Infectious diseases – AS 9700 Biology June 2022

1. June/2022/Paper_11/No.37

What will reduce the rate at which bacteria become resistant to antibiotics?

1 prescribing two antibiotics with different modes of action

2 prescribing different antibiotics for the same bacterium

3 finishing a prescribed course of antibiotics

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

2. June/2022/Paper_12/No.22

Rifampicin is an antibiotic used to treat tuberculosis.

It works by inhibiting RNA polymerase in bacteria.

Which processes are directly inhibited by this antibiotic?

1 DNA replication

2 enzyme synthesis

3 ATP synthesis

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

3. June/2022/Paper_12/No.37

Why is it difficult to control the spread of tuberculosis?

1 Global air travel for commerce and tourism has increased.

2 The bacterium that causes tuberculosis has evolved resistance to some antibiotics.

3 The bacterium that causes tuberculosis shows great antigenic variability.

4 Civil unrest and poverty result in overcrowded living conditions.

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

4. June/2022/Paper_12/No.38

Rabies is a viral disease which can be spread to humans by a bite from an infected animal.

One method of treatment is to inject the patient with antibodies specific to the rabies virus.

Which statements about this treatment are correct?

1 The patient will have natural passive immunity to rabies.

2 The injected antibodies will be broken down by the patient.

3 The patient's memory cells will be able to produce this antibody more rapidly in the future.

4 The immunity provided will only last a short time.

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

5. June/2022/Paper_13/No.37

Which terms can be used to describe the role of mosquitoes in the transmission of malaria?

1 malarial parasite

2 pathogen

3 vector

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

6. **(a)** Infectious diseases are caused by pathogens and are described as transmissible diseases.

Explain what is meant by the term transmissible.

.....

..... [1]

(b) *Vibrio cholerae* is the bacterium that causes cholera.

Fig. 5.1 is a transmission electron micrograph of *V. cholerae*.

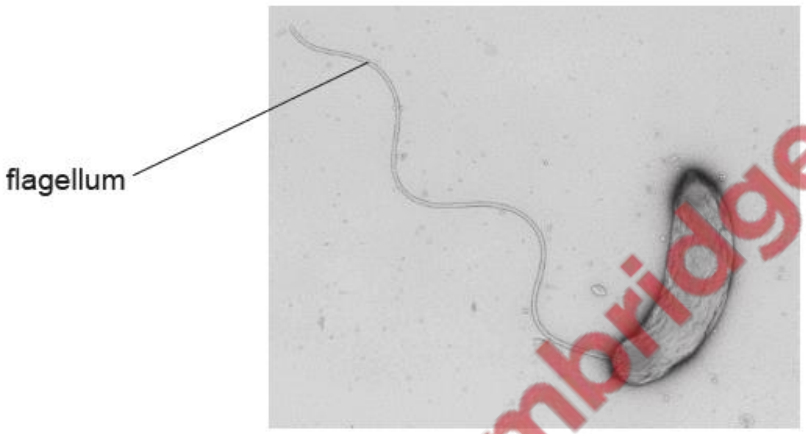

Fig. 5.1

A student wanted to know the actual length of the flagellum shown in Fig. 5.1.

State the information that is needed so that the student can calculate the actual length of the flagellum.

.....

.....

..... [2]

(c) Table 5.1 shows data on large outbreaks of cholera that occurred in seven countries in 2019.

The case-fatality rate is the number of deaths as a percentage of the number of cases.

Table 5.1

country	number of cases of cholera	number of deaths from cholera	case-fatality rate /%
Cameroon	1307	55	4.2
DR Congo	29087	501	1.7
Haiti	684	3	0.4
Kenya	5150	39	0.8
Somalia	9968	50	0.5
Sudan	346	11	3.2
Yemen	2260495	3767	

(i) Complete Table 5.1 by calculating the case-fatality rate for Yemen. [1]

(ii) Suggest why large outbreaks of cholera occurred in the countries listed in Table 5.1, but there were very few cases in most other countries.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 9]

7. June/2022/Paper_22/No.2

Cholera is a life-threatening and infectious disease caused by the bacterium *Vibrio cholerae*. One of the symptoms of the disease is severe diarrhoea.

