



5: Disease and protection against disease – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2017	May/June	21
6	2017	May/June	21
3	2017	May/June	23

The mark scheme for each question is provided at the end of the document.

- 3 Fig. 3.1 is a diagram that shows the structure of an antibody molecule.

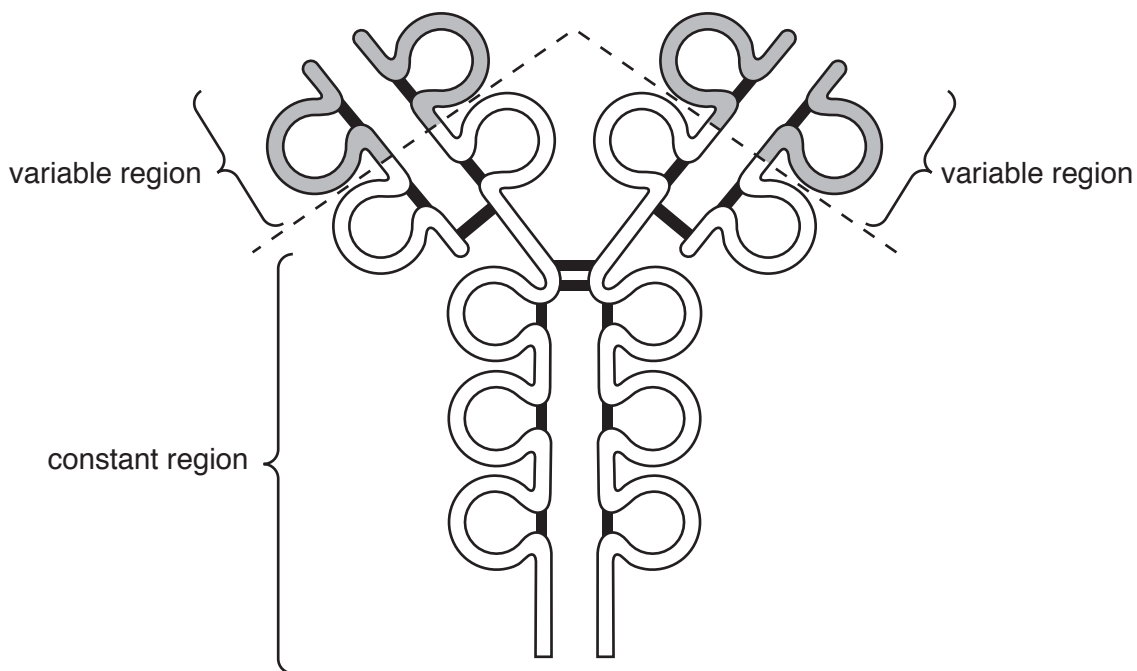


Fig. 3.1

- (a) State why the antibody molecule shown in Fig. 3.1 has quaternary structure.

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.....[1]

- (b) (i) Use Fig. 3.1 to explain how the structure of the variable region of an antibody molecule is related to its function.

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.....[3]

- (ii) State the role of the constant region of an antibody.

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(c) Monoclonal antibodies are used both in diagnosis and in treatment of disease.

(i) Outline how monoclonal antibodies are produced.

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(ii) Suggest the advantages of using monoclonal antibodies in diagnosis of disease.

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[Total: 11]

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

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

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(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 cholera toxin. These glycolipids are found on many cell surface membranes.

When cholera toxin 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.

