

- 1 In a photomicrograph of magnification $\times 5000$, a chloroplast measures 25 mm in diameter.

What is the actual diameter of the chloroplast?

- A $0.2\text{ }\mu\text{m}$ B $0.5\text{ }\mu\text{m}$ C $2\text{ }\mu\text{m}$ D $5\text{ }\mu\text{m}$

- 6 Solution X was tested for the presence of non-reducing sugars. It did **not** contain reducing sugars.

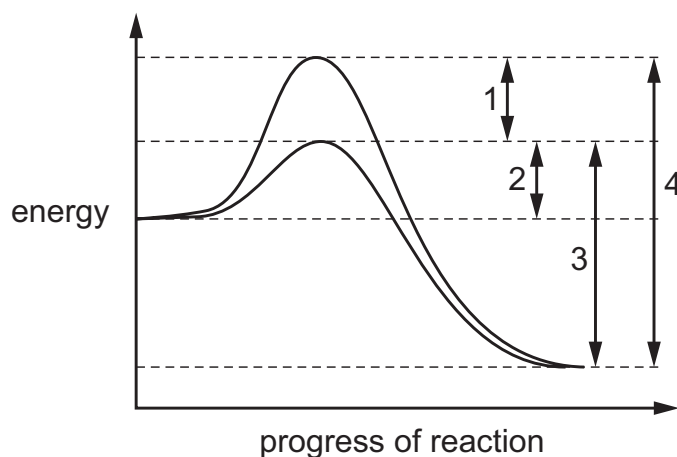
Some steps that can be used to test for the presence of biological molecules are listed.

- 1 Add Benedict's solution to the test-tube.
- 2 Add dilute hydrochloric acid to the test-tube.
- 3 Add sodium hydrogencarbonate to the test-tube.
- 4 Heat the test-tube in a water-bath.

Which order of steps to identify the presence of non-reducing sugars in solution X is correct?

- A $1 \rightarrow 4$
B $2 \rightarrow 3 \rightarrow 1 \rightarrow 4$
C $2 \rightarrow 4 \rightarrow 3 \rightarrow 1 \rightarrow 4$
D $3 \rightarrow 2 \rightarrow 4 \rightarrow 1$

- 13 The graph shows energy changes in a chemical reaction.



What is the activation energy when an enzyme is added?

- A $1 + 2$ B 2 only C $3 - 2$ D 4

15 What are the main roles of glycolipids in cell surface membranes?

- 1 to help cells to attach to each other to form tissues
- 2 to act as antigens for cell-to-cell recognition
- 3 to increase fluidity for the cell surface membrane

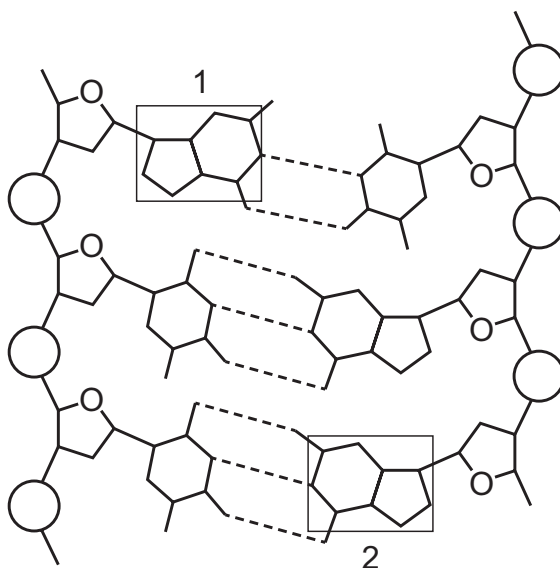
A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

20 Telomeres become shorter during each cell cycle of a specialised cell.

In which phase of the cell cycle do telomeres shorten?

- A** cytokinesis
B G₁
C S
D G₂

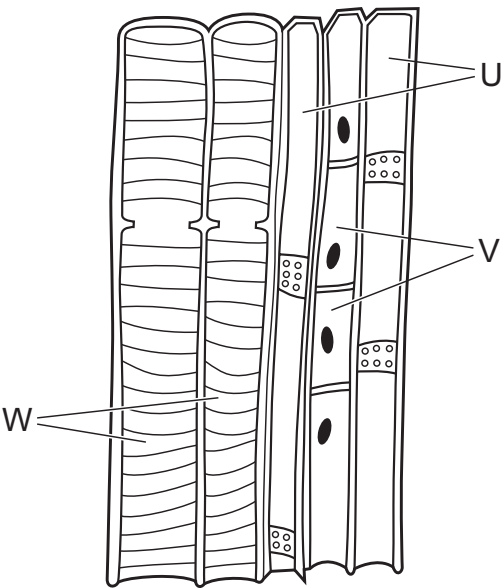
23 The diagram shows a section of DNA. Two of the bases in this section are labelled 1 and 2.



Which row correctly identifies the bases 1 and 2?

	base 1	base 2
A	purine	adenine
B	purine	guanine
C	pyrimidine	adenine
D	pyrimidine	guanine

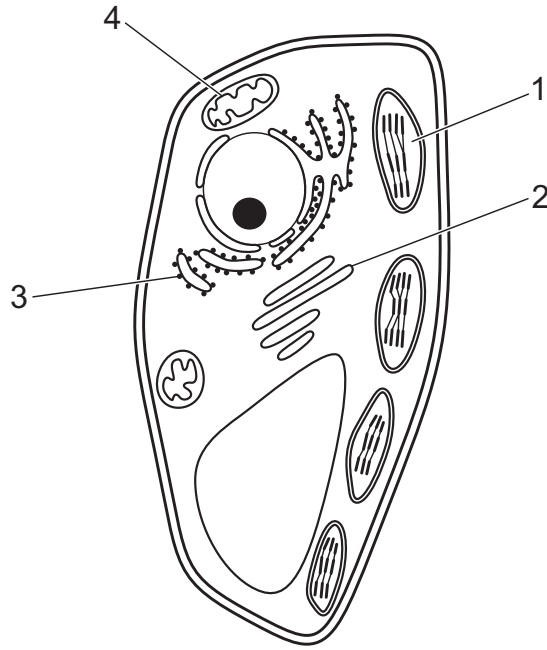
26 The diagram shows a vertical section through part of the stem of a dicotyledonous plant. Three types of structures are labelled.



