1. Scientists are conducting trials on a monoclonal antibody to treat cervical cancer by immunotherapy.

(i) Suggest how cancerous cells are targeted and destroyed by immunotherapy.

---

[3]

(ii) Most cases of cervical cancer are caused by infection with Human Papilloma Virus (HPV) which is a sexually transmitted virus.

A vaccine to protect against HPV is now routinely offered to girls between the ages of 11 and 13.

For many people the vaccination is considered unethical.

Suggest **two** reasons why this vaccination programme may be considered unethical.

1

2

---

[2]

2. Vaccination can be used to reduce the spread of human papilloma virus (HPV) in human populations.

(i) Outline **one** ethical argument against the use of the HPV vaccine in the UK.

[1]

(ii) Explain how the HPV vaccine leads to the development of long-term immunity against HPV in a person receiving the vaccine.

In your answer you should make clear the order in which the events occur.

[8]

3(a). *Mycobacterium tuberculosis* causes the infectious disease tuberculosis.

Strains of *M. tuberculosis* have evolved that are resistant to several antibiotics.

Explain how *M. tuberculosis* can evolve resistance to antibiotics **and** describe how hospital staff and medical professionals can help to prevent the spread of these resistant strains.

In your answer, you should provide a balanced account of both aspects of the question.

[8]

(b). In 2014, scientists discovered a new antibiotic called teixobactin.

The effectiveness of teixobactin in controlling bacterial growth was compared with that of two established antibiotics in a series of tests. Some of the test results are shown in Fig. 7.2.

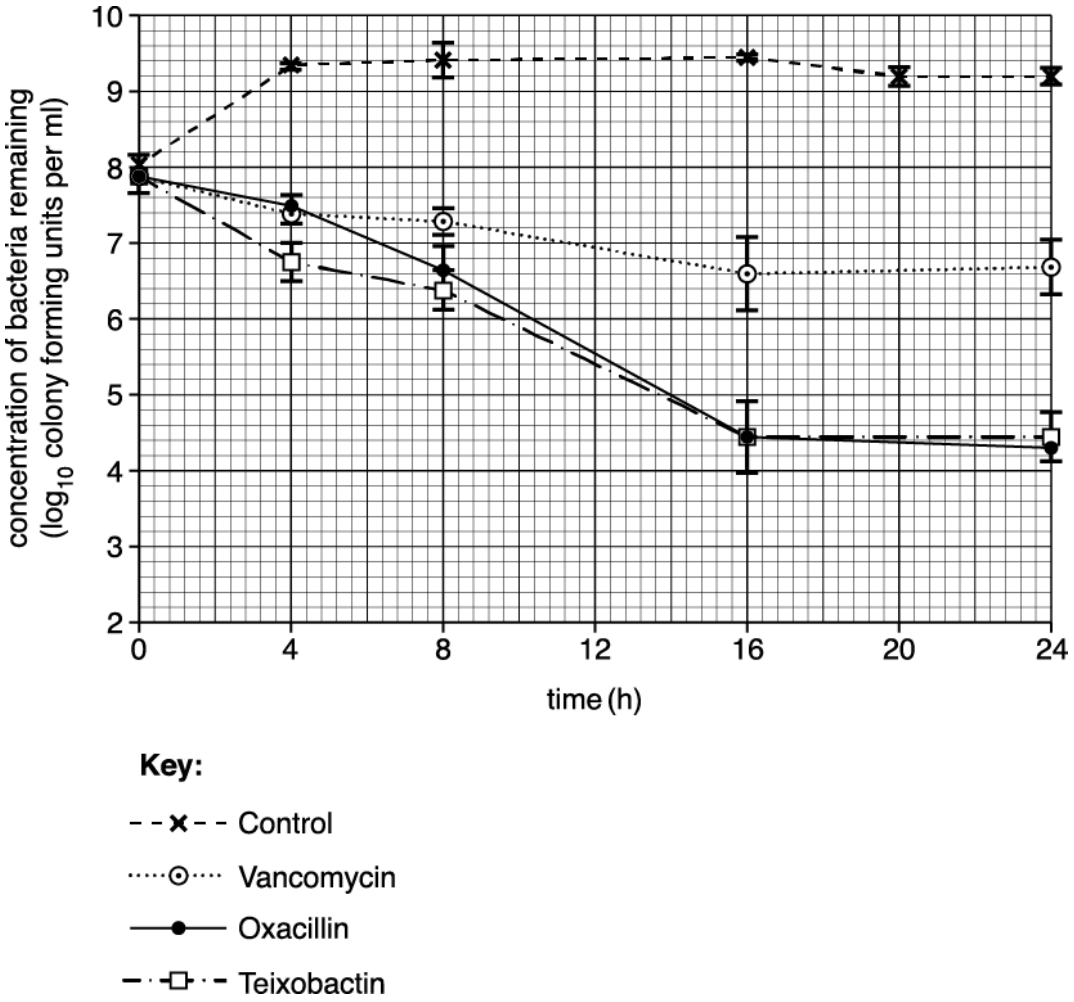

Fig. 7.2

Using the information in Fig. 7.2, discuss the relative effectiveness of antibiotics in controlling bacterial growth.