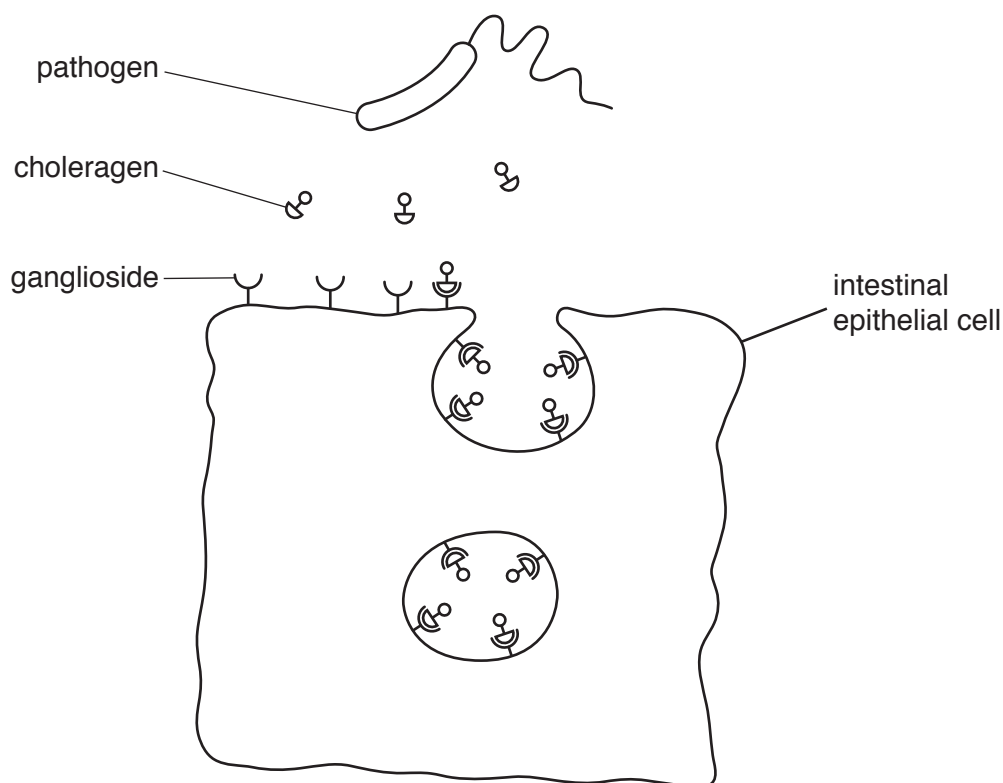


Fig. 6.1

not drawn to scale

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

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

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Once inside the cells cholera toxin 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]

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The graph displays two data series over time. The solid line represents deaths from TB, which starts at approximately 60 in 1925, peaks at 80 in 1930, and then declines steadily to near zero by 1970. The dashed line represents new cases of TB, which starts at approximately 80 in 1925, peaks at 100 in 1950, and then declines steadily to near zero by 1970. Both series show a significant downward trend over the 85-year period.

Year	Deaths from TB (per 100,000)	New Cases of TB (per 100,000)
1925	60	80
1930	80	80
1935	60	80
1940	50	90
1945	45	100
1950	25	100
1955	10	90
1960	5	55
1965	2	30
1970	1	20
1975	0.5	15
1980	0.2	10
1985	0.1	8
1990	0.1	7
1995	0.1	6
2000	0.1	5
2005	0.1	4
2010	0.1	3

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

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.

.....[5]

(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]

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
<u>underline</u>	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

Question	Answers	Marks
3(a)	(antibody has) more than <u>one polypeptide</u> ; A four polypeptides R two / two or more / two types of / many / AW, polypeptides	1
3(b)(i)	<i>allow epitope for antigen</i> 1 (two) antigen-binding, site(s) / region(s) ; A binds to / AW, antigens R active site 2 (shape / structure is) <u>complementary</u> to antigen ; 3 <i>idea of specificity</i> / AW ; 4 <i>ref. to</i> , primary structure / sequence of amino acids ; 5 <i>ref. to</i> R-groups / (amino acid) side chains, and interactions with antigen / giving specific shape ;	max 3
3(b)(ii)	binds to (receptors on), phagocytes / macrophages / neutrophils ; A other correct named cell of the immune system AVP ; e.g. gives class of antibody (e.g. IgM, IgG, IgA, IgE)	max 1

Question	Answers	Marks
3(c)(i)	<ol style="list-style-type: none"> <u>antigen</u>, introduced / AW, into, (small) mammal ; A named small mammal B-lymphocytes / B cells / plasma cells / splenocytes / antibody-producing lymphocytes, are taken / are isolated (from the spleen / lymph nodes) ; (these) cells are fused / AW, with, myeloma / cancer, cells ; <u>hybridoma</u> cells / <u>hybridomas</u>, formed ; R hybridised cells / hybrid cells hybridoma cell, is cloned / AW ; screening / testing, for hybridoma that produces desired antibody ; <i>ref. to</i> scaling up / large-scale production / grow in a fermenter ; AVP ; e.g. fusion using, fusogen / polyethylene glycol / PEG / electric current (electrofusion) / (Sendai) virus HAT medium, for, hybridoma growth / inhibiting myeloma growth humanisation of monoclonal antibody 	max 4
3(c)(ii)	<p>I <i>suggestions for treatment</i></p> <ol style="list-style-type: none"> monoclonal antibodies used all have the same specificity ; R 'are specific' unqualified detect only one, antigen / epitope ; can distinguish between different, pathogens / strains of, pathogens ; A types of cancer cells can be, labelled / tagged / marked / AW ; e.g. with fluorescent label monoclonal antibodies can detect location of, tissues expressing antigen / cancer cells / blood clots ; A <i>idea of</i> locating areas of infection fast(er) (diagnosis) ; can detect antibody levels (e.g. HIV) ; AVP ; e.g. some pathogens cannot be cultured I <i>ref. to</i> cost 	max 2
Total: 11		