What are the structures U, V and W?

	companion cells	phloem sieve tube elements	xylem vessel elements
A	U	W	V
B	V	U	W
C	U	V	W
D	W	V	U

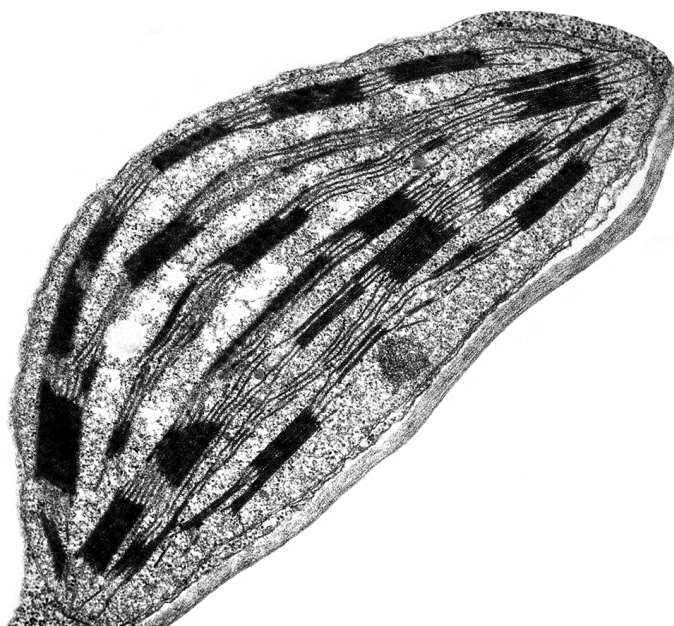
3 The diagram shows a plant cell.



Which labelled organelles would contain nucleotides?

- A** 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

4 The image shown is produced using a microscope.



How many statements about this image are correct?

- It is an electron micrograph.
- It shows part of a eukaryotic cell.
- It shows at least one mitochondrion.
- It shows a specimen viewed at more than $\times 400$ magnification.

A 1

B 2

C 3

D 4

5 Bacterial ribosomes consist of two subunits and a total of three rRNA molecules per ribosome. An analysis of **all** the 70S ribosomes from a single cell of the bacterium *Escherichia coli* showed that there were:

- 57 000 rRNA molecules
- three types of rRNA molecule
- 19 000 copies of each type of rRNA molecule.

How many 70S ribosomes were there in the *E. coli* cell?

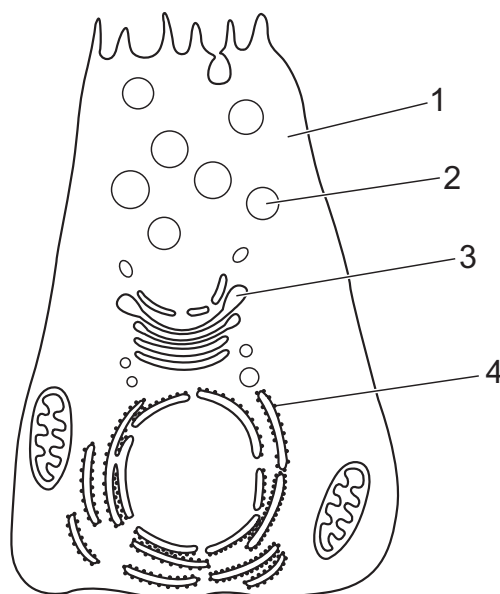
A 9500

B 19 000

C 38 000

D 57 000

- 6** Radioactively labelled amino acids are introduced into a tracheal cell that uses them to make mucus (a glycoprotein).



Which route will the amino acids take?

	first	→			last
A	1	2	3	4	
B	1	4	3	2	
C	4	1	2	3	
D	4	3	2	1	

- 5** Some features of cells are listed.

- 1 cytoplasm
- 2 cell surface membrane
- 3 ribosomes

Which features are found in animal cells and also in prokaryotic cells?

- A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

- 4 Fig. 4.1 is a photomicrograph of a copepod. These animals are found living in sea water and in fresh water environments.

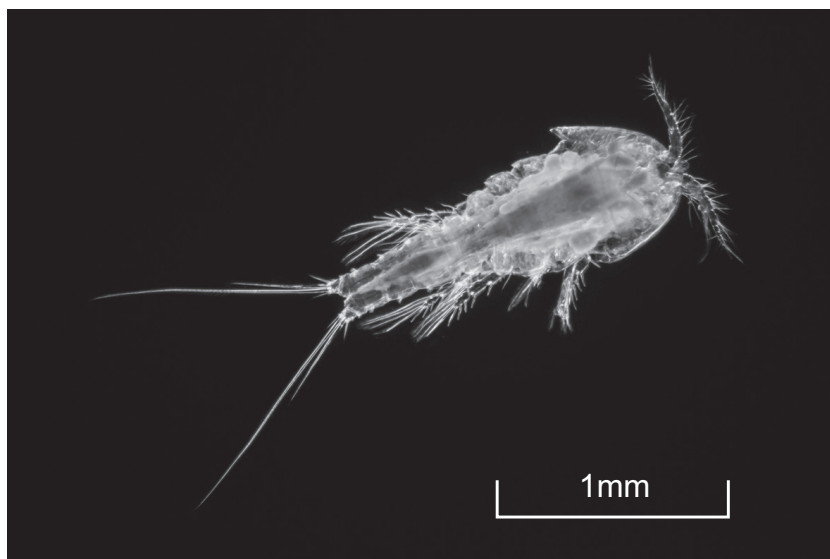


Fig. 4.1

- (a) The outer surface of a copepod is covered in a layer of the polysaccharide chitin.

