Cambridge International AS & A Level

BIOLOGY (9700) PAPER 2

Past Paper Questions By Topic
+ Answer Scheme

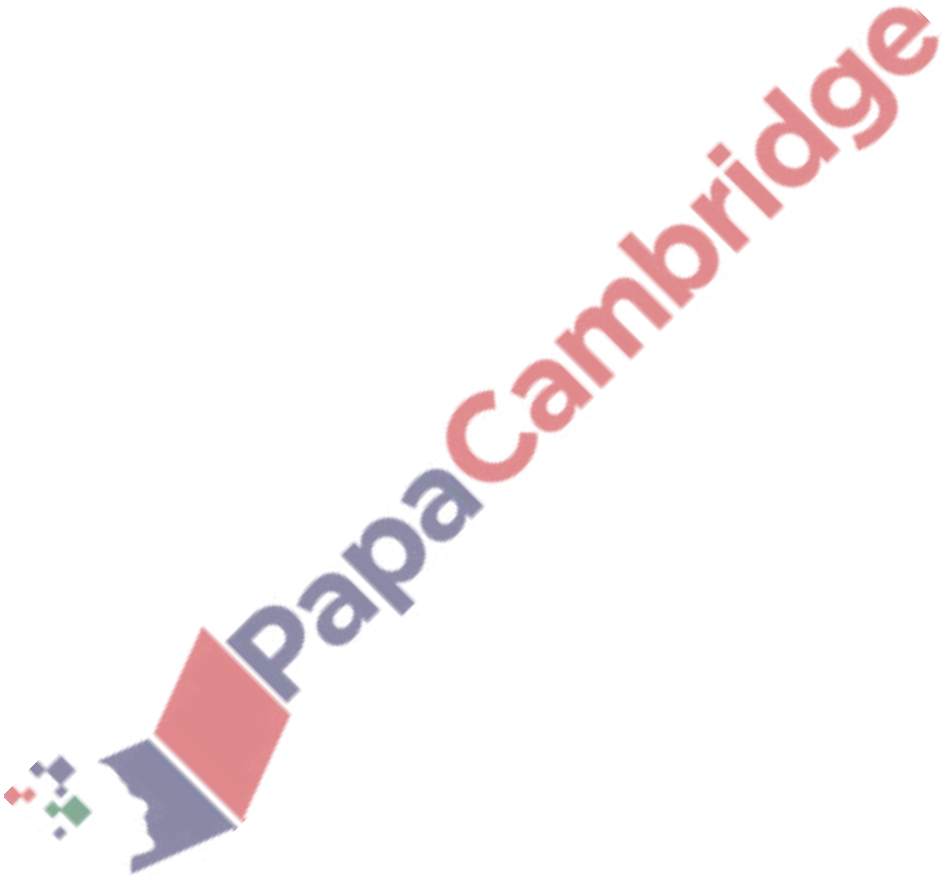
2015 - 2020

Complete Syllabus

PapaCambridge

Chapter 10

Infectious disease



10.1 Infectious diseases

183. 9700_s19_qp_22 Q: 4

The bacterium *Vibrio cholerae* is the causative organism of the infectious disease cholera.

V. cholerae has structural features typical of all bacterial cells. It also has a flagellum for movement.

(a) Fig. 4.1 is an outline drawing of *V. cholerae*.

Complete Fig. 4.1 by drawing **and** labelling the structures found in *V. cholerae*.

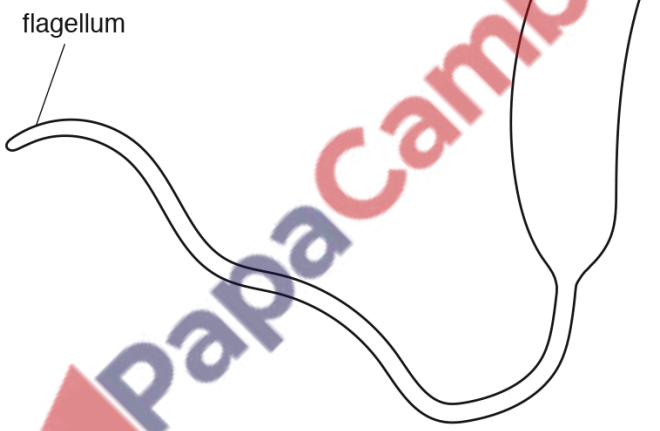


Fig. 4.1

[4]

(b) The World Health Organization (WHO) collects data about cholera from the 194 countries that are members of the World Health Assembly (WHA).

In 2015:

- there were cases of cholera in 42 of the member countries of the WHA
- the total number of cases of cholera reported was 172 454
- there were deaths as a result of cholera in 23 of these countries
- the total number of deaths from cholera reported was 1304.

The case fatality rate for cholera is the proportion of cases of cholera that results in death within a particular time period.

A country with cases of cholera that are properly treated should have a case fatality rate of less than 1%.

(i) Calculate the case fatality rate for the 42 member countries of the WHA for 2015.

Give your answer to the nearest 0.1%.

case fatality rate = ... % [1]

(ii) Many of the 23 countries reporting deaths from cholera in 2015 had a case fatality rate of less than 1%.

However, two of the 23 countries had case fatality rates greater than 5%.

Suggest **two** explanations for the higher case fatality rate in these two countries.

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(c) In 2010, the country of Haiti experienced a major earthquake. This led to an outbreak of cholera.

(i) Explain why an earthquake may lead to a cholera outbreak.

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..... [1]

(ii) Fig. 4.2 shows data about cholera collected by WHO over a period of 8 years, from 2008 to 2015. These data include:

- the total number of cases of cholera for each year
- the number of countries in each year that had cases of cholera.