V. cholerae O1 and *V. cholerae* O139 are the two forms of the pathogen that are associated with cholera epidemics (large outbreaks). These two forms have different antigens that can be detected.

(a) If an outbreak of cholera is suspected but not confirmed, a standard home treatment for diarrhoeal diseases can be used immediately to help prevent severe illness as a result of dehydration. If cholera is the cause of the disease, this standard treatment also helps to prevent a larger outbreak of the disease.

(i) Outline the standard treatment that can be used for suspected cholera cases.

.....

.....

.....

.....

..... [2]

(ii) Suggest **and** explain why this treatment can help to prevent a larger outbreak of cholera.

.....

.....

.....

.....

..... [2]

(b) Rapid diagnostic testing (RDT) can be used to diagnose cholera by detecting the presence of *V. cholerae*. One type of RDT involves using a dipstick that contains mobile and immobilised monoclonal antibodies.

Monoclonal antibodies (mAbs) are specific in their action.

Fig. 2.1 shows a simplified diagram of an RDT dipstick that can be used to distinguish between *V. cholerae* O1 and *V. cholerae* O139. A faecal sample from a person with suspected cholera is collected and added to a reagent solution to form the test mixture.

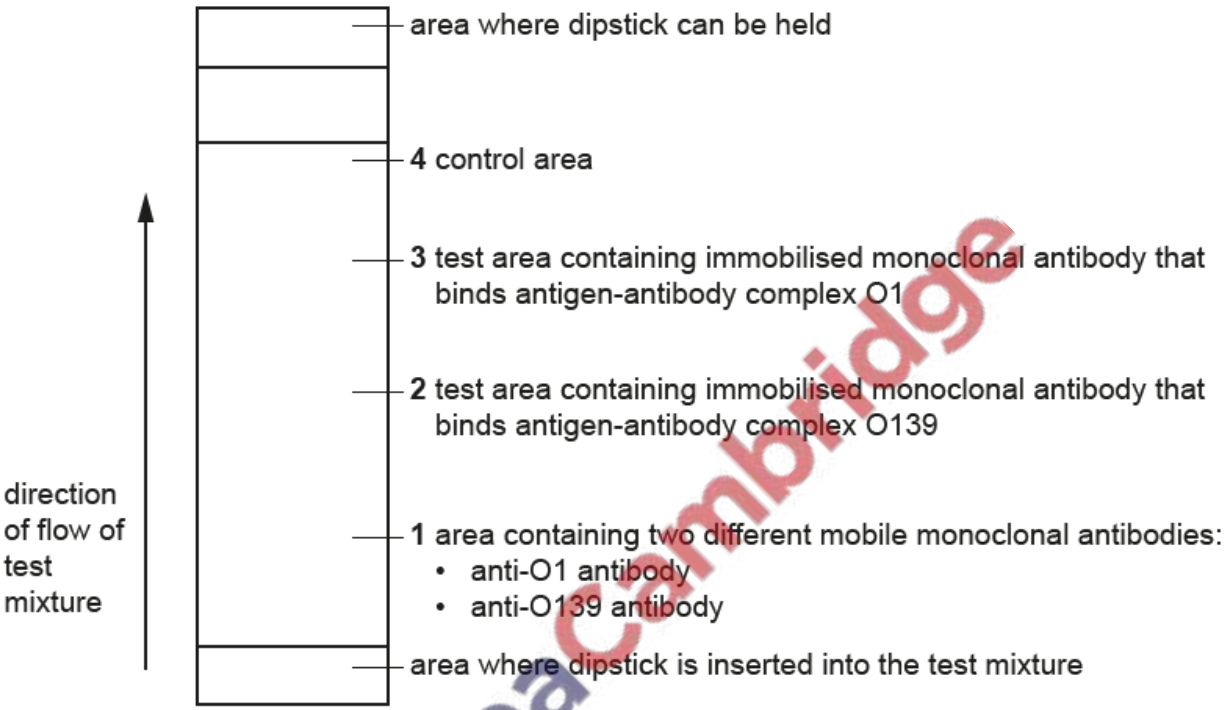

Fig. 2.1

The test mixture moves up the dipstick through area **1**. The mobile monoclonal antibodies are attached to tiny gold particles. If these antibodies collect in test area **2** or **3**, a coloured band becomes visible.

A coloured band that becomes visible in area **4** confirms that the test strip is working and that the results are valid.

(i) Explain how the structure of the monoclonal antibodies in the dipstick allows them to be specific in their action.

.....

.....

.....

.....

..... [2]

(ii) Fig. 2.2 shows the results for samples taken from two different people, **A** and **B**, who are suspected of having cholera.

Fig. 2.2

With reference to Fig. 2.2, state **and** explain the conclusions that can be drawn from the results of the RDT dipsticks for each person.

.....

.....

.....

.....

.....

.....

..... [3]

(c) Table 2.1 shows the results of an investigation to evaluate the effectiveness of an RDT dipstick in diagnosing cholera.

Samples taken from 156 people were tested using a dipstick and compared to the results obtained by culturing the pathogen in a laboratory for accurate identification.

Table 2.1

	number of test results		