Fig. 4.2 shows part of a chitin molecule.

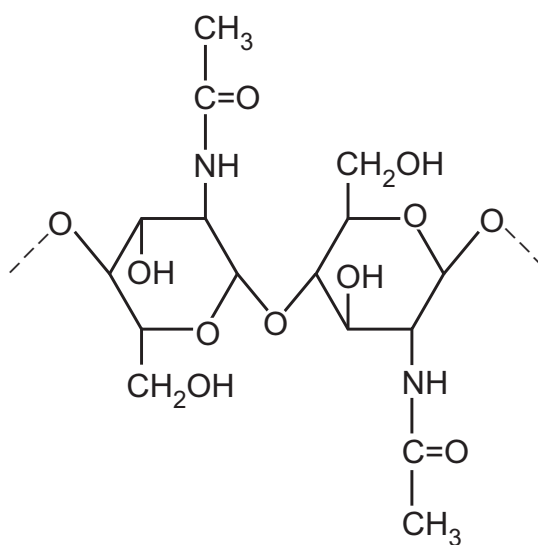


Fig. 4.2

- (i) Draw a circle around a glycosidic bond in Fig. 4.2.

[1]

- (ii) In aquatic environments, *Vibrio cholerae* can live on the surface of copepods. *V. cholerae* secretes enzymes to hydrolyse chitin to its N-acetylglucosamine monomers. These can be broken down to provide carbon, nitrogen and a source of energy.

Draw the monomer that is formed when chitin is hydrolysed by *V. cholerae*.

[2]

(b) *V. cholerae* is a pathogen that causes cholera.

Scientists studied the transmission of *V. cholerae* in groups of people living in an area where there is a high number of cases of cholera.

Some families living in this area filtered their water through several layers of folded fabric from old clothing. The folded fabric traps particles and organisms larger than $20\mu\text{m}$.

The scientists recorded the number of cases of cholera in families that filtered their water through folded fabric and compared this to the number of cases of cholera recorded in families that did **not** filter their water through the folded fabric.

The results are shown in Fig. 4.3.

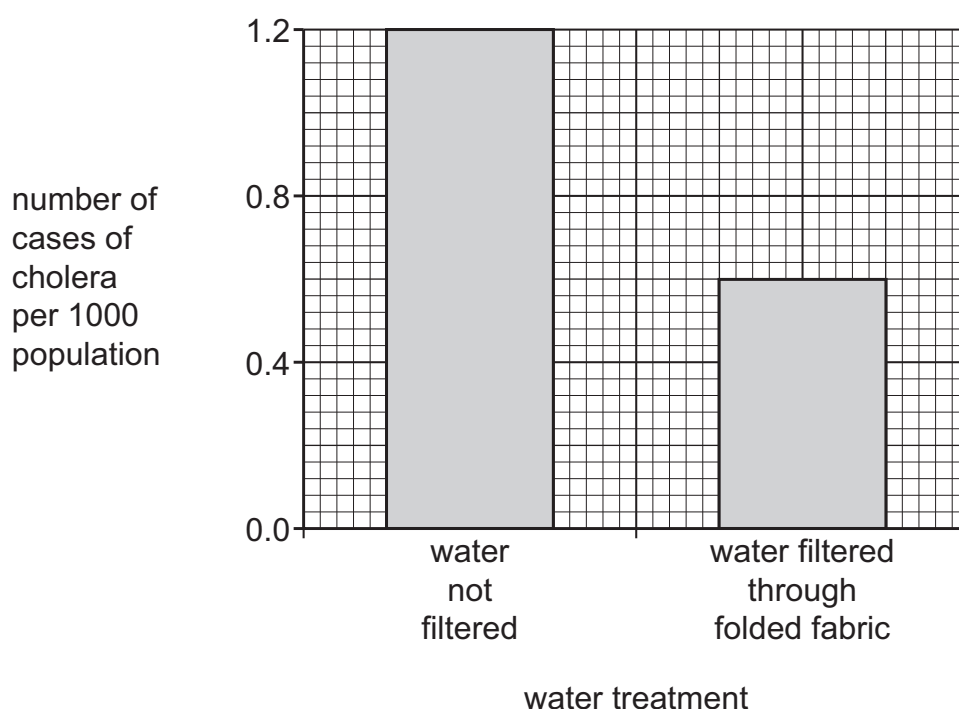


Fig. 4.3

Suggest possible explanations for the results shown in Fig. 4.3.

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- (c) The World Health Organization (WHO) recommends the use of an oral cholera vaccine (OCV) to protect people living in an area where a cholera outbreak has occurred.

People who receive an OCV and make changes in their behaviour are less likely to have a serious case of cholera.

- (i) Describe **one** change in behaviour that a person can make, **other** than purifying water, to help prevent a serious case of cholera.

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

- (ii) The antibiotic tetracycline is used to treat cholera. However, some bacteria that cause cholera have evolved resistance to this antibiotic.

Scientists have reported that resistant bacteria have an extra protein in their cell surface membrane. This protein has been found to use ATP.

Suggest how the presence of this protein in the cell surface membrane gives *V. cholerae* resistance to tetracycline.

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..... [2]

- (iii) For some vaccines, there may not be an effective secondary immune response when a person is infected by the specific pathogen. The antibodies that are produced do **not** act on the pathogen. This is known as immune evasion.

Evolution of resistance of bacteria to antibiotics occurs more frequently than immune evasion.

Suggest why bacteria evolve resistance to antibiotics more frequently than vaccines that lose their effectiveness in protecting against bacterial pathogens.

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..... [2]

[Total: 12]

6 (a) Alveolar macrophages are phagocytes found in the human gas exchange system. They produce hydrolytic enzymes, such as lysozyme, to digest pathogens entering the alveolus.