Question	Answers	Marks
6(a)(i)	<u>Vibrio cholerae</u> ;	1
6(a)(ii)	<p>faecal-oral route ;;</p> <p><i>description of faecal / oral route</i> <i>infected person</i> <u>faeces</u> / <u>sewage</u> / <u>stool</u>, contaminating (drinking) water R (human) waste unqualified or poor hygiene so transferring, faecal material / sewage, onto utensils / food / AW or defaecating / putting sewage, onto vegetable plots ; or flies in contact with contaminated faeces landing on food and contaminating / AW</p> <p><i>uninfected person</i> eating contaminated food / using contaminated utensils or drinking contaminated water ;</p>	max 2
6(b)	<p>1 ganglioside is the <u>receptor</u> for cholera toxin ;</p> <p>2 cholera toxin is <u>complementary</u> to ganglioside ;</p> <p>3 any interaction between molecules ; e.g. (hydrogen / ionic) bonding</p>	max 2
6(c)	<u>endocytosis</u> ; A phagocytosis / pinocytosis	1
6(d)	<p>1 loss of water / dehydration ;</p> <p>2 by osmosis ;</p> <p>3 (water moves out) down water potential gradient / from high to low water potential / high Ψ to low Ψ ;</p> <p>4 Loss of cations / positively-charged ions (as well as chloride ions) ;</p> <p>5 change in potential (difference) / change in charge across membrane ;</p> <p>6 AVP ; e.g. disruption of absorption (of products of digestion / vitamins / mineral ions) disruption of digestion</p>	max 2

Question	Answers	Marks
6(e)	<ol style="list-style-type: none"> 1 rehydration therapy, is effective / can treat cholera / reduces death rate ; 2 any detail ; e.g. solution of glucose and salts 3 antibiotic is a selection pressure / described ; 4 <i>ref. to</i>, antibiotic / tetracycline, resistance ; 5 <i>ref. to</i>, vertical transmission / horizontal transmission, of resistance ; A described, A transfer for transmission 6 antibiotics will become, ineffective / less effective / AW ; 7 keep antibiotics for use 'as last resort' ; AW 8 <i>ref. to</i> cost ; 9 antibiotics kill gut bacteria ; 10 <i>idea that</i> disrupts functions of digestive system ; 11 AVP ; e.g. antibiotics going into the environment / food chain antibiotics can cause mutation decreases need to develop new drugs prevents development of active immunity <i>idea of</i> transmission between bacterial species plasmids with resistance genes 	max 3
		Total: 11

Question	Answer	Marks
3(a)	<i>Mycobacterium tuberculosis</i> / <i>Mycobacterium bovis</i> ; correct spelling	1
3(b)	<p>1 deaths decrease to zero / new cases fall to 4 per 100 000, (in 2010) ; A other values that confirm decrease <i>(after introduction of antibiotics)</i></p> <p>2 deaths relatively constant / approx. 52 per 100 000, until 1943–6 (<i>accept any in range</i>) ; A for a few years A idea that rate of decrease not improved</p> <p>3 number of new cases initially stops increasing / plateaus ;</p> <p>4 (overall) number of new cases increases before decreases ;</p> <p>5 data to support mp 3 or 4 ; e.g. 88–90 per 100 000 (1940–44) rises to / drops from, 104 per 100 000 in 1946 ; <i>(after introduction of vaccination)</i></p> <p>6 no change in trend of decrease in deaths / deaths continue to decrease ;</p> <p>7 decrease from 36–40 per 100 000 (in 1948) ;</p> <p>8 short plateau / 100 per 100 000 (until 1950), in new cases, then decreases ;</p> <p>9 antibiotics may not have been in widespread use at first ; ora</p> <p>10 vaccine, reduces spread / gives (herd) immunity ;</p> <p>11 <i>ref.</i> to decrease less steep initially as time needed to build up herd immunity ;</p> <p>12 AVP ; e.g. suggestion why increase in new cases after introduction of antibiotics suggestion why cases have not decreased to zero not possible to tell relative effect of vaccine v antibiotic</p>	max 5

Question	Answer	Marks
3(c)(i)	<p>some people who are HIV+ will have developed HIV / AIDS ; <u>HIV / AIDS</u> weakens <u>immune</u> system / response ; ora</p> <p><i>allow ecf for HIV+ people</i> detail of why immune response weakened ; people with HIV / AIDS, prone to opportunistic diseases ; A TB is an opportunistic disease A more susceptible to, diseases / TB (Table 3.1 shows that) a greater proportion / AW, people die of TB if they are HIV+ ; AW e.g. greater chance of dying from TB if HIV+ dormant TB more likely to become the active form in, HIV+ people / people with HIV / AIDS ; AW</p> <p>AVP ; a high proportion of deaths from HIV / AIDs is due to TB mortality HIV+ people do not respond well to treatment for life-threatening diseases inability to pay for treatment for all conditions for HIV+ people</p>	max 3
		Total: 9