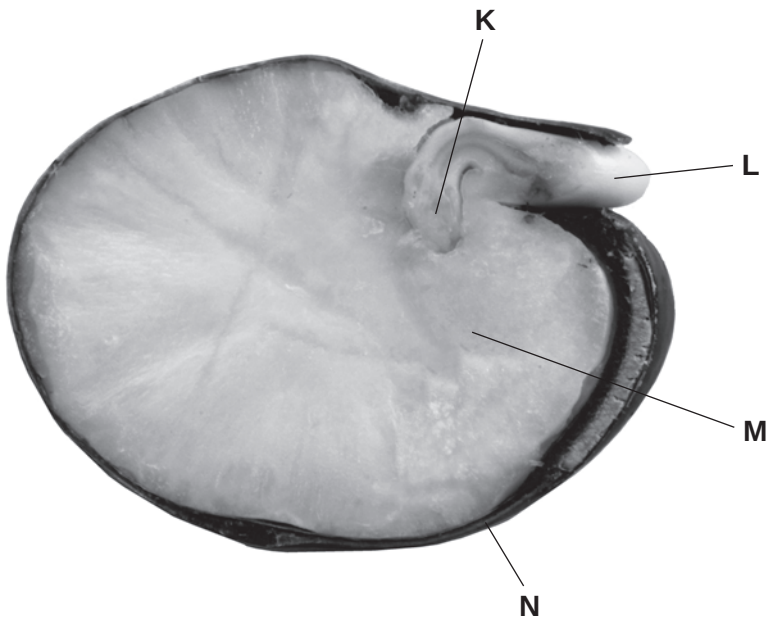

Fig. 3.1

(a) Name **K** to **N**.

K .....

L .....

M .....

N ..... [4]

Broad beans contain starch. The germinating beans are colonised by yeasts and other fungi, such as *Aspergillus*.

Aspergillus grows over the surface of beans and digests starch. It has a body made of thin threads that secrete enzymes, such as amylase.

(b) Name the thin threads that make up the body of a fungus, such as *Aspergillus*.

..... [1]

(c) The action of enzymes is often explained in terms of the 'lock and key' model as shown in Fig. 3.2.

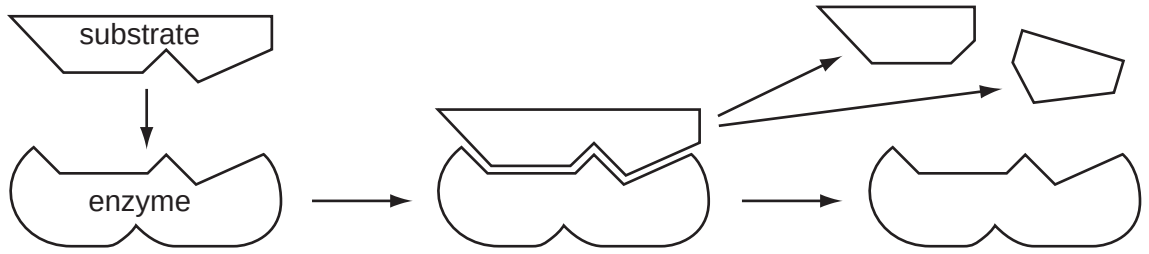

Fig. 3.2

Use the information in Fig. 3.2 to explain how enzymes work to break down nutrient materials, such as starch.

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..... [4]

Enzymes in bean seeds are activated during germination. Some of these enzymes break down protein stored in the seeds.

A large number of bean seeds were soaked and germinated. Researchers took samples of germinating seeds over a period of 15 days. The seeds were chopped into small pieces and crushed with water to make an extract. Equal quantities of the extracts were placed into protein solutions at pH 5 and at pH 8.

The activity of the enzymes in each extract was determined by recording how quickly the protein was broken down. The results are shown in Fig. 3.3.