(i) State the term used to describe the sequence of nucleotides in the DNA of the alveolar macrophage that codes for a protein, such as lysozyme.

..... [1]

(ii) Synthesis of lysozyme occurs in two stages. The first stage occurs in the nucleus using one strand of DNA to synthesise mRNA.

State the name of the strand of DNA that is used to synthesise mRNA.

..... [1]

(iii) Name the organelle where the translation of mRNA takes place to produce lysozyme.

..... [1]

(iv) Lysozyme destroys bacterial cells by hydrolysing bonds in peptidoglycan.

Explain how the hydrolysis of bonds in peptidoglycan leads to the destruction of bacterial cells.

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..... [2]

(b) (i) Alveolar macrophages are found in contact with squamous epithelial cells in the walls of alveoli.

Explain how the cells lining the alveoli are adapted for gas exchange.

[2]

(ii) Describe the role of elastic fibres in the wall of an alveolus.

[2]

[Total: 9]

- 1 The wall of the small intestine is highly folded to form villi. Between the villi are infoldings known as crypts of Lieberkühn.

Fig. 1.1 is a diagram of a section through a single villus and a crypt of Lieberkühn.

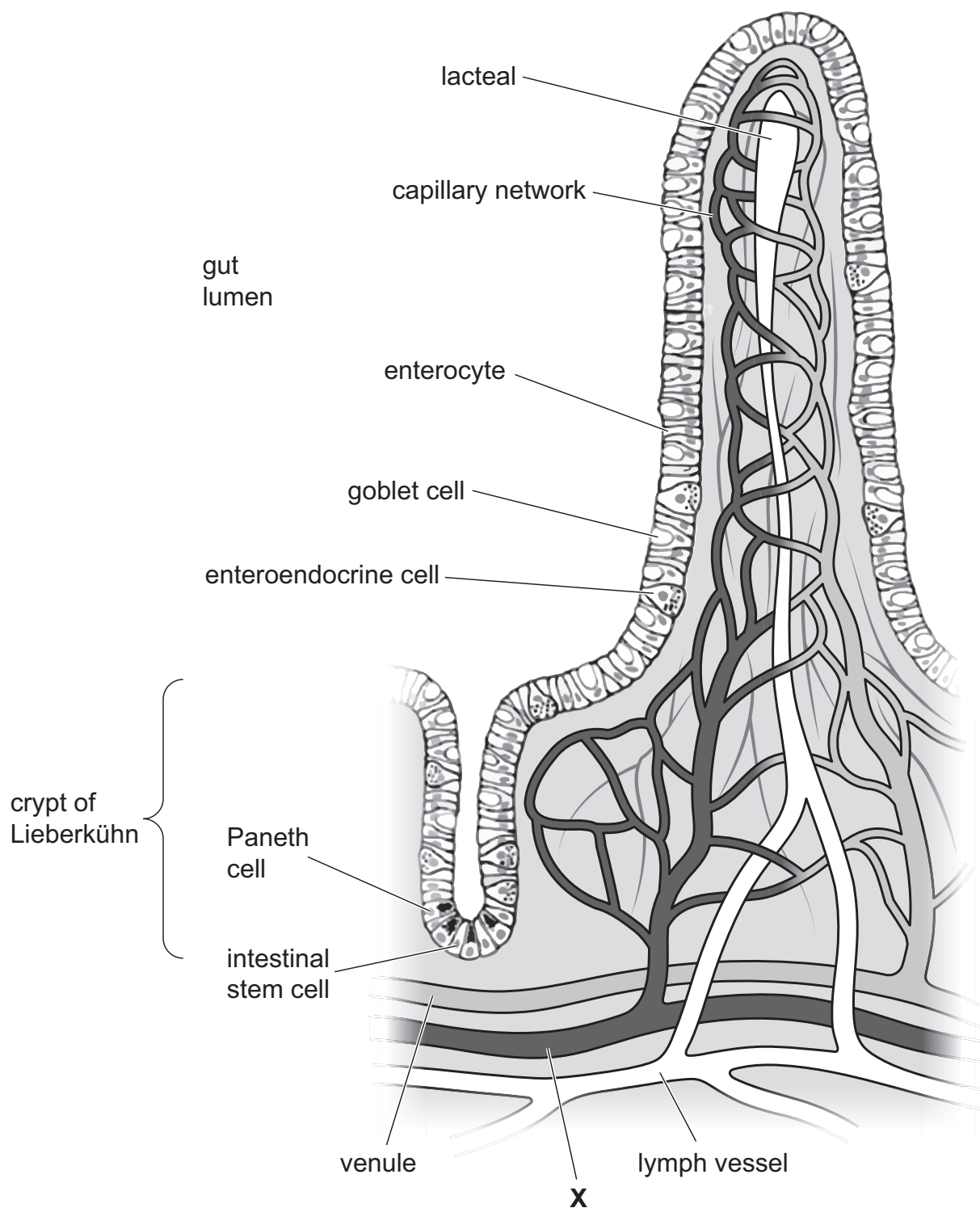


Fig. 1.1

Fig. 1.1 shows that the epithelium of the villus contains mainly goblet cells and cells known as enterocytes. Both cell types have microvilli on the apical surface (surface facing the gut lumen).

Goblet cells are involved in the production of mucus.

Enterocytes are adapted for the absorption of the soluble products of digestion. These products enter the circulatory system.

- (a) A student incorrectly stated that an enterocyte has many **cilia** on its apical surface.

Explain the difference between a cilium and a microvillus.

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..... [2]

- (b) Suggest **one** role of the mucus produced by the goblet cells of the villus.

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..... [1]

- (c) In Fig. 1.1, blood vessel **X** delivers blood to the capillary network of the villus, where tissue fluid is formed. Some of the fluid passes back into the capillaries and then into the venule.

- (i) Blood vessel **X** receives blood from an artery.

Name the type of blood vessel represented by **X**.

..... [1]

- (ii) Describe the formation of tissue fluid in the capillary network of the villus.