[3]

4. Respiratory syncytial virus (RSV) is a major cause of bronchiole infections in small children.

(i) RSV contains the enzyme reverse transcriptase.

What type of nucleic acid will be found in RSV?

---

[1]

(ii) Currently, no vaccines have been developed for preventing RSV infection.

Suggest one **biological** problem in developing a vaccine for RSV.

---

[1]

5. Multidrug-resistant tuberculosis (MDR-TB) is a disease caused by a strain of *M. tuberculosis* that is resistant to the two most effective antibiotics, isoniazid and rifampicin.

Fig. 4.2 shows the number of cases of MDR-TB and the number of antibiotic prescriptions between 2000 and 2010.

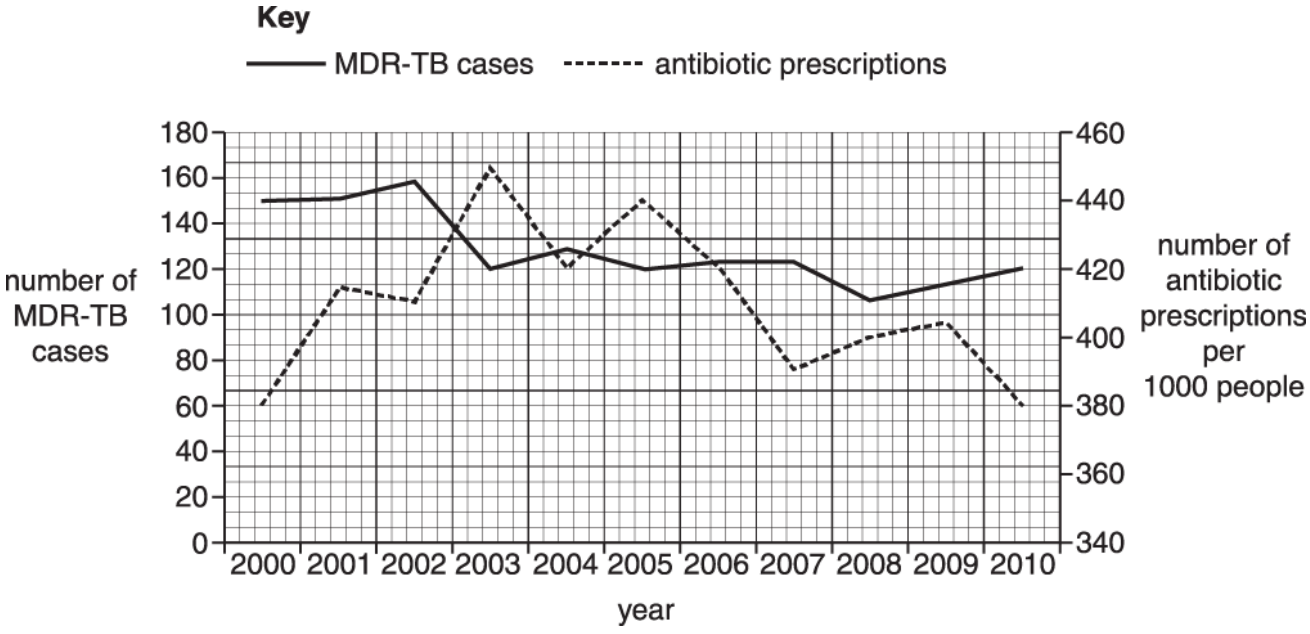

Fig. 4.2

(i) Using Fig. 4.2, calculate the mean percentage decrease **per year** in the number of MDR-TB cases between 2000 and 2010.

Show your working.

Answer =_____ % **[2]**

(ii) Scientists have concluded that the increase in MDR-TB cases is due to the overuse of antibiotics.

Evaluate this conclusion using the data in Fig. 4.2.

---

[3]

6(a). TB is caused by the bacterium *Mycobacterium tuberculosis*.

Populations of bacteria may become resistant to antibiotics.

Stages in the development of antibiotic-resistant bacteria are listed in Table 1.1.

A	random mutations in some bacterial cells make them resistant to antibiotics
B	the next generation of bacteria are resistant to antibiotics
C	the surviving bacteria reproduce and pass on alleles for resistance to their offspring
D	bacterial populations show genetic variation
E	when antibiotics are used inappropriately, the resistant bacteria survive and the non-resistant bacteria are killed

Table 1.1

Place the stages in the correct order to describe how populations of bacteria become resistant to antibiotics. The first stage has been done for you.

D

[2]

(b). The protective effect of the current TB vaccine is approximately 80%. This means only 80% of those vaccinated against TB are protected from the disease. The protective effect of the vaccine varies between different populations and can be much lower than 80%.

Epidemics of TB are more likely to occur when only a low percentage of the population has been protected by the TB vaccine.

Explain why.

---**[2]**

(c). A vaccine against HIV has yet to be developed.

Suggest why developing a vaccine for HIV has proved difficult.