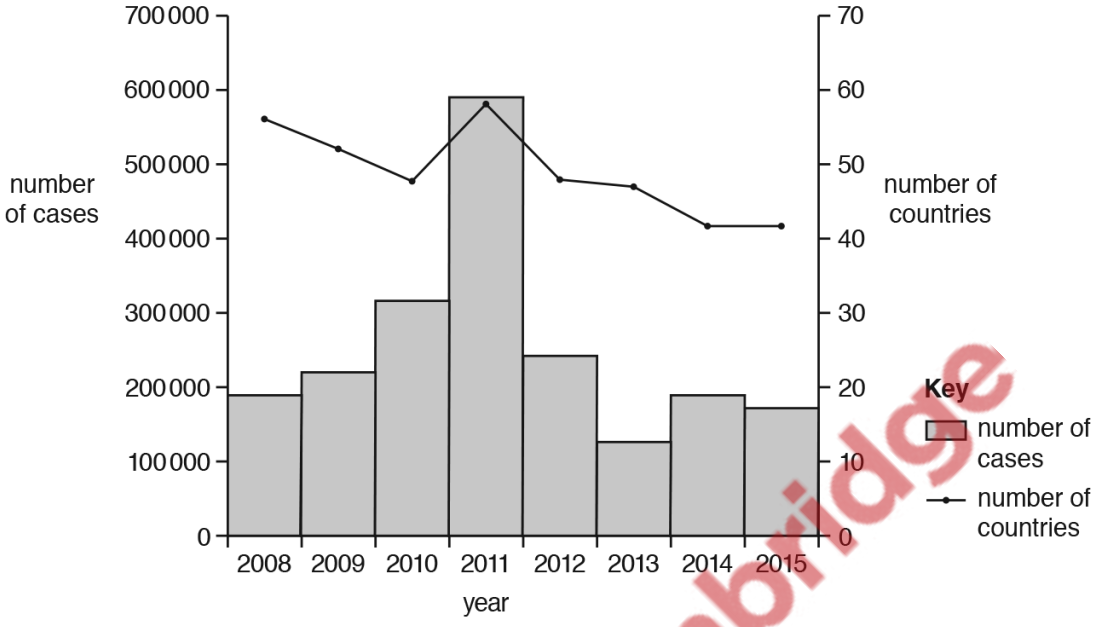

Fig. 4.2

Comment on the trends shown in Fig. 4.2.

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[Total: 11]

184. 9700_s18_qp_22 Q: 5

When tobacco smoke is inhaled, chemicals such as nicotine and carbon monoxide enter the circulatory system through the gas exchange system. Tar builds up on the lining of the gas exchange system.

Many people decide to give up smoking tobacco in order to improve their health.

(a) Some of the structures in the human gas exchange system through which tobacco smoke passes are shown in Fig. 5.1.

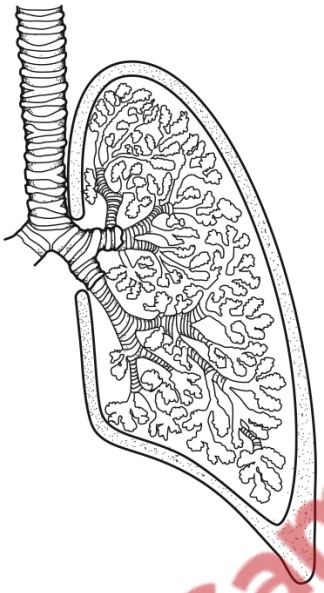

Fig. 5.1

Describe the gross structure of the human gas exchange system.

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(b) Soon after a person stops smoking, the short term effects of nicotine are reversed.

State the **changes** that will occur in the cardiovascular system as a result of reduced nicotine levels.

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(c) Fig. 5.2 shows oxygen dissociation curves for adult haemoglobin.

Curve **A** shows measurements obtained from a person who is a heavy smoker.

Curve **B** shows measurements obtained several weeks after the same person stopped smoking.

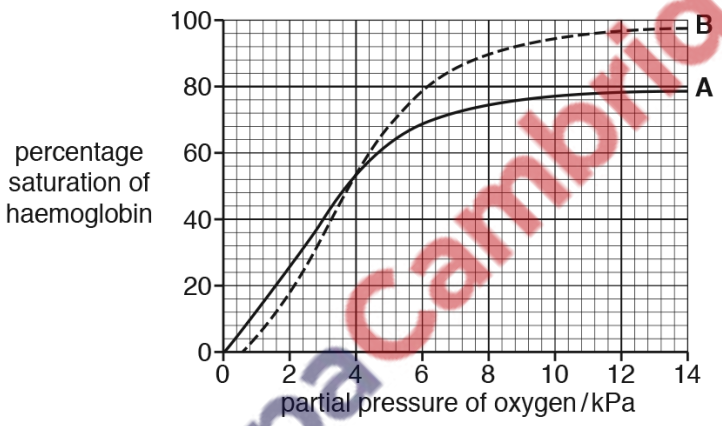

Fig. 5.2

With reference to Fig. 5.2, describe and explain how the results show some of the health benefits of stopping smoking.

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(d) A person who gives up smoking decreases their risk of developing lung cancer, a non-infectious disease.

Explain why lung cancer is described as a *non-infectious disease*.

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[Total: 11]

185. 9700_s18_qp_23 Q: 4

Oxygen enters the blood stream from the alveoli in the lungs and carbon dioxide leaves the bloodstream to enter the alveoli. Most of the oxygen is carried by haemoglobin in red blood cells to the body tissues.

(a) Outline how oxygen enters the blood stream from an alveolus.

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Fig. 4.1 is an oxygen dissociation curve for adult haemoglobin. The curve shows the affinity of haemoglobin for oxygen at the range of partial pressures found in the body.

The values for plotting the curve are obtained in the laboratory by bubbling oxygen at different partial pressures through a solution of haemoglobin at 37 °C and pH 7.4. At a different temperature or pH the measured values will change, resulting in a different oxygen dissociation curve.