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..... [2]

- (d) In response to the presence of compounds in the gut lumen, enteroendocrine cells synthesise and release peptides (short chains of amino acids) that are cell-signalling molecules. One of these cell-signalling molecules is known as GLP-1.

GLP-1 initiates a number of responses in different body cells. Some of these responses include:

- the increase in release of the hormone insulin from cells in the pancreas
- the decrease in release of acid from cells in the stomach.

Outline, **in sequence**, the main stages involved in the process of cell signalling by GLP-1.

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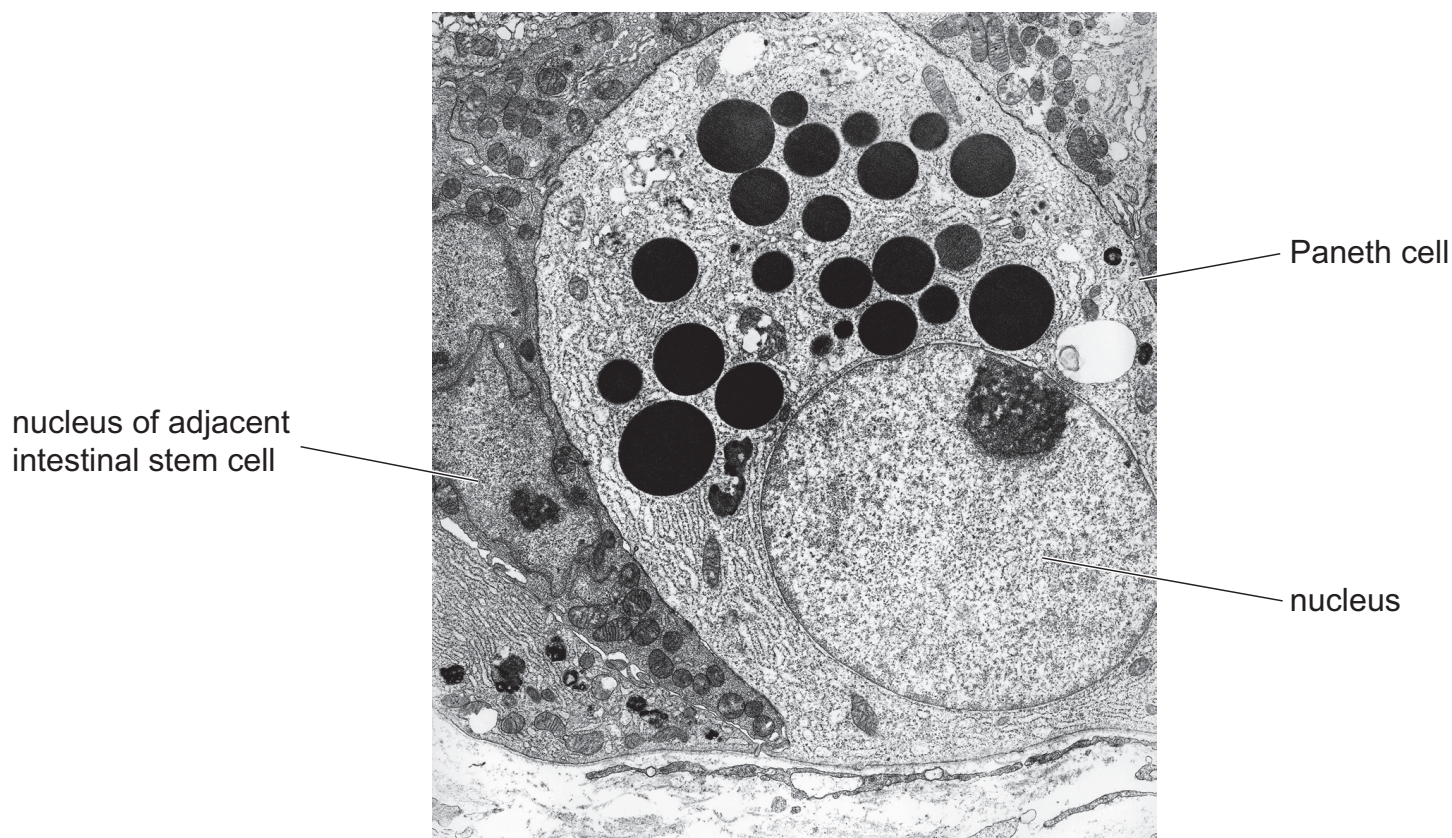
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..... [3]

- (e) Paneth cells, which are secretory cells, are located between intestinal stem cells at the base of the crypt of Lieberkühn, as shown in Fig. 1.1.

A Paneth cell has a very different appearance to an intestinal stem cell.

Fig. 1.2 is a transmission electron micrograph of a Paneth cell.



- (i) Paneth cells are formed following the mitotic division of an intestinal stem cell during a cell cycle.

Complete the cell cycle shown in Fig. 1.3 by naming, **in sequence**, the stages of mitosis.