---[2]

7(a). This question is based on the case study **'VACCINATING THE YOUNG' (Case Study 2).**

You were told in the case study that the NHS now recommends that pregnant women should be given vaccinations against whooping cough.

(i) Explain what is meant by the term *vaccine.*

---

[1]

(ii) When a pregnant woman is vaccinated against whooping cough, both she and her baby gain immunity.

Choose **two** words from the list below to describe the type of immunity gained by the mother, and **two** words to describe the immunity gained by the baby.

NATURAL ARTIFICIAL ACTIVE PASSIVE

Immunity gained by mother _____ and _____

Immunity gained by baby _____ and _____

[1]

(iii) The programme of vaccination used in the United Kingdom (UK) requires booster vaccinations to be given against some diseases, including whooping cough.

Explain why booster vaccinations are necessary.

---

[2]

(b). The NHS now offers the HPV vaccination to girls aged 12 and 13 years in order to reduce the spread of HPV infection.

Why are HPV infections **not** treated with a course of antibiotics?

---

[1]

8. The human papillomavirus (HPV) can infect the skin and mucous membranes of the body.

Most cases of HPV infection are eradicated naturally by the immune system.

Sometimes HPV cannot be eradicated naturally by the immune system. Persistent HPV infection is the main cause of cervical cancer.
A vaccine against the **HPV-16** and **HPV-18** strains is offered to females aged 12 to 14 years.
Scientists wanted to determine whether the vaccine should be given over two or three doses.
They compared the effectiveness of two-dose and three-dose regimes by measuring antibody levels in the blood one month and three years after completion.
The results are summarised in Table 34 below.

Data group	Number of subjects	HPV-16 antibody level ($mMU\,dm^{-3}$)		HPV-18 antibody level ($mMU\,dm^{-3}$)	
		Median	Range	Median	Range
Two-dose regime after one month	102	830	761–882	812	704–866
Two-dose regime after three years		739	729–755	214	101–483
Three-dose regime after one month	116	829	781–893	820	794–860
Three-dose regime after three years		731	718–754	747	709–773

Table 34

(i) Using the information in Table 34, evaluate the effectiveness of different vaccination regimes.

---

[4]

(ii) Antibody levels were also measured two weeks after the first dose of vaccine. They were significantly lower than those measured after the second and third doses of vaccine.
Explain why.

[3]

9(a). The MenB vaccine was developed to protect against disease caused by the bacterium *Neisseria meningitidis*. Infection with this bacterium (meningococcal infection) is a major cause of meningitis and blood poisoning, particularly in babies and young children.

The MenB vaccine was introduced into the routine UK vaccination schedule on 1st September 2015. It is available to all new babies born on or after 1st July 2015.

(i) The MenB vaccine is a subunit vaccine.

Explain what is meant by a subunit vaccine.

---

[1]

(ii) Parents have been reassured that the MenB vaccine cannot cause meningitis in their children.

Explain why the MenB vaccine cannot cause the disease.

---

[1]

(iii) The MenB vaccine has also been shown to be effective against other types of meningococcal infection.

Suggest why.

---

[2]

(b). Evaluate the importance of herd immunity in the prevention of epidemics.

[6]

10. Tuberculosis (TB) is caused by the bacterium *Mycobacterium tuberculosis.*

Isoniazid is one of the antibiotics used to treat TB.

Isoniazid works by inhibiting the production of mycolic acid, a fatty acid required for the synthesis of some bacterial cell walls.

(i) Explain how isoniazid causes the death of *M. tuberculosis* cells.

---

[3]

(ii) Isoniazid kills bacterial cells but has no effect on human cells.

Explain why.

---

[1]

11(a) There are different types of vaccine for immunising against different diseases.

.

The table below shows three different types of vaccine.

Complete the missing information in the table.

Type of vaccine	Features of the vaccine	Advantage
…….. …….. 	Non-pathogenic, modified strains of the bacteria or virus are used	…….. …….. …….. ……..
Isolated extracted antigens	…….. …….. …….. …….. 	Can produce vaccines for different strains of bacteria / viruses
Killed inactivated pathogens	…….. …….. …….. …….. 	…….. …….. …….. ……..

[3]

(b). In 2015, a trial was conducted in Guinea, Africa to test the effectiveness of the vaccine rVSV-ZEBOV against the Ebola virus.

- Researchers wanted to save as many lives as possible, so ring vaccination was used during the trial instead of a placebo.
- In communities where at least one new case of the disease had been reported, 7651 participants were randomly assigned to one of two groups.
- Group one were vaccinated immediately after Ebola was reported.
- Group two were vaccinated ten days after group one.
- The incubation time for the Ebola virus is ten days.

Results showed that there were no new cases of Ebola among the 4123 people in group one and 16 cases among the 3528 people in group two.

(i) What was the purpose of **group two** in this trial?

____ [1]

(ii) Discuss the ethical issues related to this trial.

____

____

____

____ [2]

(iii) Using the information, evaluate the effectiveness of the rVSV-ZEBOV vaccine.