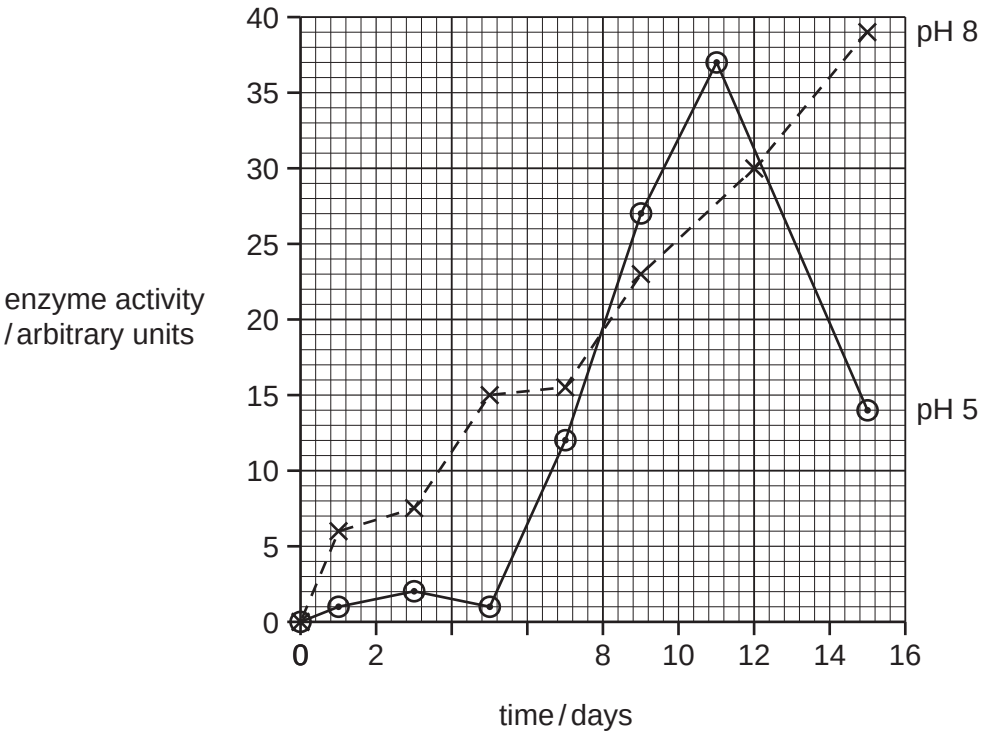

Fig. 3.3

(d) Describe the activity of the enzymes in the extracts at pH 5 over 15 days.

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..... [3]

(e) The researchers concluded that the beans contained two different enzymes that break down protein.

State the evidence from Fig. 3.3 for this conclusion.

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..... [3]

[Total: 15]

3 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]

4 Sewage disposal involves the removal of human waste in pipes from houses to sewage treatment works.

Fig. 6.1 is a diagram that shows how sewage is treated.