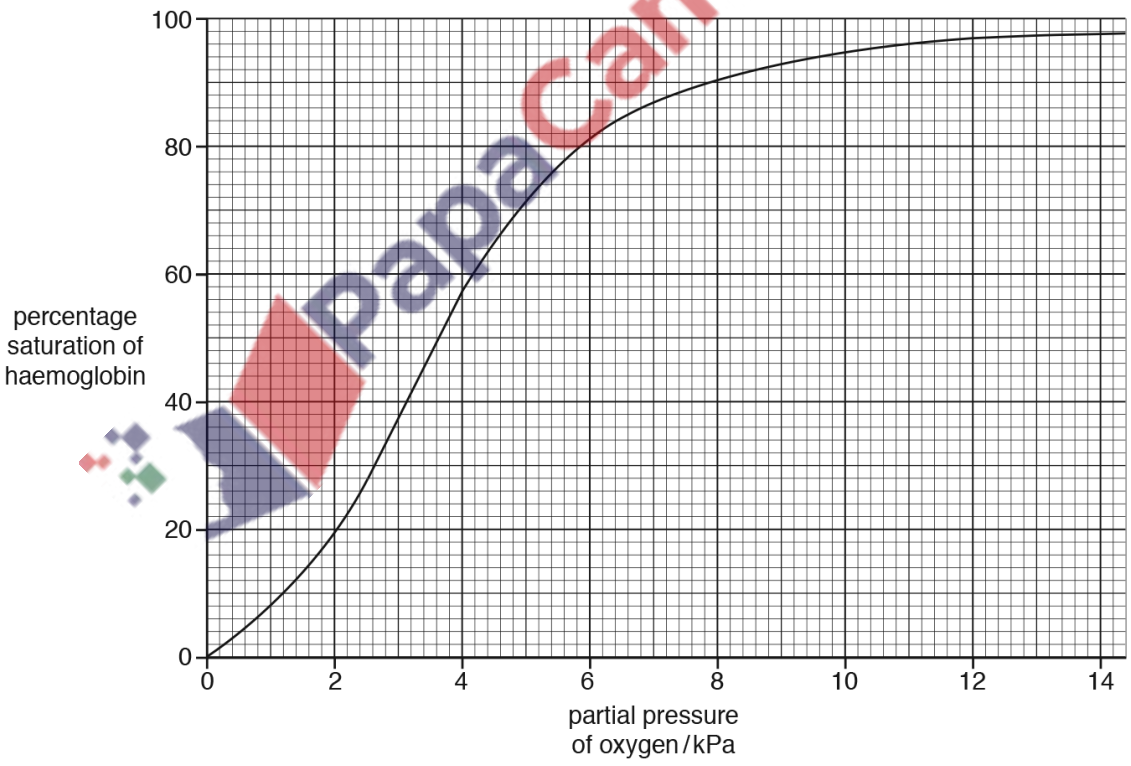

Fig. 4.1

(b) Fig. 4.1 shows that the percentage saturation of haemoglobin changes at different partial pressures of oxygen.

(i) Use Fig. 4.1 to calculate the difference in percentage saturation of haemoglobin at the lower partial pressure of oxygen of 2.7 kPa compared to the higher partial pressure of 13.0 kPa.

Show your working.

difference = ...[1]

(ii) Explain the advantage of having a difference in percentage saturation of haemoglobin at lower and higher partial pressures of oxygen.

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In a person with sickle cell anaemia, the ability of haemoglobin to transport oxygen and carbon dioxide is severely affected.

The cause of this disease is a mutation in the gene coding for the β-globin polypeptide of haemoglobin.

(c) Define the term *disease*.

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.....[2]

(d) Outline the differences between the Hb^A (normal) and Hb^S (sickle cell) alleles of the gene coding for the β-globin polypeptide **and** explain how these differences lead to a change in the haemoglobin molecule formed.

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[Total: 14]

186. 9700_s18_qp_23 Q: 6

(a) Fig. 6.1 is a list of infectious diseases. Each of the statements **A** to **D** describes a feature that applies to one or more of these diseases.

cholera
HIV/AIDS
malaria
measles
smallpox
tuberculosis (TB)

Fig. 6.1

For each of the statements **A**, **B**, **C** and **D**, name **all** the diseases in Fig. 6.1 that match the feature described.

A The causative organism of the disease is a virus.

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B The causative organism of the disease is a prokaryote.

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C The disease is transmitted by a faecal-oral route, for example, sewage containing the pathogen contaminates drinking water.

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D The causative organism of the disease spends part of its life cycle inside an insect, which acts as a vector of the disease.

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[4]

(b) Although many infectious diseases are caused by prokaryotic organisms, there are some that are caused by eukaryotic organisms.

Complete Table 6.1 to show some differences between a prokaryotic cell and a eukaryotic cell.

Table 6.1

prokaryotic cell	eukaryotic cell
no true nucleus, genetic material not enclosed	true nucleus, genetic material enclosed by a double membrane known as a .....
..... DNA	linear DNA
70S ribosomes only	70S and ..... ribosomes
no double membrane-bound organelles	double membrane-bound organelles such as .....
cell wall contains	where cell wall is present, generally contains mainly cellulose or chitin

[2]

[Total: 6]

187. 9700_w18_qp_23 Q: 5

The bacteria that cause tuberculosis (TB) can be found in many parts of the body including the lungs.

(a) (i) State the name of the bacterium that causes TB.

..... [1]

(ii) The presence of the pathogen in the lungs attracts phagocytes to the area of infection. The phagocytes release elastase, which digests elastin.

Many people with TB feel tired all the time.

Suggest **and** explain how the effect of phagocytes on tissues in the lungs leads to people feeling tired all the time.

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(b) Discuss the **biological** factors and **social** factors that make TB a difficult disease to control.

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[Total: 9]

188. 9700_s17_qp_22 Q: 3

Malaria is a disease caused by the protoctist, *Plasmodium*. The organism has a very complex life cycle as it has two hosts, a human and a mosquito.

(a) Name **one** of the four species of *Plasmodium* that infects humans.

.....[1]

(b) State the name of the mosquito that is host to *Plasmodium*.

.....[1]

Fig. 3.1 is a transmission electron micrograph showing the developing *Plasmodium* cells inside a protective structure known as an oocyst. In this stage of the life cycle the oocysts are found in the mosquito gut. When mature, the *Plasmodium* cells are released and travel to the salivary glands of the mosquito.

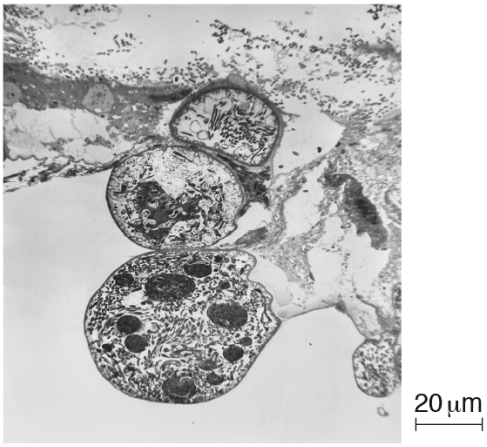

Fig. 3.1

(c) The magnification used in Fig. 3.1 can also be obtained using a light microscope.

Suggest why an electron microscope was used to obtain this image instead of a light microscope.

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.....[2]

(d) Use the scale bar to calculate the magnification of the image shown in Fig. 3.1.

Write down the formula and use it to make your calculation. Show your working.

formula

magnification × .....[3]

(e) Outline the role of the mosquito in the transmission of malaria.

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[Total: 9]

189. 9700_s16_qp_21 Q: 1

Table 1.1 shows features of three infectious diseases: malaria, tuberculosis (TB) and cholera.

Complete Table 1.1.

Table 1.1

feature	malaria	tuberculosis	cholera
name of pathogen	……..... *falciparum*	*Mycobacterium tuberculosis*	……..... …….....
type of organism	…….....	bacterium	…….....
method of transmission	……..... ……..... …….....	……..... ……..... …….....	drinking water and food contaminated with human faeces

[6]

[Total: 6]

190. 9700_s15_qp_22 Q: 2

Fig. 2.1 is a scanning electron micrograph of an area of the trachea showing the presence of *Bordetella pertussis* bacteria.

B. pertussis is the causative organism of a respiratory disease in humans known as whooping cough. The disease is transmitted from person to person in a similar way to tuberculosis (TB).