____

____

____

____ [2]

12. Following the injection of a vaccine the antibody concentration in the blood changes.

Fig. 4 shows the concentration of antibody in the blood of an individual following a BCG vaccination for tuberculosis (TB).

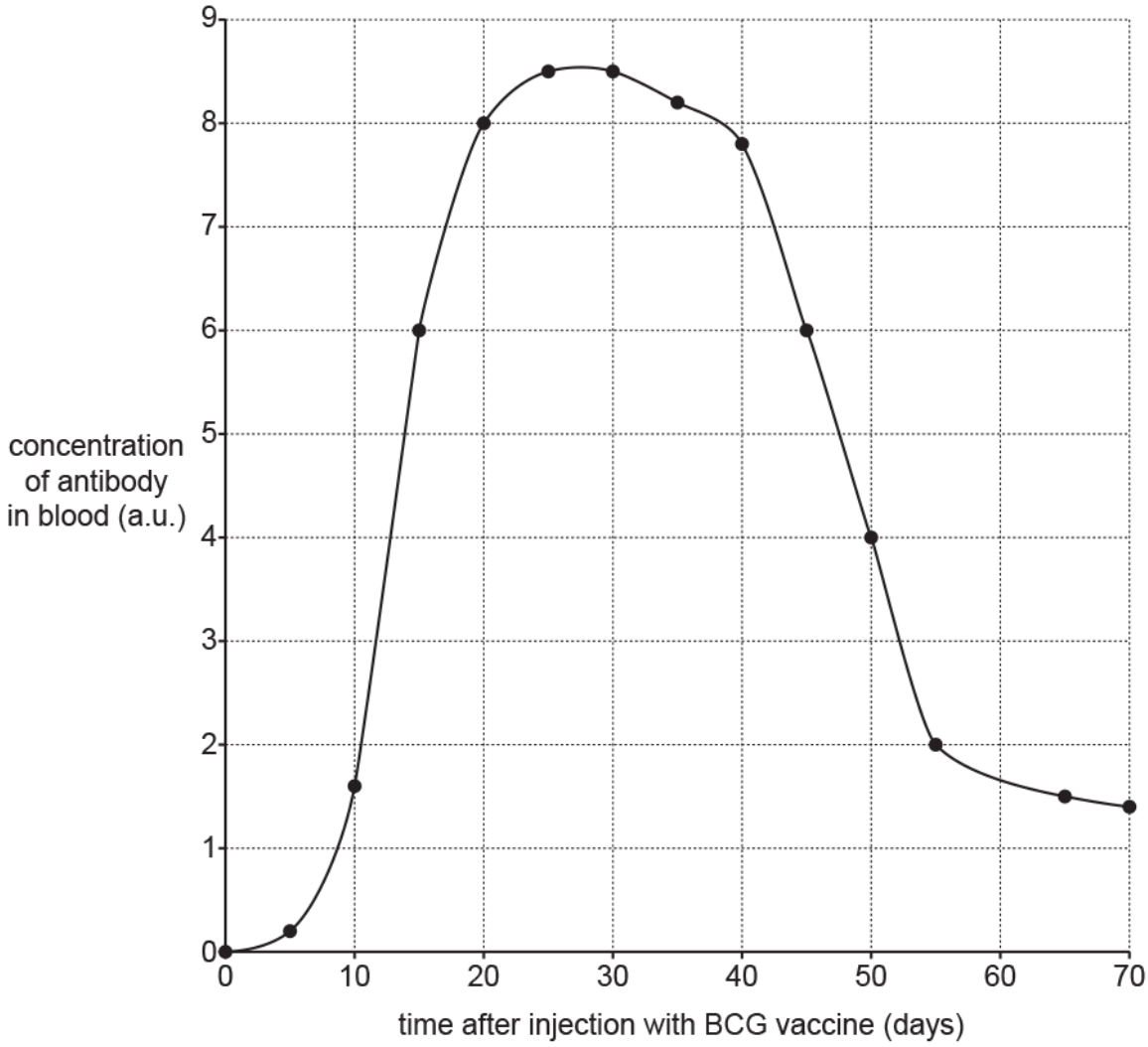

Fig. 4

Describe **and** explain the pattern in the data shown in Fig. 4.

---[4]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1		i	**Any 3 from:** amino acid sequence gives complementary shape to antigen (1) variable region specific to antigen on cancer cells (1) chemotherapeutic agent attached to antibody (1)* (Antibody Drug Conjugate) floats in the bloodstream sticking only to cancer cells (1) once attached, the agent kills the cancer cell (1) direct attachment of antibodies to cancer cells (1) (monoclonal antibody) marks cancer cell for destruction (1) antibodies attach to T cells to stimulate them to attack cancer cells (by keeping them switched on) (1)	3	*ALLOW toxin / drug is attached to the antibody
		ii	**Any 2 from:** may encourage unprotected sex (1) requires parental consent (1) does not consider the child's point of view (1) vaccines can have side effects (1)	2	
			Total	**5**	
2		i	(vaccine) given to girls below the (legal) age of consent; could be viewed as encouraging underage sex; *idea that* the vaccine is offered only to females;	1 max	e.g given to 11 year old girls <u>Examiner's Comments</u> This question centred on vaccinations and long term immunity. Candidates struggled to correctly link the chronological events that lead to the formation of memory cells and confused many different types of lymphocytes e.g. killer T cells forming memory cells. This question gave equal weighting to AO1 and AO2. Most candidates confidently offered a correct statement. Some candidates referred to sex at a young age without being specific with that reference.