	using culture techniques (to obtain accurate identification)	using dipstick	
		correct diagnosis	incorrect diagnosis
positive results for cholera	102	97	5
negative results for cholera	54	32	22

(i) With reference to Table 2.1, calculate the percentage chance of an RDT dipstick correctly confirming that a person with cholera has the disease.

[1]

(ii) Using an RDT dipstick to diagnose cholera is much cheaper than culturing the pathogen and requires less technical skill.

Suggest **one** additional advantage of using an RDT dipstick, rather than culture techniques, to diagnose cholera.

.....

.....

..... [1]

[Total: 11]

8. June/2022/Paper_23/No.4

There are many different forms of *Vibrio cholerae*, a bacterium that is found naturally in aquatic environments. The bacterium is motile (can move) and uses a cell structure known as a flagellum to allow it to move through water.

Fig. 4.1 is a drawing of four cells of one form of *V. cholerae*.

Fig. 4.1

Two main forms of *V. cholerae*, O1 and O139, are able to colonise the small intestine and cause cholera. These two forms are able to produce a toxin, choleragen, which causes the symptoms of diarrhoeal disease. Mutant *V. cholerae* that lack flagella are less able to cause disease.

(a) The magnification of the diagram shown in Fig. 4.1 is ×32 000.

Calculate the actual width **X–Y** in Fig. 4.1 in nanometres (nm) **and** give your answer to the nearest 10 nm.

Complete Fig. 4.2 to show the formula you will use to make your calculation.

actual width =

Fig. 4.2

answer = ... nm [2]

(b) State the term used to describe disease-causing organisms, such as the bacterium *V. cholerae*.

..... [1]

(c) Outline **one** way in which an uninfected person may become infected by *V. cholerae*.

.....

.....

..... [1]

(d) Choleragen is produced after *V. cholerae* has penetrated (passed through) the mucus lining and attached to intestinal epithelial cells.

Choleragen is composed of two subunits:

- subunit **A** consists of one polypeptide
- subunit **B** consists of five identical polypeptides
- the polypeptide in subunit **A** is different from the polypeptides in subunit **B**.

Two genes, *ctxA* and *ctxB*, are needed to produce choleragen. Only one strand of the DNA forming gene *ctxA* is involved in the production of subunit **A**. Only one strand of the DNA forming gene *ctxB* is involved in the production of subunit **B**.

Explain why only one strand of the DNA of each gene is involved in the production of the subunits.

.....

.....

.....

.....

.....

.....

.....