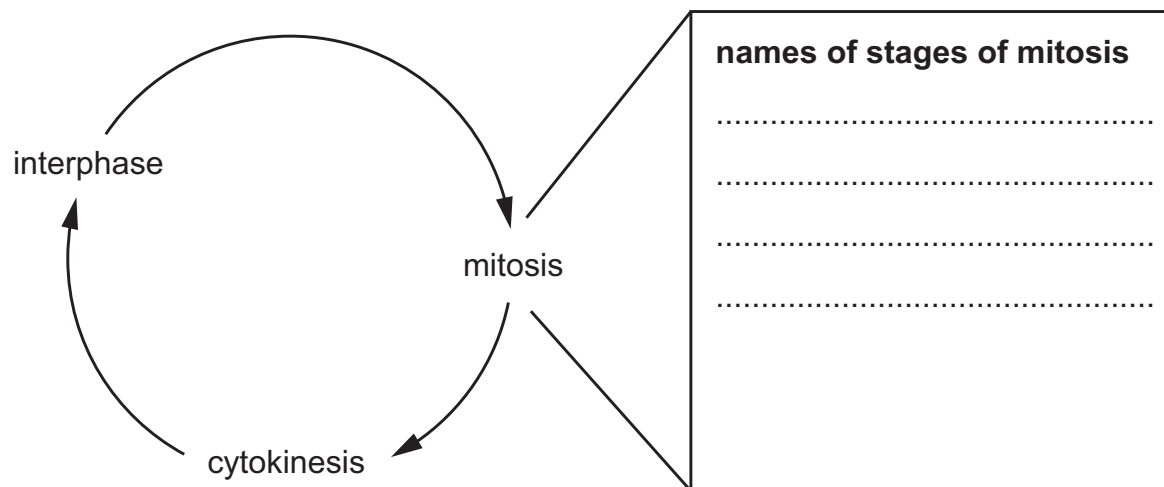


Fig. 1.3

[1]

- (ii) One of the functions of a Paneth cell is to synthesise and secrete peptides and proteins that act against pathogens in the gut lumen.

State **and** explain the evidence, **visible in Fig. 1.2**, which suggests that a Paneth cell:

- is a secretory cell
- synthesises many peptides and proteins.

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..... [3]

- (iii) Explain why a Paneth cell has a very different appearance to an intestinal stem cell.

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..... [1]

2 Collagen is a fibrous protein found in many tissues in animals.

Fig. 2.1 shows the composition of a collagen fibre.

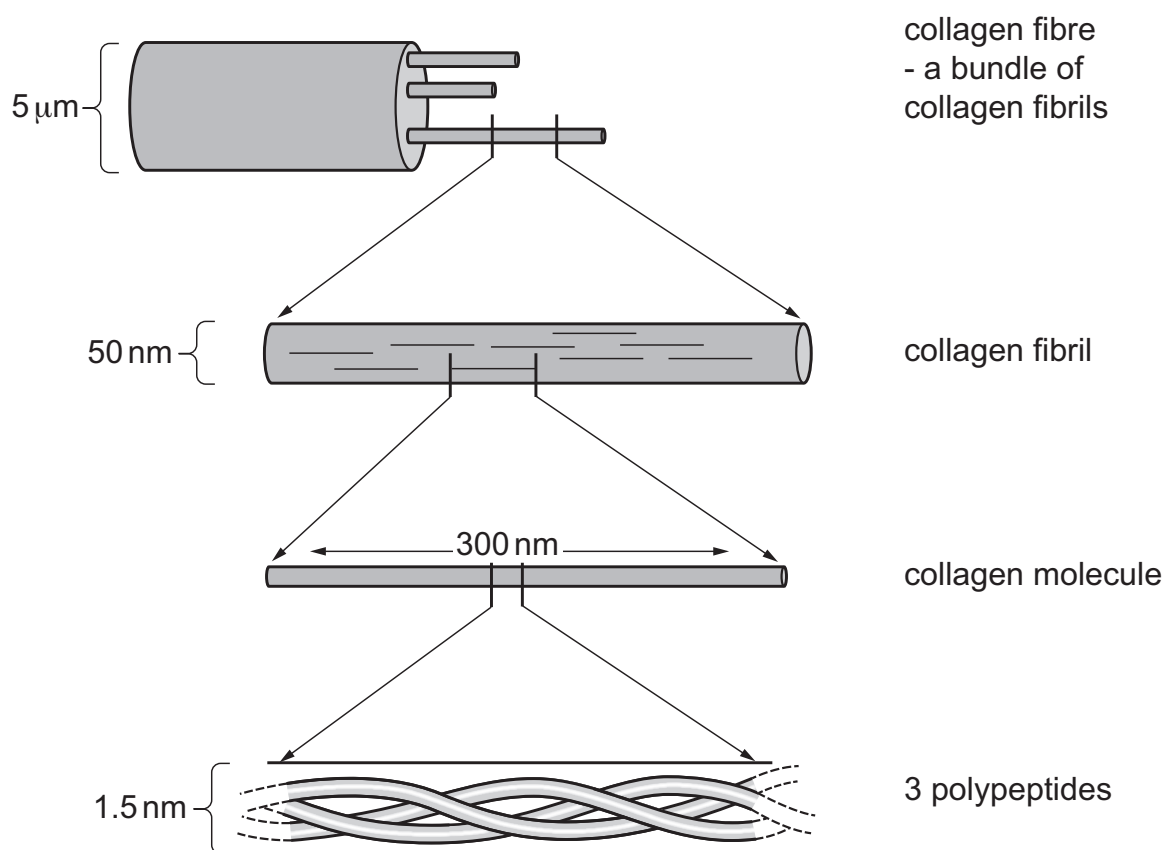


Fig. 2.1

(a) (i) Describe the arrangement of the 3 polypeptides in each molecule of collagen.

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..... [2]

(ii) With reference to Fig. 2.1, explain how the molecules of collagen are arranged **and** held together in a collagen fibril.

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- (b) Collagen fibres and elastic fibres are found in the structures of the gas exchange system of mammals.
- (i) Suggest **two** properties of collagen that contribute to the function of cartilage in the trachea in the gas exchange system.

[2]

- (ii) State the function of elastic fibres in the alveoli in the lungs.

[1]

- (c) Table 2.1 shows the DNA triplets in the two strands of DNA in part of a gene that codes for one of the polypeptides in collagen.

Table 2.1

non-transcribed strand	GGT	CCA	ATG	GGT	CCC	CGA	GGT	CCC	CCA	GGT
template strand	CCA	GGT	TAC	CCA	GGG	GCT	CCA	GGG	GGT	CCA
amino acid	gly									

Table 2.2 shows the triplets of bases in **DNA** and the amino acids for which they code.

The table can be used to determine the sequence of the amino acids in a polypeptide.