Question			Answer/Indicative content	Marks	Guidance
		ii	*A* vaccine contains (HPV) antigen; *B (antigen)* displayed on cell surface of, antigen-presenting cell / APC / macrophage / dendritic cell; *B* clonal selection of lymphocytes; *B* clonal, expansion / proliferation; *B* by mitosis; *B* B / plasma, cells release antibodies against, antigen / HPV; *C* lymphocytes <u>differentiate</u> into memory cells; *C* memory cells last a long time; *C idea that* response is, greater / faster if, HPV / same antigen, enters body; *C* booster / more than one vaccination, required;	7 max	ACCEPT description for clonal selection
		ii	QWC	1	AWARD QWC if mark A is awarded first and the first B mark is awarded before a C mark <u>Examiner's Comments</u> The whole range of marks were awarded here and there were some good responses gaining full credit including the QWC. However, weaker candidates often confused the terms 'clonal selection' and 'clonal expansion'. Candidates often mixed the lymphocytes and failed to usethe term differentiation to describe the formation of memory cells. Many candidates also simply described the immune response in its entirety which, whilst gaining some marks, did not fully explain how this would then lead to long term immunity following a vaccination. Extra space was used by a large number of candidates.
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
3	a		*evolve resistance* 1. mutation; 2. (mutated) gene gives resistance to antibiotics; 3. resistance genes found on plasmids; 4. example of resistance; 5. resistant bacteria survive and reproduce; 6. resistance gene, passed on to offspring / transferred between bacteria / transferred by conjugation; *prevent spread* 7. isolation of patients (with resistant *M. tuberculosis*); 8. disinfecting hands / wearing disposable gloves; 9. cleaning, equipment / bedding / clothing; 10. regular cleaning of surfaces (on wards);	7 max	ACCEPT gene variant / allele e.g. enzyme that metabolises the antibiotic
			QWC	1	AWARD QWC if candidate scores 2 marks from mps 1-6 and 2 marks from mps 7-10 Examiner's Comments This related to antibiotics and antibiotic resistance. This tested AO1 and AO3. This differentiated well and good candidates gave clear descriptions of the development of antibiotic resistance and could describe the electron micrograph of M. tuberculosis. The majority of candidates were able to describe how to prevent the spread of resistant strains but there were few good responses for how the resistance evolved. However, many candidates were still able to achieve QWC as they understood that 'mutations' were often involved and that resistant bacteria would 'survive and reproduce'. A few candidates confused antibiotic resistance with antibodies and antigens, seemingly reading antibiotics as antigens, and their answers followed through with the bacteria producing specific antibodies to the antigens. Many candidates discussed the prevention of spread in terms of DOT and not over prescribing antibiotics.

Question			Answer/Indicative content	Marks	Guidance
	b		all antibiotics more effective than the control / AW; teixobactin more effective than vancomycin / AW; teixobactin more effective than oxacillin up to 8 hours / AW; no (significant) difference between oxacillin and teixobactin after 8 hours;	3 max	**CREDIT** ora for vancomycin **CREDIT** ora for Oxacillin Examiner's Comments This caused quite a few problems for weaker candidates who did not offer a discussion about the 'relative effectiveness' so could not gain credit. Very few candidates referred to the control as a comparative measure and some even discussed it in terms of another antibiotic.
			Total	11	

Question			Answer/Indicative content	Marks	Guidance
4		i	RNA ✓	1	IGNORE ref to type of RNA e.g. messenger Examiner's Comments This question provided a straightforward end to the question paper with short answers involving AO1 recall or straightforward AO2 'suggest' style questions. Timing issues were the most likely cause of 'no responses' for some of the question parts.
		ii	antigens (on viral coat) constantly change ✓ *idea that* the virus is inside host cell so does not attract antibody ✓ *idea that* frequency of mutation is high ✓	1 max	Examiner's Comments This question provided a straightforward end to the question paper with short answers involving AO1 recall or straightforward AO2 'suggest' style questions. Timing issues were the most likely cause of 'no responses' for some of the question parts. Candidates needed to apply their knowledge of HIV as a retrovirus to this question about the RS virus. Many candidates were able to suggest RNA but fewer candidates went on to suggest a correct response for the problem of developing a vaccine for the virus.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
5		i	2% (decrease per year) ✓✓	2	((150–120)/150) × 100 = 20 20/10 = 2% decrease per year Correct answer = 2 marks If answer given is not 'per year' **allow 1 mark** for ((150–120)/150) x 100 = 20 Examiner's Comments The calculation in (i) was well answered by many candidates but there were a lot of candidates that clearly did not understand how to calculate a percentage decrease.