..... [3]

Monoclonal antibodies (mAbs) can be designed to act against components of the cell wall of *V. cholerae*. The cell wall has an outer membrane with lipopolysaccharide (LPS) molecules, shown in Fig. 4.3.

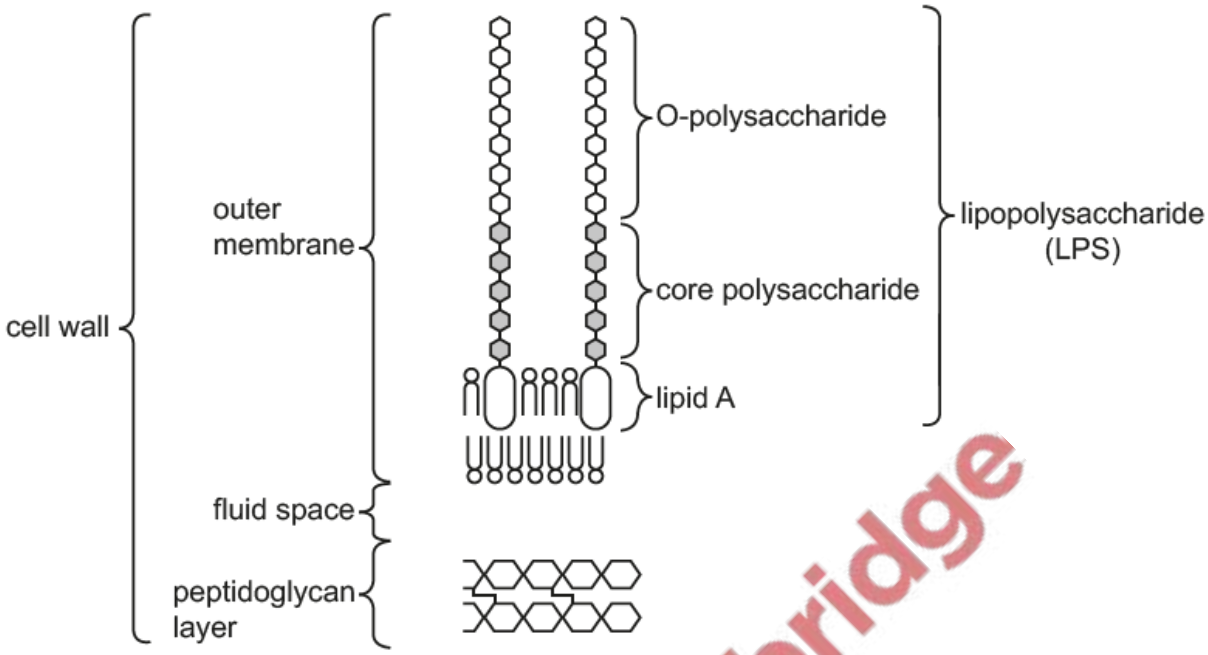

Fig. 4.3

The core polysaccharide and the lipid A components of the LPS molecules are the same in *V. cholerae* O1 and *V. cholerae* O139. However they have different O-polysaccharides.

There are also different types of *V. cholerae* O1 and these have different O-polysaccharides.

(e) Laboratory tests were carried out using two different monoclonal antibodies that had been designed and produced to act against the LPS of bacterial cultures of *V. cholerae* O1:

- mAb 2D6 acts against the O-polysaccharide
- mAb ZAC-3 acts against the core polysaccharide and lipid A components.

(i) Explain why the mAb ZAC-3 produced against the core polysaccharide and lipid A components will not act against the O-polysaccharide of the LPS molecules.

.....

.....

.....

.....

..... [2]

(ii) The results of the tests showed that both mAbs were effective in causing agglutination (clumping) of bacteria and in preventing their motility. This suggests they may be useful for preventing cholera and for treating the disease.

Discuss whether mAb 2D6 and mAb ZAC-3 may be useful for preventing cholera **and** for treating the disease.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 13]