A symptom that is common to TB and to whooping cough is the production of an excess of mucus.

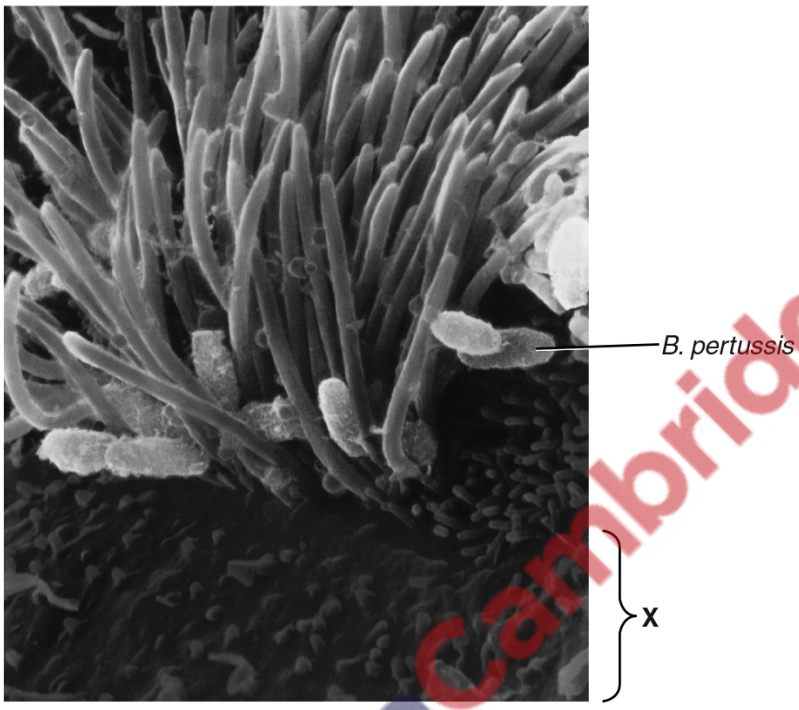

Fig. 2.1

(a) Describe the damage caused by *B. pertussis* that is shown in the area labelled **X** on Fig. 2.1 **and** explain how this will affect the functioning of the epithelial tissue of the trachea.

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.....[3]

(b) Goblet cells produce mucus. Name one other structure in the gas exchange system that also produces mucus.

.....[1]

(c) Suggest how whooping cough is transmitted.

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.....[2]

(d) The presence of *B. pertussis* stimulates the production of mucin, a gel-like glycoprotein that is the main component of mucus.

The mucin produced by the cell is packaged into vesicles ready for exocytosis.

(i) The first stage in the production of mucin involves transcription of the gene *MUC5AC*.

Outline the stages occurring in transcription.

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(ii) Following translation, the polypeptide formed is modified by the addition of many short chains of monosaccharides in a process called glycosylation.

Suggest where glycosylation occurs in the cell **and** explain why mucin is packaged into vesicles.

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.....[2]

(e) Overproduction of mucus is one of the symptoms of chronic obstructive pulmonary disease (COPD).

Describe the signs and symptoms that enable diagnosis of COPD.

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[Total: 16]

191. 9700_w15_qp_22 Q: 5

Diseases can be infectious or non-infectious.

(a) Explain the difference between an infectious and a non-infectious disease.

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..... [2]

Malaria is an infectious disease caused by *Plasmodium*. *Plasmodium* requires two hosts to complete its complex life cycle. One of the hosts is the *Anopheles* mosquito, which acts as a vector of malaria.

Transmission of malaria occurs when females of some species of *Anopheles* take blood meals from humans infected with *Plasmodium*, and then feed on uninfected individuals.

Both male and female *Anopheles* mosquitos have piercing and sucking mouthparts. The female mosquito is shown in Fig. 5.1.

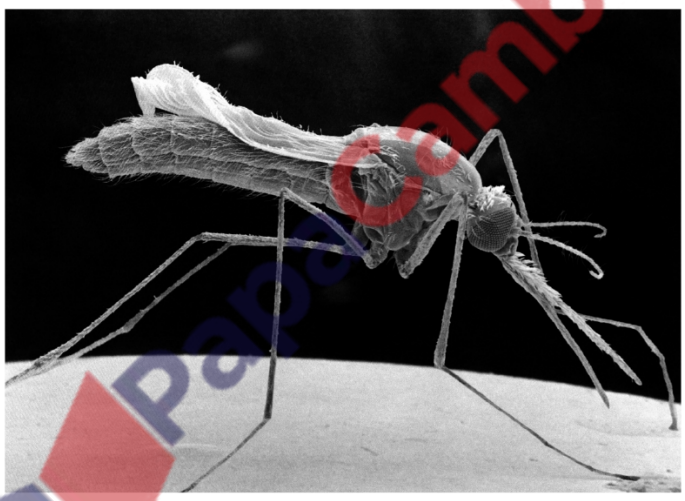

Fig. 5.1

(b) The blood meals are a good source of protein for *Anopheles* for the production of eggs.

Explain why blood is a good source of protein.

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(c) Fig. 5.2 shows the global distribution of those species of *Anopheles* that are able to act as hosts for Plasmodium.

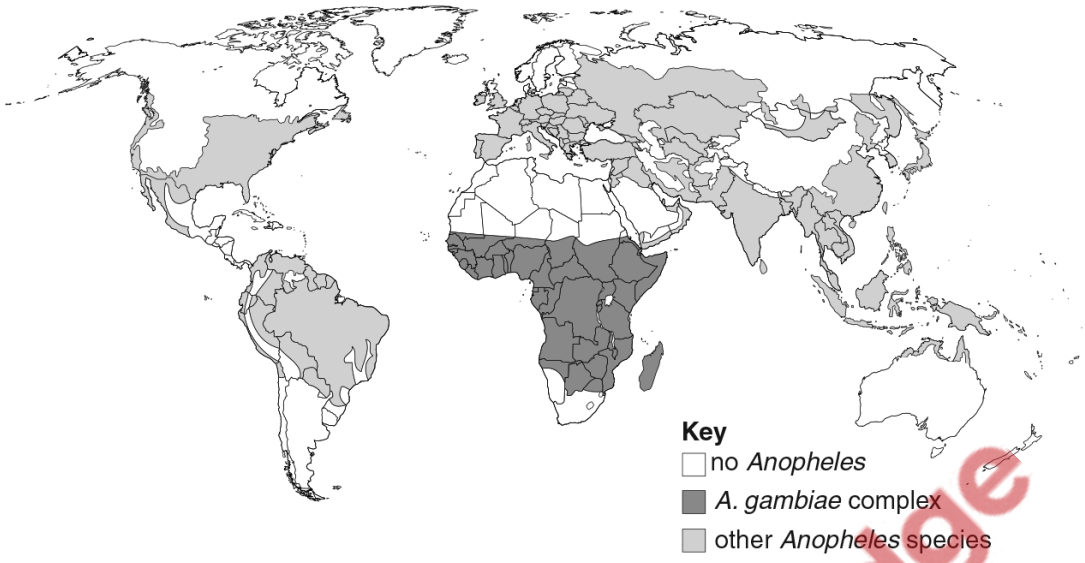

Fig. 5.2

(i) Describe **and** explain the difference between the global distribution of *Anopheles* shown in Fig. 5.2 and the global distribution of malaria.