Question			Answer/Indicative content	Marks	Guidance
		ii	**Supports** between 2000 and 2002 antibiotic resistant MDR–TB increases as prescriptions increase ✓ decrease in number of prescriptions from 2003 to, 2008 / 2009 / 2010, results in, slight decrease / no, change in MDR TB cases ✓ **1 Max** **Undermines** between 2002 and 2003 antibiotic resistance decreases even though prescription number increases ✓ between 2004 to 2005 an increase in prescriptions but MDR-TB cases decrease ✓ **1 Max** comparative data quoted ✓	3 Max	Year / Number of MDR TB cases / Antibiotic prescription per 1,000 2000 150 380 2001 151 415 2002 160 410 2003 120 450 2004 128 420 2005 120 440 2006 124 420 2007 124 390 2008 107 400 2009 112 405 2010 120 380 **Note** must include years, number of cases and number of prescriptions per 1000 for either supports or undermines Examiner's Comments Less capable candidates discussed the trends on the graph for (ii) with no reference to data, which suggests an issue with training candidates to read the question and practice different question types. Very few candidates got the data quote mark point as they missed out some part or incorrectly read some values. A few candidates did not interpret the data correctly, quoting figures for number of prescriptions such as 450,000 rather than 450 per 1000 people. The range of years quoted often covered many years with peaks and troughs so marks could not be awarded.
			Total	5	

Question			Answer/Indicative content	Marks	Guidance
6	a		A E C B;;	2	A first and B last; E before C; Examiner's Comments This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed AO1, and AO2 skills. This question proved to be accessible to most candidates.
	b		herd immunity not reached; *Idea that* someone with TB has a higher chance of meeting someone who could catch it;	2	CREDIT reverse argument (ref to reaching herd immunity when most are vaccinated) ACCEPT idea that unable to prevent spread to susceptible (non-immunised) people Examiner's Comments This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed AO1, and AO2 skills. This question was answered relatively well and most candidates could describe the increased likelihood of an infected person meeting a susceptible one due to lack of herd immunity. A few candidates misinterpreted the question and related this to primary and secondary immune response.

Question			Answer/Indicative content	Marks	Guidance
	c			2	
			idea of high mutation rate in virus; *idea of* change in antigens / different strains have different antigens ; *idea of* antibody specificity;		REJECT disease ACCEPT antigenic drift e.g. antibodies only fit one type of antigen / antibodies for one strain of HIV will not bind to antigens of a new strain
			ref to antigenic concealment / described;		Look for the idea of hiding in (correctly) named) cells Examiner's Comments This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed AO1, and AO2 skills. Most candidates knew that HIV mutates very often, and could relate that to a change in antigen shape. Some referred to the antigens mutating rather than the virus, or were not precise in their description of why a vaccine against one strain would be ineffective against a mutated strain.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
7	a	i	*idea of* a preparation containing antigens, which, triggers / AW, an immune response / AW;	1	LOOK FOR idea of a weakened or dead microorganism OR fragments of a microorganism DO NOT CREDIT 'disease' for 'microorganism' CREDIT a description of the immune response e.g. producing memory cells Examiner's Comments This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed A01, AO2 and AO3 skills. This was usually a well learned definition. Weaker candidates made reference to vaccines containing a weakened form of the disease rather than antigens or the pathogen, or failed to include that it provoked an immune response.
		ii	(mother =) artificial active **and** (baby =) natural passive;	1	Examiner's Comments Several candidates failed to correctly describe the type of immunity gained by vaccination.
		iii	increases, (number of) memory cells; *idea of* memory cell numbers fall over time; faster (immune) response OR ref to <u>secondary</u> (immune) response;	2 max	ACCEPT maintains memory cell numbers ACCEPT more antibody production Examiner's Comments Many candidates were able to identify the requirement for more memory cells, although few picked up on the death or decrease of memory cells over time. Weaker candidates discussed viral mutations as the reason for the requirement for booster vaccinations.

Question			Answer/Indicative content	Marks	Guidance
	b		(antibiotics) ineffective against / AW, viruses;	1	CREDIT antibiotics only effective against bacteria IGNORE 'cannot be treated by antibiotics' as this is given in the question. Examiner's Comments This was generally well answered although some candidates discussed antibiotic resistance and virus mutation as a reason for why antibiotics would be ineffective. Some candidates failed to say that antibiotics would not be effective, but rather stated that HPV was a virus without further qualification, or just repeated the question stem that they are not treated with antibiotics.
			Total	5	