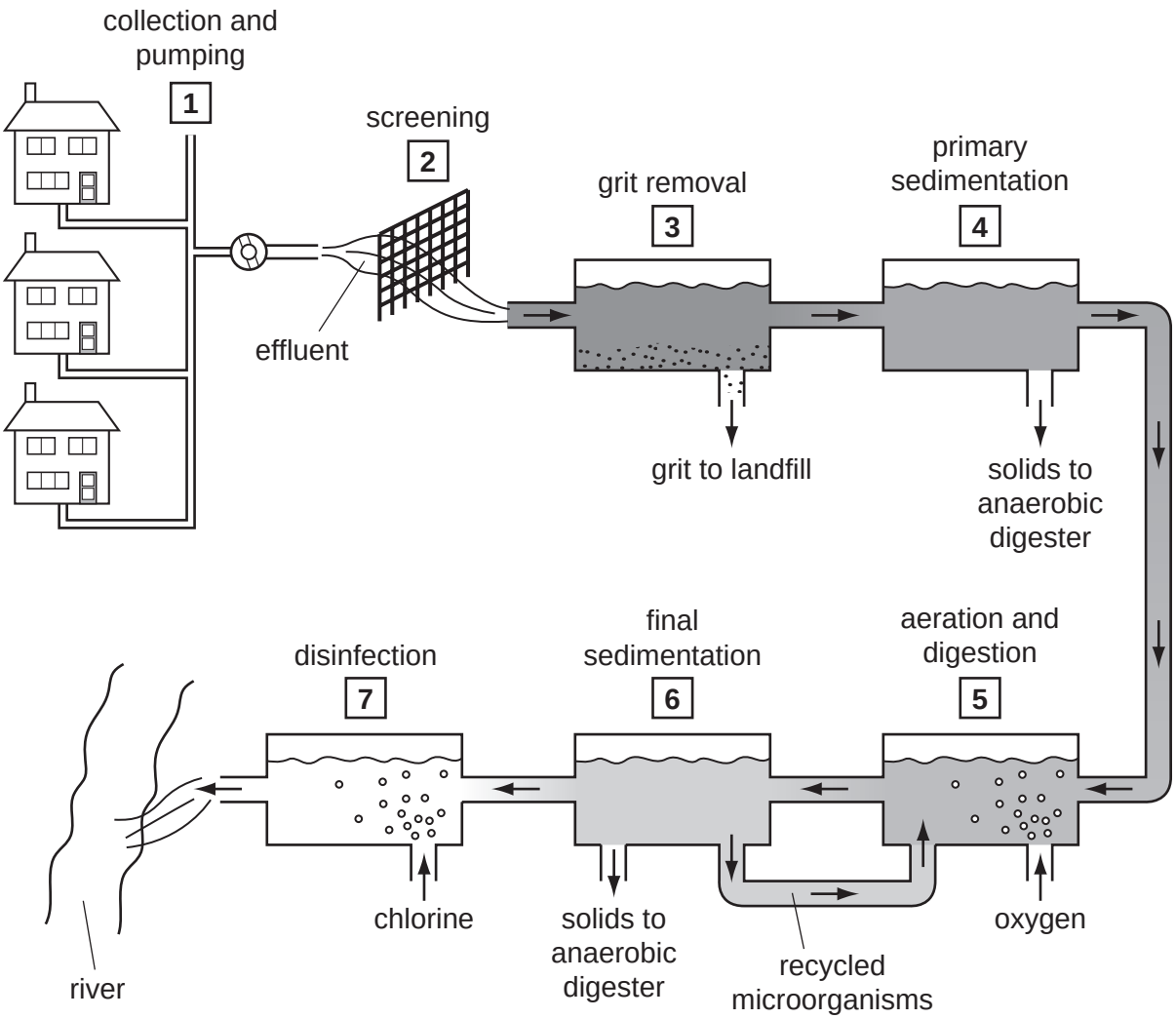

Fig. 6.1

(a) During stage **5** microorganisms break down organic matter consisting of cellulose, starch, protein and lipid (fat). The microorganisms multiply during this stage and are recycled.

Complete Fig. 6.2 by writing in the boxes the names of the enzymes used to catalyse the reactions shown. The first box has been completed for you.

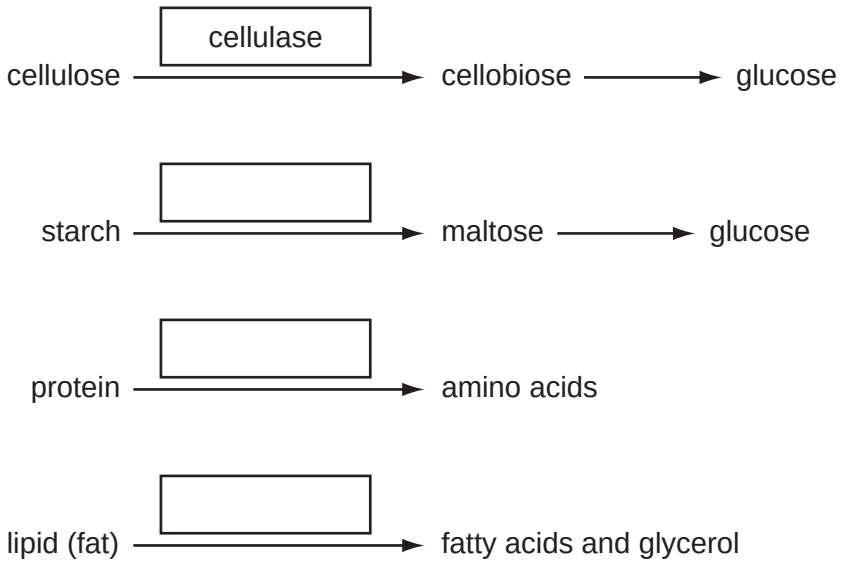

Fig. 6.2 [3]

(b) State why it is important that sewage is treated.

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..... [1]

(c) At stage **5** in Fig. 6.1, oxygen and microorganisms are added.

Explain why oxygen is bubbled through the tank at this stage.

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..... [4]

(d) Suggest **and** explain the advantage of recycling microorganisms from stage **6** to stage **5** as shown in Fig. 6.1.

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..... [3]

(e) Explain why chlorine is added at stage **7**.

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..... [2]

[Total: 13]