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(ii) The distribution of *Anopheles* shown in Fig. 5.2 includes over forty different species that are vectors of malaria. The areas with the highest number of cases of malaria are also the areas where *Anopheles gambiae* occurs. *A. gambiae* is responsible for most of the transmission of the disease in these areas.

Suggest why *A. gambiae* is responsible for most of the transmission of *Plasmodium*.

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Fig. 5.3 is part of a complex food web in an area of Kenya where the larvae and adults of *A. gambiae* occur.

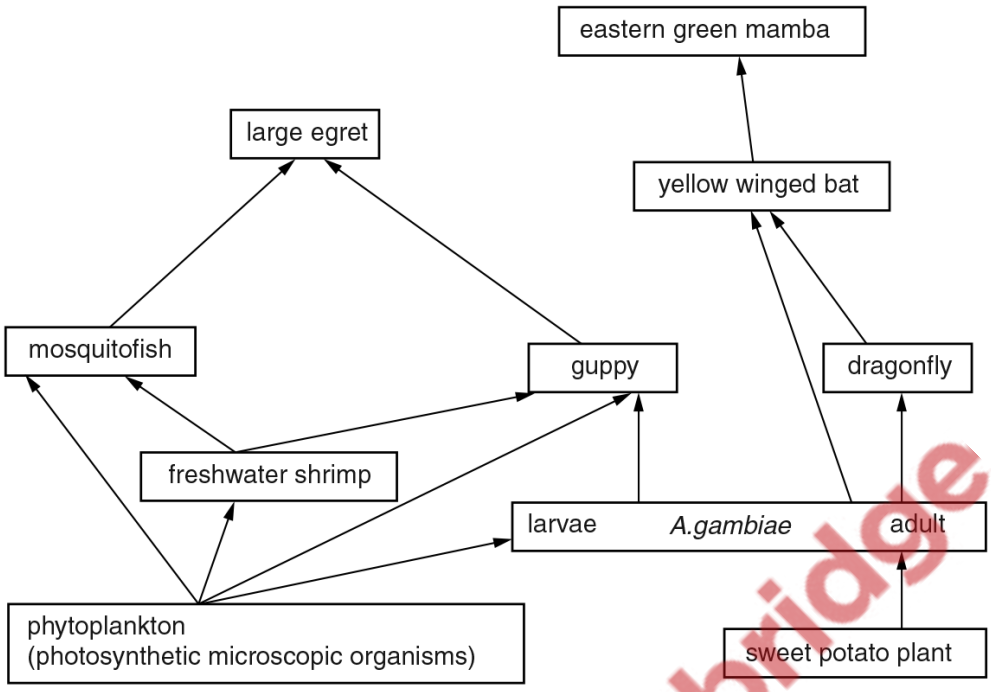

Fig. 5.3

(d) (i) Name **one** organism in Fig. 5.3 that is a tertiary consumer.

..... [1]

(ii) Explain, in terms of energy transfer, why it is likely that the eastern green mamba feeds on other organisms in addition to yellow winged bats.

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..... [3]

(iii) Suggest how the information in Fig. 5.3 can be used in the control of malaria in other areas of Kenya.

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(e) Both male and female adult *A. gambiae* feed on sweet potato plants. Fig. 5.4 shows a sweet potato plant.

Fig. 5.4

Suggest the parts of the sweet potato plants that are the main source of food for adult *A. gambiae* **and e**xplain your answer.

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[Total: 18]

10.2 Antibiotics

192. 9700_w20_qp_21 Q: 3

(a) The circulatory system of mammals is a double circulation.

(i) Explain what is meant by the term double circulation.

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..... [1]

(ii) Fig. 3.1 is a photograph showing one valve in the mammalian heart.

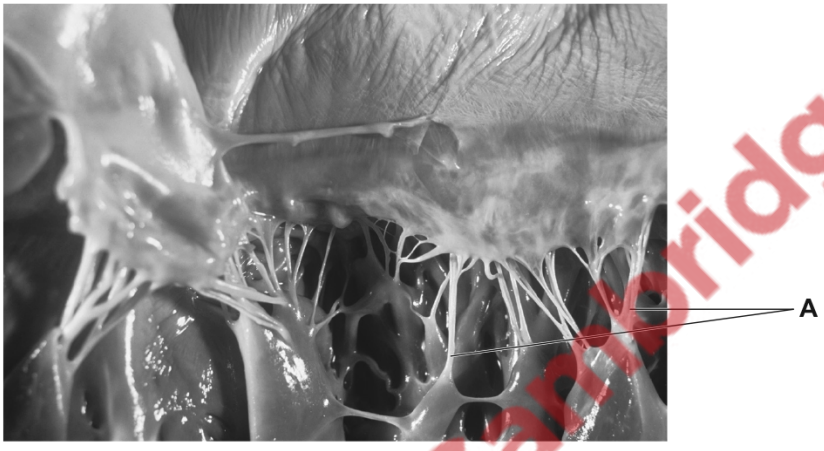

Fig. 3.1

Identify the structures labelled **A** in Fig. 3.1 **and** describe their role during the cardiac cycle.

structure **A** .....

role of structure **A**

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[3]

(b) The endocardium is a thin layer of tissue lining the chambers of the heart. A serious condition called endocarditis results if bacteria infect this tissue.

Endocarditis is treated with a combination of antibiotics. This increases the effectiveness of the treatment and reduces the risk of antibiotic resistance in bacteria.

Table 3.1 shows the action of two antibiotics used together to treat endocarditis.

Table 3.1

antibiotic used in treatment	action of antibiotic
gentamicin	binds permanently to the bacterial ribosomes
penicillin G	inhibits an enzyme involved in cell wall synthesis

(i) With reference to Table 3.1, explain why treating endocarditis with a combination of gentamicin and penicillin G reduces the risk of developing antibiotic resistance.

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(ii) Describe how the bacteria that cause endocarditis could become resistant to gentamicin.