Question			Answer/Indicative content	Marks	Guidance
8		i	3 FROM *Idea that*: for HPV 16, no significant difference between the 2 dose and the 3 dose regime ✓ for HPV18, two-dose less effective than three-dose ✓ for both HPV16 and HPV18, both regimes produce similar antibody levels at 1 month / 3 years (3 dose) – equally effective ✓ comparison of median or range values in support of one of the above statements ✓ 1 FROM EITHER: top of range for HPV18 antibody levels at 3 years in two- dose schedule does not overlap with ranges in other datasets ✓ OR very large range for HPV18 antibody levels at 3 years in two-dose schedule ✓	4	Examiner's Comments **(b)(i)** was a demanding question with many candidates not understanding that each dosage regime was one experiment and that the number of antibodies was measured after one month and then after 3 years. The question asked candidates to compare the 2-dose regime with the 3-dose regime for both viral strains. It was common for candidates to focus on the differences in the data instead of explaining how similar most of the data was. Many candidates highlighted tiny differences in median antibody levels despite the extremely large and overlapping ranges. The only candidates to gain full marks were those who appreciated that the 2-dose regime after 3 years was the only data set that had a significantly different median antibody level to all other data because the range did not overlap with any other.
		ii	first exposure no <u>memory</u> B cells prior to first dose ✓ *idea that*: it takes time for clonal selection / clonal expansion / small number of plasma cells to produce antibodies ✓ second / third exposure memory cells stimulated to divide rapidly / clonal selection faster / clonal expansion faster ✓ memory cells <u>differentiate</u> into (many) <u>plasma</u> cells ✓ <u>plasma</u> cells produce antibodies faster and in greater numbers ✓	max 3	ALLOW small number of B cells produce antibodies Examiner's Comments **(b)(ii)** was a stretch and challenge question and the marks reflected this. Many candidates were clearly familiar with the primary and secondary immune response but relatively few could explain this in good biological detail. Few candidates mentioned the lack of memory cells prior to the first dose or the idea that clonal selection / expansion took time. Similarly, after the second exposure many candidates failed to mention memory cells differentiating and the subsequent plasma cells producing antibodies. Overall, answers were too generalised to gain marks.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
9	a	i	contains (purified) <u>antigens</u> ✓ from (several) different strains ✓	1 max	**Examiner's Comments** In **(a)(i)** most candidates realised that the vaccine contains antigens although it was often stated as attached to the pathogen, not the idea of purified antigens. Some candidates confused this with booster vaccines. Few candidates appreciated that this was antigens from different strains of bacteria.
		ii	vaccine does not contain any, bacterial genetic material / virulence factor ✓ vaccine does not contain bacteria that could replicate ✓	1	**IGNORE** ref to viruses **ALLOW** DNA / nucleic acid / nucleus **DO NOT ALLOW** RNA **Examiner's Comments** Candidates struggled with **(a)(ii)**. Most candidates stated that the pathogen could not cause disease but failed to elaborate on what that actually means. Candidates should realise that pathogens cause disease by being able to replicate and then release toxins/destroy cells.
		iii	(because) related strains of bacteria have, similar / same, antigens / glycoproteins / surface proteins ✓ antibodies (produced after vaccine), recognise / AW, antigens on (these) related strains of bacteria ✓	1	**Examiner's Comments** In responses to **(a)(iii)** , most candidates showed a good understanding of antigens being similar but often stated between meningococcal infections without stating bacteria. Candidates should appreciate that structural features, like antigens, should be discussed in the context of an organism not in the context of a possible consequence of that organism. Few candidates related antibodies to binding to the antigens, instead the secondary response was discussed in general terms only or antibodies were mentioned as being more effective, without reference to binding or recognition.

Question			Answer/Indicative content	Marks	Guidance
	b		*Summary of instructions to markers:* *Read through the whole answer.* *(Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1**, **Level 2** or **Level 3**, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the **Communication Statement** (shown in italics):* ◦ award the higher mark where the Communication Statement has been met. ◦ award the lower mark where aspects of the Communication Statement have been missed. • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.***		
			Level 3 (5—6 marks) A comprehensive evaluation of the importance of herd immunity in the control of epidemics, including risks and benefits of vaccination. A reasoned conclusion is drawn about the benefits to society and/or the individual resulting from herd immunity including ethical issues. *There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** A limited evaluation of the importance of herd immunity, with some reference to risks and/or benefits. An attempt is made to link ethical issues with the benefits of	6	**Indicative scientific points may include:** Epidemic is a sudden increase in incidence of infectious disease in an area. **Herd immunity** Successful vaccination programme requires large population to be immune. Can eradicate an infectious disease Reduces chances of pathogen being passed on, so reduces risk of epidemics. Requires 80 – 95% of population to be immune. Depends on how easily pathogen is spread. Reference to ring vaccination **Vaccination risks** Live-attenuated vaccines may revert and cause disease.

Question			Answer/Indicative content	Marks	Guidance
			herd immunity. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.* Level 1 (1–2 marks) A description of herd immunity and link to epidemics. Little or no mention of risks or ethical issues. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* 0 marks *No response or no response worthy of credit.*		Possibility of allergic reaction / anaphylaxis / side effects May not be effective in all individuals due to genetic differences Reference to discredited study of MMR risks. Ethical issues Balance between individual's right to refuse consent and need to establish minimum immunity levels. Herd immunity protects those who cannot be immunised. Helps to eradicate a pathogen so it cannot spread to other countries where immunisation levels low due to socioeconomic reasons Helps to contain the spread so it doesn't reach those who cannot be immunised. Examiner's Comments was generally not well answered with many candidates failing to appreciate the relevance of herd immunity, not mentioning vaccination and just discussing immunity in general with many stating all the population being immune. The candidates that gave a clear description of an epidemic often achieved high marks as they related it well to protecting those un-vaccinated individuals and preventing the spread of a pathogen. Very few candidates discussed the risks of vaccination.
			Total	10	