Table 2.2

		second base										
first base			T		C		A		G			third base
		T	TTT	phe	TCT	ser	TAT	tyr	TGT	cys	T	
			TTC		TCC		TAC		TGC		C	
			TTA	leu	TCA		stop	TGA	stop	A		
			TTG		TCG			TAG	TGG	trp	G	
		C	CTT	leu	CCT	pro	CAT	his	CGT	arg	T	
			CTC		CCC		CAC		CGC		C	
			CTA		CCA		gln	CGA	A			
			CTG		CCG			CAG	CGG		G	
		A	ATT	ile	ACT	thr	AAT	asn	AGT	ser	T	
			ATC		ACC		AAC		AGC		C	
			ATA		ACA		AAA	lys	AGA	arg	A	
			ATG	met	ACG		AAG		AGG		G	
		G	GTT	val	GCT	ala	GAT	asp	GGT	gly	T	
			GTC		GCC		GAC		GGC		C	
			GTA		GCA		glu	GGA	A			
	GTG		GCG		GAG			GGG	G			

- (i) Complete Table 2.1 to show the amino acids coded by the DNA nucleotide sequence in Table 2.1. [1]

(ii) The sequence of amino acids that you have worked out is representative of the whole of the collagen polypeptide.

Explain how the sequence of amino acids makes the polypeptide suitable as a component of a collagen molecule.

[3]

- (iii) Two mutations, **P** and **Q**, can have an effect on the primary structure of the polypeptide.
- Mutation **P** is a deletion of the first nucleotide pair in the DNA nucleotide sequence shown in Table 2.1.
 - Mutation **Q** is a substitution of G with T as the first base in the DNA nucleotide sequence shown in Table 2.1.

State the effects of the mutations, **P** and **Q**, on the primary structure of the polypeptide.

mutation **P**

mutation **Q**

[2]

[Total: 14]

- 4 In mammals, the gas exchange system includes a set of branching airways that carry air to and from the gas exchange surface.

Air from the external atmosphere passes through different types of airway to reach the gas exchange surface.

- (a) Name the type of airway of the gas exchange system that branches into airways known as bronchioles.

..... [1]

- (b) Fig. 4.1 is a photomicrograph of a section through a bronchiole.

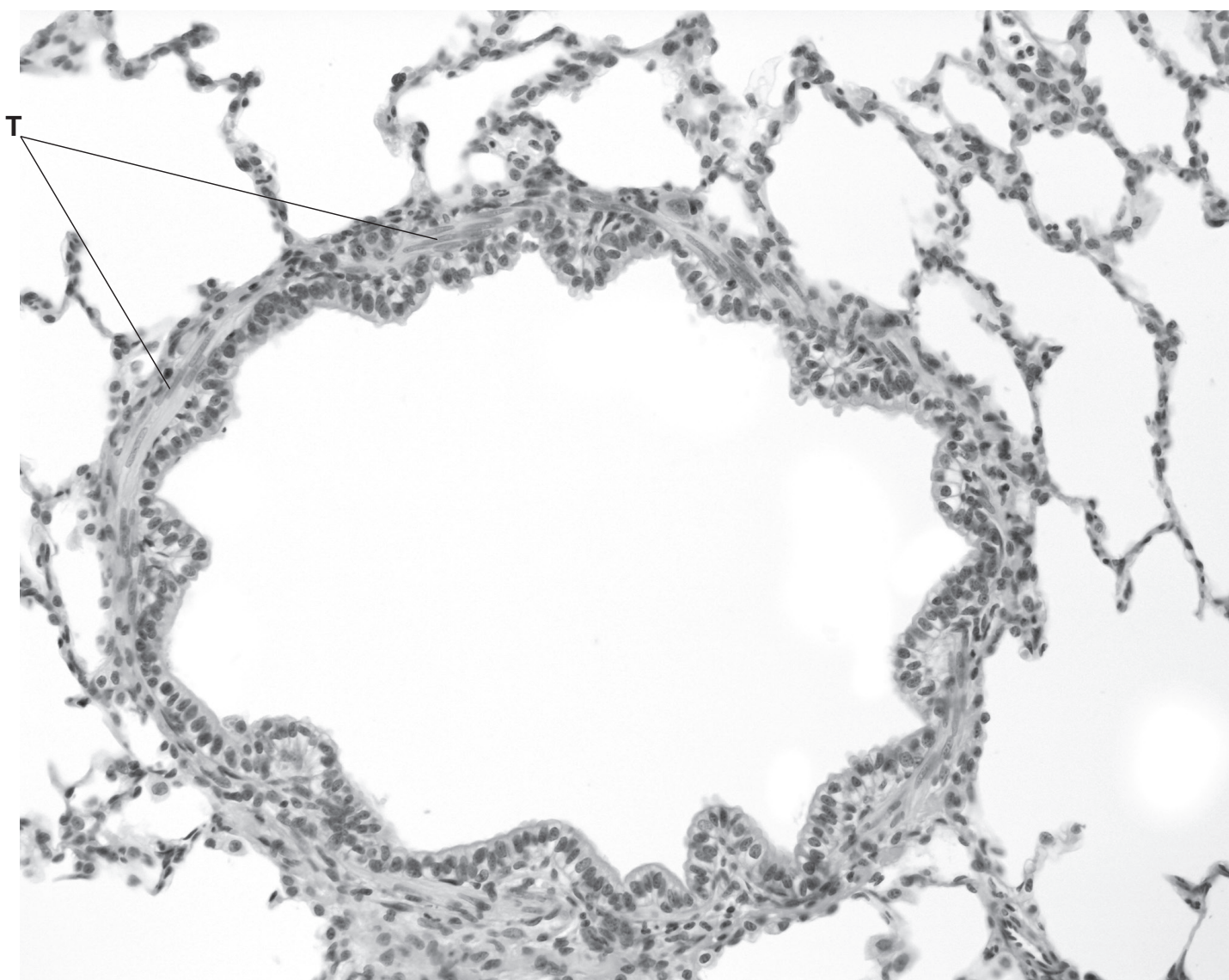


Fig. 4.1

(i) The bronchiole shown in Fig. 4.1 is **not** part of the gas exchange surface.