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[Total: 9]

193. 9700_w20_qp_22 Q: 2

The treatment for people with active tuberculosis (TB) lasts six months and involves a combination of antibiotics. This is usually very effective if the person has a susceptible (non-resistant) strain of *Mycobacterium tuberculosis*, the causative organism of TB.

Table 2.1 summarises one recommended treatment strategy that involves a combination of antibiotics.

Table 2.1

antibiotic	length of treatment	mode of action of antibiotic
rifampicin (R)	6 months	enters bacterial cells and inhibits protein synthesis
isoniazid (H)	6 months	prevents the synthesis of cell wall components known as mycolic acids
ethambutol (E)	first two months	prevents mycolic acids from being added to the cell wall
pyrazinamide (Z)	first two months	prevents the synthesis of fatty acids

(a) Susceptible strains of *M. tuberculosis* will be killed using any one of the antibiotics listed in Table 2.1. However, combination treatment is preferred as it is one method that can be used to reduce the impact to society of antibiotic resistance.

With reference to Table 2.1, explain how combination treatment for TB can help to reduce the impact of antibiotic resistance compared to single antibiotic treatment.

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Rifampicin binds tightly to an RNA polymerase molecule close to its active site. This affects the activity of the enzyme.

(b) (i) RNA polymerase catalyses the formation of messenger RNA (mRNA) from DNA.

State the term for this process.

..... [1]

(ii) During the formation of RNA, a number of events occur that involve the action of RNA polymerase.

Suggest ways in which rifampicin can affect the activity of RNA polymerase.

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..... [3]

(c) RNA polymerase is composed of five different polypeptides. Gene *rpoB* codes for one of these polypeptides known as the β-subunit.

One or more mutations in a specific region of *rpoB* result in strains of *M. tuberculosis* that are resistant to rifampicin. In these strains, mutations often occur in two DNA triplets in this region, in positions 526 and 531.

Table 2.2 summarises the results of an investigation into seven rifampicin-resistant strains, **A** to **G**, that have amino acid changes for positions 526 and 531.

Table 2.2 includes:

- the change in the **mRNA codon** for position 526 or position 531
- the amino acid change that has occurred as a result of the mutation
- the minimum concentration of rifampicin required to inhibit growth of the bacterial strain (MIC)
- the number of **other** mutations occurring within the specific region of *rpoB*.

Table 2.2

Key
≈ approximately ⩾ greater than or equal to ⩽ less than or equal to

strain	codon involved	mRNA codon change	amino acid change	MIC / $\mu g\ cm^{-3}$	number of other mutations in the specific region
A	526	CAC ⟶ UAC	His ⟶ Tyr	⩽50	0
B	526	CAC ⟶ AAC	His ⟶ Asn	⩾100	1
C	526	CAC ⟶ CGC	His ⟶ Arg	≈50–75	2
D	526	CAC ⟶ CGC	His ⟶ Arg	⩾100	3
E	526	CAC ⟶ CGC	His ⟶ Arg	≈50	3
F	526	CAC ⟶ UUC	His ⟶	⩾100	3
	531	UCG ⟶ UUG	Ser ⟶ Leu		
G	526	CAC ⟶ UAC	His ⟶	⩾100	3
	531	UCG ⟶ UUC	Ser ⟶ Phe		

(i) Complete Table 2.2 to show the amino acid changes that have occurred in strains **F** and **G**.

[1]

(ii) With reference to Table 2.2, list the strains of *M. tuberculosis* that show the greatest resistance to rifampicin.

..... [1]

(iii) Suggest reasons to explain why strains **C**, **D** and **E** show:

- resistance to rifampicin
- different levels of resistances to rifampicin.

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[Total: 13]

194. 9700_w20_qp_23 Q: 4

Antibiotic sensitivity tests can be carried out to choose appropriate antibiotics to use for treatment of bacterial diseases.

A researcher carried out an antibiotic sensitivity test using two pathogenic bacteria, **X** and **Y**.

The researcher prepared two Petri dishes containing agar.

- A culture of each bacterium was spread over the surface of the agar.
- Filter paper discs containing antibiotics were placed on the surface of the agar in each dish.
- The Petri dishes were incubated at 25 °C for two days.

The results of the test using three antibiotics, **P**, **Q** and **R**, are shown in Fig. 4.1.

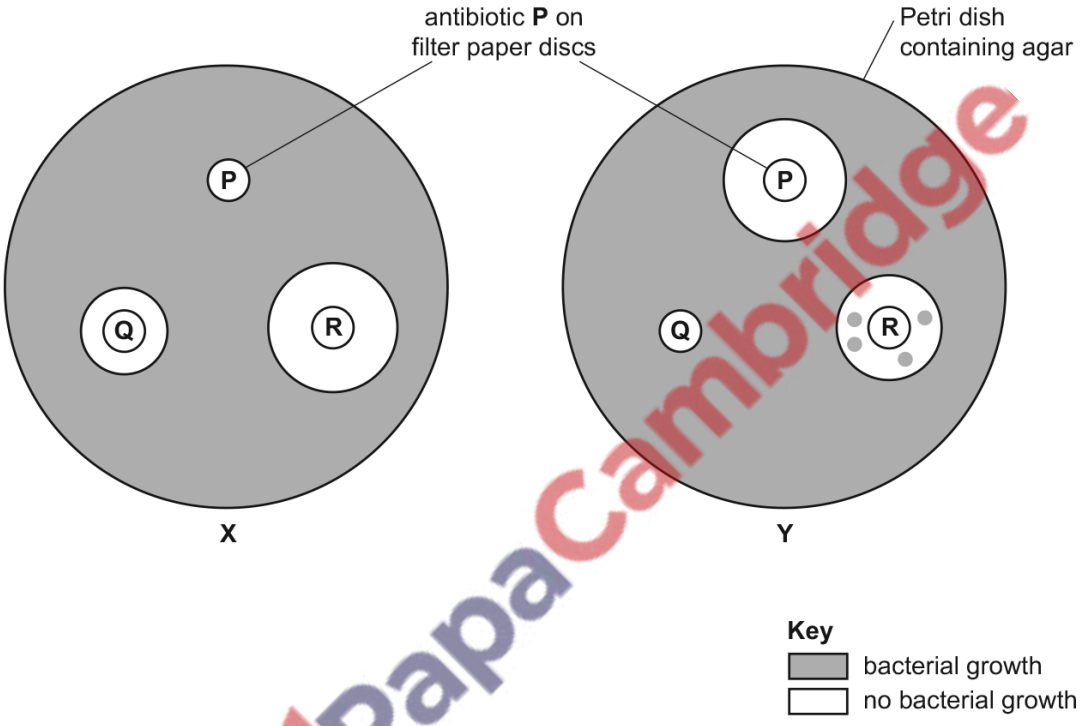

Fig. 4.1

(a) (i) State the most effective antibiotic to treat infections of bacterium **X** and bacterium **Y**.

bacterium **X** .....

bacterium **Y** .....