Question			Answer/Indicative content	Marks	Guidance
10		i	cell wall not synthesized ✓ water enters (cells) by osmosis ✓ from higher water potential to lower water potential ✓ cells, lyse / burst ✓	Max 3	Examiner' Comments Many candidates mentioned lack of cell wall in and cell lysing **(b)(i)** but very few explained why they lysed.
		ii	human cells do not have cell walls ✓ idea that human cells do not need mycolic acid ✓	Max 1	Examiner' Comments There were a lot of vague answers to **(b)(ii)** with many candidates describing why bacterial cells are different from human cells without mentioning the cell wall.
			Total	4	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>11</td><td>a</td><td></td><td>
<table>
<tr><th>Type of vaccine</th><th>Features of the vaccine</th><th>Advantage</th><th></th></tr>
<tr><td>Live / attenuated</td><td>Non-pathogenic modified strains of , the bacteria / virus , are used</td><td>Stronger immune response
OR
long lasting immunity</td><td>✓</td></tr>
<tr><td>Isolated extracted antigens</td><td>specific antigens are used (that trigger immune response)</td><td>Can produce vaccines for different strains of bacteria / viruses</td><td>✓</td></tr>
<tr><td>Killed inactivated pathogens</td><td>pathogens killed by , heat / chemicals
OR
antigens still present (to trigger immune response)</td><td>more stable than live vaccine
OR
Safer than live vaccine
OR doesn't need refrigeration
OR
can be given to patients with weakened immune systems</td><td>✓</td></tr>
</table>
</td><td>3</td><td>Award one mark per row
Green dot to indicate a correct box (partial answer) within a row.
Examiner's Comments
Stronger candidates made a good attempt at completing the table to achieve all three marking points but some candidates struggled to correctly list a feature or an advantage to gain any credit. Some candidates could name the type of vaccine as 'live / attenuated' but few consolidated their response with an advantage of this vaccine. Both were needed for one mark.</td></tr>
<tr><td></td><td>b</td><td>i</td><td>idea that group two could be used as a comparison
OR
control group ✓</td><td>1</td><td>Examiner's Comments
Good responses showed an understanding that the other group in the trial was used as a comparison or a control. There were some misconceptions with a few candidates thinking that it was to see if the patients already had the virus.</td></tr>
<tr><td></td><td></td><td>ii</td><td>idea that healthy participants were being given untested vaccine ✓☐
idea that group 2 were being given the vaccine later than group 1✓☐
idea that group 2 were given the vaccine after known incubation time for the Ebola virus ✓☐
idea that only communities with new cases of Ebola could participate in the trial ✓☐
idea that group 2 may think that they , would be immune to / wouldn't become infected with , Ebola ✓☐</td><td>2max</td><td>IGNORE participants not having a choice

e.g. healthy people may suffer side effects

e.g. unethical to split into two groups as group 2 still exposed to Ebola
Examiner's Comments
Many candidates gained one mark, usually for reference to group 2 having to wait ten days for the vaccination and some went on to gain both marking points with excellent ideas relating to the vaccine being untested or for comments such as 'the long term effects of the vaccine are unknown'.</td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
		iii	100% effective if given immediately / AW ✓ *idea that* it is still effective after incubation period ✓☐	2max	ALLOW data processing for mp 2 e.g. only 0.5% new cases in group 2 Examiner's Comments At the end of the paper, Q25(b) (iii) proved challenging. Candidates were required to evaluate the data provided in the trial and there were vague responses which referred to the vaccine as being 'fairly' effective or 'quite' effective which were not credited. Examiners were looking for the idea that the vaccine was totally or 100% effective if given immediately as shown by the data for group 1.
			Total	8	
12			*description* 1. (small) increase in antibody concentration from ✓ 2. rapid increase in antibody concentration between days 5 and 25 ✓ 3. antibody concentration peaks at day 25 ✓ 4. antibody concentration decreases from day 25 ✓ 5. antibody concentration remains higher than before the BCG vaccine ✓ *explanation* 6. *idea* that time needed for , antigen / vaccine , to trigger immune response ✓ 7. *idea* that antibody production rises due to differentiation of (B) lymphocytes to plasma cells ✓ 8. *idea* that production and break down of antibody are balanced ✓ 9. idea that fewer antibodies produced and more broken down ✓	Max 4	ALLOW 3 max from description ALLOW 3 max from explanation ALLOW any stated day between 5 to 10 ALLOW any stated days between 5 to 10 and 25 to 30 ALLOW antibody concentration peaks between days 25 and 30 ALLOW any stated day between 25 to 30 Examiner's Comments On the whole, candidates were able to describe the pattern in the graph but usually found it more difficult to explain the pattern. This was the case even with higher ability candidates that seemed to know the topic. Candidates need more practice linking their scientific knowledge to patterns and trends obtained from unfamiliar data.
			Total	4	