Name **one** structure in the gas exchange system, **visible in Fig. 4.1**, where gas exchange is carried out.

..... [1]

(ii) Name the type of cell found in the tissue labelled **T** in Fig. 4.1.

..... [1]

(iii) State the features that help to identify the type of airway shown in Fig. 4.1 as a bronchiole and **not** the other types of airway present in the gas exchange system.

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..... [3]

(c) Blood is pumped to the lungs in the pulmonary circulation.

The lungs also receive a supply of blood from the systemic circulation.

Explain why the pulmonary circulation **and** the systemic circulation need to supply blood to the lungs.

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

[Total: 8]

2 Compounds containing nitrite ions (NO_2^-) are present in many foods eaten by humans.

Scientists tested the effect of different concentrations of nitrite ions on the population growth of 5 species of bacterium. All 5 species are pathogenic and can infect the human digestive system.

For each species of bacterium, the scientists placed suspensions of the bacteria in a microwell plate. A microwell plate is a plastic plate containing 96 wells, which are similar to small test-tubes.

In each well, the scientists added:

- a suspension of the bacterial species
- a solution containing nitrite ions
- nutrient broth.

The scientists incubated the microwell plate at 37°C for 24 hours. After 24 hours, the scientists estimated the number of bacteria in each well by measuring optical density, using a microwell plate reader.

For each species of bacterium, the scientists repeated the experiment with several different concentrations of solution containing nitrite ions.

The scientists determined the lowest nitrite concentration at which no bacterial population growth had occurred after 24 hours.

(a) The scientists standardised temperature, pH (pH4.8) and time in the investigation.

State **two other** variables that the scientists should standardise in this investigation.

1

2

[2]

(b) The results of the investigation are shown in Fig. 2.1.

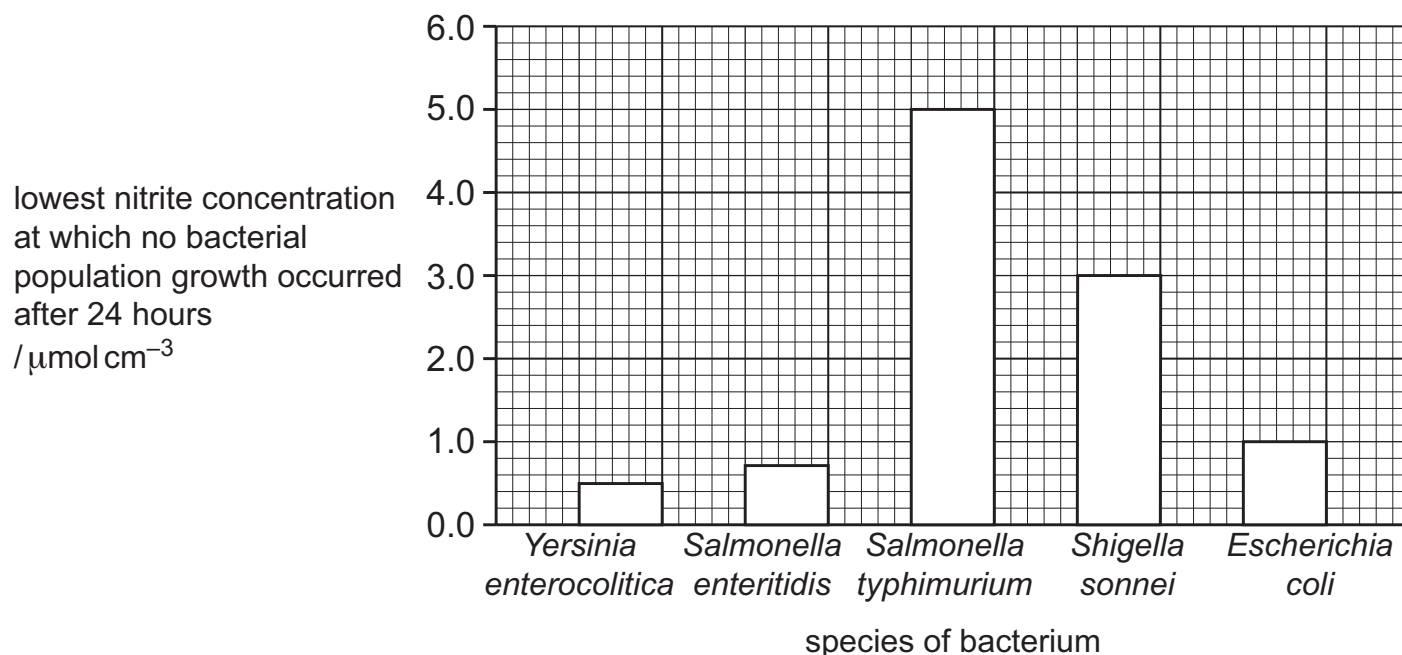


Fig. 2.1

- (i) State the type of **data** represented by the species of bacterium and the lowest nitrite concentration in Fig. 2.1.

species of bacterium

lowest nitrite concentration

[2]

- (ii) The 2 species of *Salmonella* shown in Fig. 2.1 are closely related.

Calculate the percentage difference between the results shown in Fig. 2.1 for the 2 species of *Salmonella*.

Show your working.

.....%

[3]

- (iii) Use Fig. 2.1 to state:

- the species of bacterium that is most affected by nitrite ions
- the species of bacterium that is least affected by nitrite ions.

most affected

least affected

(c) A student looked at the results and stated:

Consuming a lot of nitrites would improve the health of people because it would help to prevent diseases in the digestive system caused by pathogenic bacteria.

Suggest **four** reasons why this conclusion might **not** be valid.

- 1
-
- 2
-
- 3
-
- 4
-

[4]

[Total: 12]