[1]

(ii) Suggest why bacterium **Y** had a different sensitivity to each of the three antibiotics.

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(b) Explain how the use of vaccines in the control of infectious diseases differs from the use of antibiotics.

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[Total: 6]

195. 9700_s17_qp_21 Q: 6

Cholera bacteria release the toxin, choleragen, when they are in the intestine.

(a) (i) Name the bacterium that is the pathogen of cholera.

.....[1]

(ii) Describe the way in which cholera is transmitted from an infected person to an uninfected person.

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Gangliosides are glycolipids that bind choleragen. These glycolipids are found on many cell surface membranes.

When choleragen is released from the bacteria in the intestine, it binds to gangliosides on epithelial cells and enters these cells as shown in Fig. 6.1.

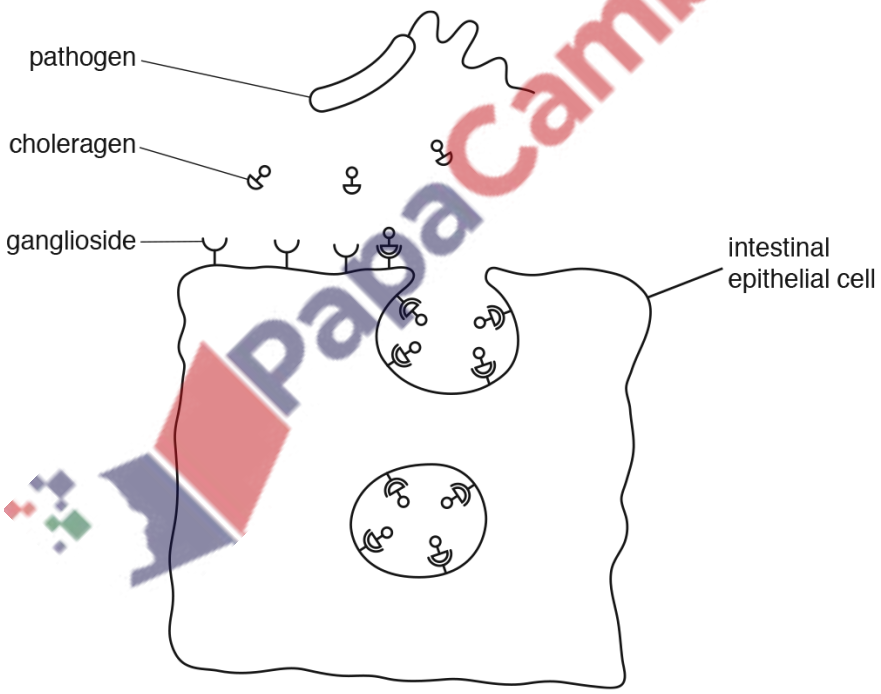

Fig. 6.1 not drawn to scale

(b) Suggest how choleragen interacts with gangliosides on intestinal epithelial cells.

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.....[2]

(c) Name the process by which choleragen enters the intestinal epithelial cell as shown in Fig. 6.1.

.....[1]

Once inside the cells choleragen is activated. One effect is to increase the movement of chloride ions through channel proteins out of cells.

(d) Suggest **and** explain the likely consequences on the intestinal epithelial cells of the loss of chloride ions through the channel proteins.

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.....[2]

(e) Health authorities recommend that antibiotics, such as tetracycline, are **only** to be used for treating people with severe cases of cholera.

Explain why it is recommended that antibiotics should **not** be given to people with mild cases of cholera or to protect people from cholera.

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[Total: 11]

196. 9700_s17_qp_23 Q: 3

(a) Name the causative organism of tuberculosis (TB).

.....[1]

(b) Fig. 3.1 shows the number of deaths from TB and the number of new cases of TB from 1925 to 2010 in Canada.

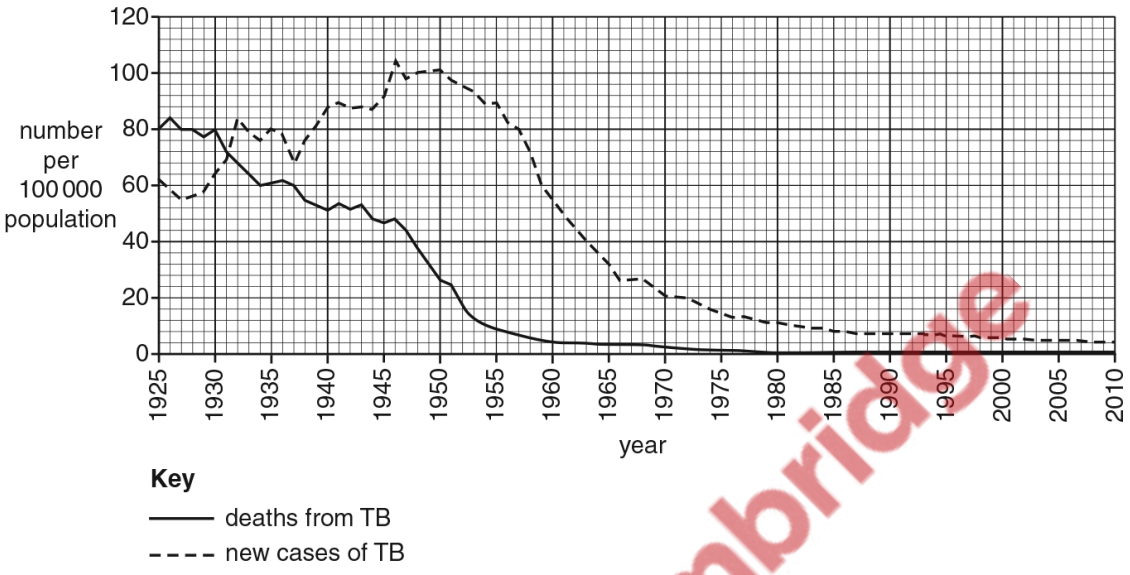

Fig. 3.1

The vaccine for TB was introduced in Canada for widespread use from 1948.

Antibiotics, such as streptomycin, were introduced in Canada from 1940.

Use the information in Fig. 3.1 to comment on the effect of the introduction of the vaccine and antibiotics on the number of new cases and deaths from TB.

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(c) In 2010, Swaziland had one of the highest death rates from TB in the world.

Swaziland also had a high number of new cases of HIV infection in its population in 2010.

People who are infected with HIV are described as HIV+ and people who are **not** infected with HIV are described as HIV–.

Table 3.1 shows the number of deaths from TB in Swaziland in 2010.

Table 3.1

HIV status	number of deaths from TB per 100 000 population
HIV+	400
HIV–	91

Using the information in Table 3.1, suggest why the number of deaths per 100 000 population of people who are HIV+ is much higher than that in people who are HIV–.

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[Total: 9]

197. 9700_s16_qp_23 Q: 5

Tuberculosis (TB) is an infectious disease caused by the bacterium *Mycobacterium tuberculosis*.

(a) Describe how TB is transmitted.

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(b) Streptomycin was the first antibiotic used to treat TB.

During the first few years after the introduction of streptomycin treatment, an increasing number of *M. tuberculosis* bacteria developed resistance to streptomycin.

Outline how this happened.

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(c) The antibiotic rifampicin was introduced as an alternative to streptomycin.

Rifampicin acts by inhibiting the enzyme RNA polymerase.

RNA polymerase is the enzyme used in transcription.

(i) Explain what is meant by transcription.

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(ii) *M. tuberculosis* and humans both use RNA polymerase for transcription.

Suggest why rifampicin does **not** affect transcription in human cells.

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.....[1]

(d) Other drugs such as isoniazid are also used in the treatment of TB.

Some bacteria are now resistant to more than one of these drugs. These bacteria are known as multi-drug resistant (MDR) bacteria.

Outline the steps that can be taken to reduce the impact of drug resistance in bacteria.

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(e) Explain why antibiotics can be used to treat bacterial infections and not viral infections.

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[Total: 14]

198. 9700_w16_qp_21 Q: 4

(a) **(i)** Name the bacterium that causes cholera.

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(ii) Describe how cholera is transmitted from an infected person to an uninfected person.

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(iii) Suggest **and** explain why cholera outbreaks are common after natural disasters.

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(b) The bacteria that cause cholera can become resistant to antibiotics by a substitution mutation.

A substitution mutation occurs when one nucleotide in the DNA sequence is replaced by a different nucleotide.

(i) Explain how a substitution mutation could result in a change in the amino acid sequence of a polypeptide.

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(ii) The antibiotic nalidixic acid acts as an inhibitor of an enzyme involved in DNA replication in the bacteria that cause cholera.

The gene *gyrA* codes for this enzyme. A substitution mutation in this gene results in resistance to the antibiotic nalidixic acid.

Suggest how a change in the amino acid sequence of the enzyme results in antibiotic resistance.

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(c) Some of the strains of bacteria that cause cholera are resistant to more than one antibiotic (multiple resistance).

Discuss the consequences of multiple resistance for health authorities.

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[Total: 13]

199. 9700_w16_qp_23 Q: 2

(a) Explain how enzymes lower the activation energy needed to allow reactions to proceed.

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(b) Folic acid is a molecule used by all cells for growth. Bacteria cannot absorb folic acid from their surroundings. Bacteria use an enzyme to make a molecule called PABA. PABA is used to make folic acid.

An investigation was carried out to determine the effect on the production of PABA when the concentration of an enzyme inhibitor is increased. Four different concentrations (1 µM to 30 µM) of the inhibitor were used, together with a control with no inhibitor.

The concentration of PABA produced in each reaction mixture was determined at 10 minute intervals.

The results are shown in Fig. 2.1.

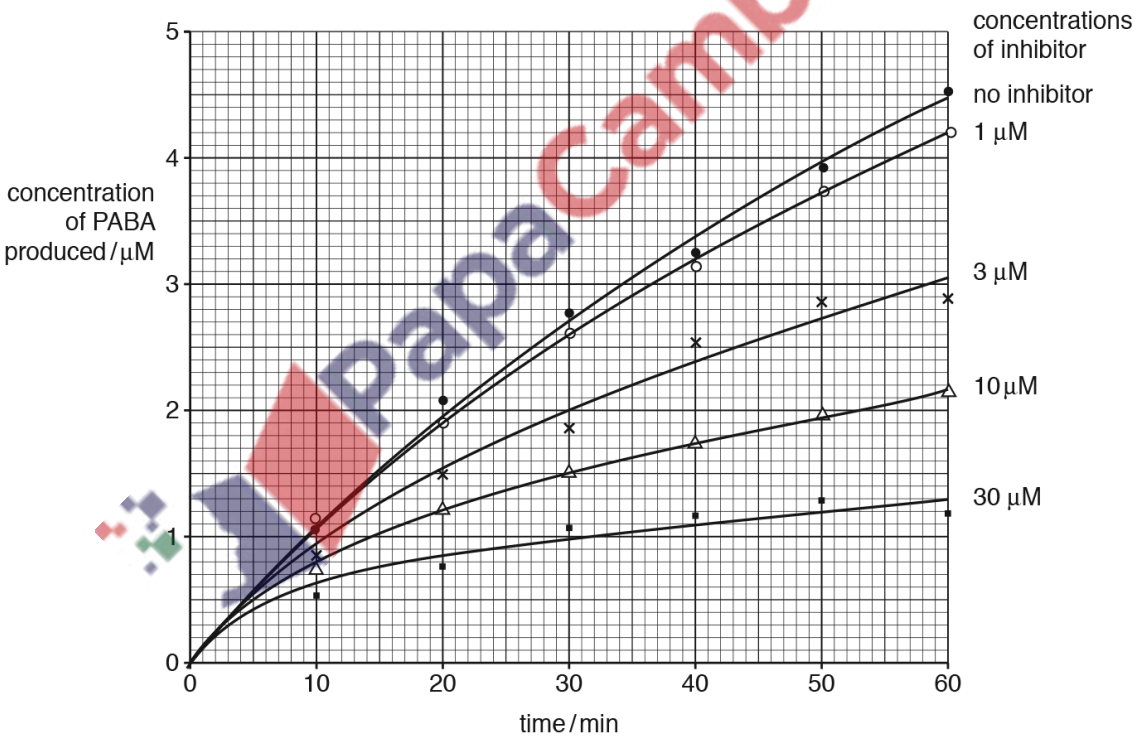

Fig. 2.1

(i) Use Fig. 2.1 to describe the results of the investigation.

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(ii) Outline an experiment that could be carried out to determine whether the inhibitor of the enzyme that catalyses the reaction to produce PABA is competitive or non-competitive.

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(iii) Folic acid from the diet is able to enter human cells, but is **not** able to cross bacterial cell walls. Human cells do **not** have an enzyme to make PABA.

Suggest why the inhibitor of this enzyme could be used as a drug to treat bacterial infections in humans.

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(iv) Suggest why there are few drugs that have any effect on viruses.

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(c) The search for new antibiotics is important because there are many strains of bacteria that are resistant to antibiotics.

Suggest two ways to reduce the spread of antibiotic resistance.

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[Total: 14]